OAEx Experiment 2010

OAEx'10 Experiment

DATA REPORT

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OAEX'10

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Introduction

The worldwide concern about the processes of climate changes has increased the pressure for the implementation of systems capable to provide a detailed environmental monitoring of the oceans. A central aspect of this issue is the need for time series of long observation period, both in coastal and in deep water. This requirement has prompted the scientific community to develop long-term plans for the observation of the oceans in terms of physical, chemical, geological and biological processes in real time through the concept of marine observatories.

The Project for International Cooperation, Acoustic Ocean Exploration (OAEx), aims to develop synergies and enhance technical collaboration between Brazil, European Union and Canada in the field of ocean monitoring by acoustic methods and technologies. In this context, OAEx will contribute to a better understanding of the global oceans, through the exchange of experiences and the use of underwater acoustics for geophysical exploration, monitoring ocean circulation and underwater acoustic communications.

The Program OAEx allows the transfer of knowledge among participants to increase their individual expertise, to be applied in future projects. Specifically, the development of techniques for environmental monitoring of the oceans by acoustic remote sensing and underwater acoustic communications techniques that can be integrated and applied to monitor the strategic and complex region oceanographically adjacent to IEAPM, more exactly the area of upwelling of the coast of Arraial do Cabo – RJ.

This report describes the acoustic and oceanographic activities and the data set acquired during the OAEx'10 cruise, that took place on the sea area of Arraial do Cabo, Brazil, from 19th to 22nd November, 2010. The OAEx'10 was a CINTAL, IEAPM, ULB and COPPE joint experiment coordinated by IEAPM within the scope of the FP7 – OAEx project, and its objectives were in line with the objectives of the OAEx project. In this aspect, five tasks were performed during the sea trial in order to accomplish the following objectives:

- To support the investigation of performance characteristics required for acoustic environmental monitoring;
- To support the definition of the requirements and suggestion of methodologies for the implementation of a generic monitoring network in Cabo Frio (Brazil);
- To carry out acoustic measurement for geoacoustic inversion aiming at the characterization of the sub-seafloor in order to complement previous geophysical survey of the area including core and seismic profiling analysis;

- To support task 2.2 of the OAEx work plan, as well as to partially perform the work covered by task 2.3 on underwater communications by performing tests in Cabo Frio instead of at the C-MARS test site in Canada;
- To collect real data to support task 2.4 of the OAEx work plan on "Real data analysis" contributing for project outcome as a whole and to WP3; and
- To carry out acoustic measurements in concomitance to oceanographic survey at high resolution in support of forecasting and the future validation of acoustic tomography methodologies developed during the first year of OAEx project.

The present report has the following organization. In Chapter 1 we have the description of the Sea Trial. In Chapter 2 we have the equipments used in the experiments along with the transmitted signals and an introduction to the received ones. Chapter 3 is the description of the geologic information gathered for the sea trial and the Chapters 4, 5, 6, 7 and 8 presents the activities conducted in order to fulfill specific tasks of the OAEx Test Plan, namely: Oceanographic Survey, Upwelling Tracking and Communication, Beta invariant parameter, Propagation Model Evaluation and Geoacoustic Inversion. In Chapter 9 we conclude and devise the next steps of the present project and future work.

Chapter 1

The OAEx'10 Sea Trial

The OAEx'10 has been based in the OAEx'10 Test Plan. It occurred close to IEAPM, located on Arraial do Cabo City, where the Cabo Frio cape (Figure 1) is a feature strong correlated to a major upwelling phenomena, driven by northeasterly winds. At this area, the shore line has a strong change in direction from NE/SW to E/W and depths of about 50 meters reach the coast on steep gradients followed by a small gradient from 50 to 150-meter depths that occurs at about 40 kilometers offshore. The region is subject to many different winds and waves regimes depending on the passage of meteorological frontal systems and mesoscale oceanographic features. Climate variability transforms the area around IEAPM into a very interesting place for acoustic research where different sound speed profiles can be found including temperature inversions where the upwelling features are abruptly interrupted by strong frontal system moving NE.

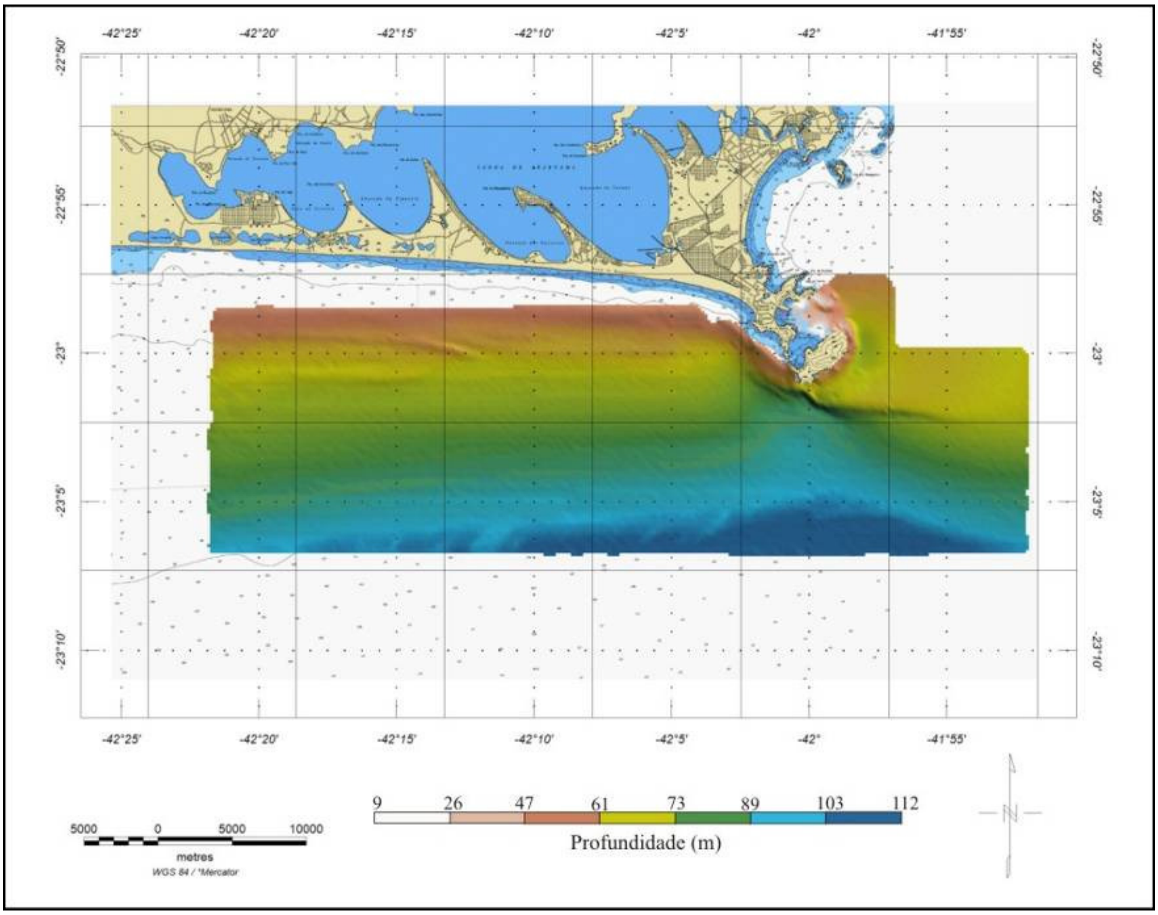

Figure 1 - Experiment Area

The work area was bounded by the following coordinates:

Table 1 - Experiment Area Coordinates.

POSITIONS	LATITUDE	LONGITUDE
1	22º55'000 S	41º55'000 W
2	23º10'000 S	41º55'000 W
3	23º10'000 S	42º15'000 W
4	22º55'000 S	42º15'000 W

The sea trial lasted 4 days, from 19 to 22 November 2010, being the first and second days of the cruise used to perform experiments of upwelling tracking and communications. For the trial's experiments two ships were used one with the transmission equipments (AvPq “Asp Moura”) and another with the reception equipments (EDCG “Guarapari”). These ships can be seen in the Figure 2 below. Transmissions and receptions schema, positions and distances will be described later.

Figure 2 – Experiment's Ships: "Aspirante Moura" (left) and "EDCG Guarapari" (right).

On the third day the experiments aim at the test of acoustic forward models and ship's cavitation recording. At last on the fourth day it has been performed the experiment for seabed characterization using geoacoustic inversion. This experiment took advantage from previous geological cores collected and analyzed by IEAPM researches used as ground proof for inversion results confirmation.

In order to control the sound speed field CTD casts were acquired during the experiments. Despite the casts collected during acoustic experiments a complete CTD (conductivity, temperature and depth) survey were performed during three consecutive nights on the stations shown in the Figure 3 below:

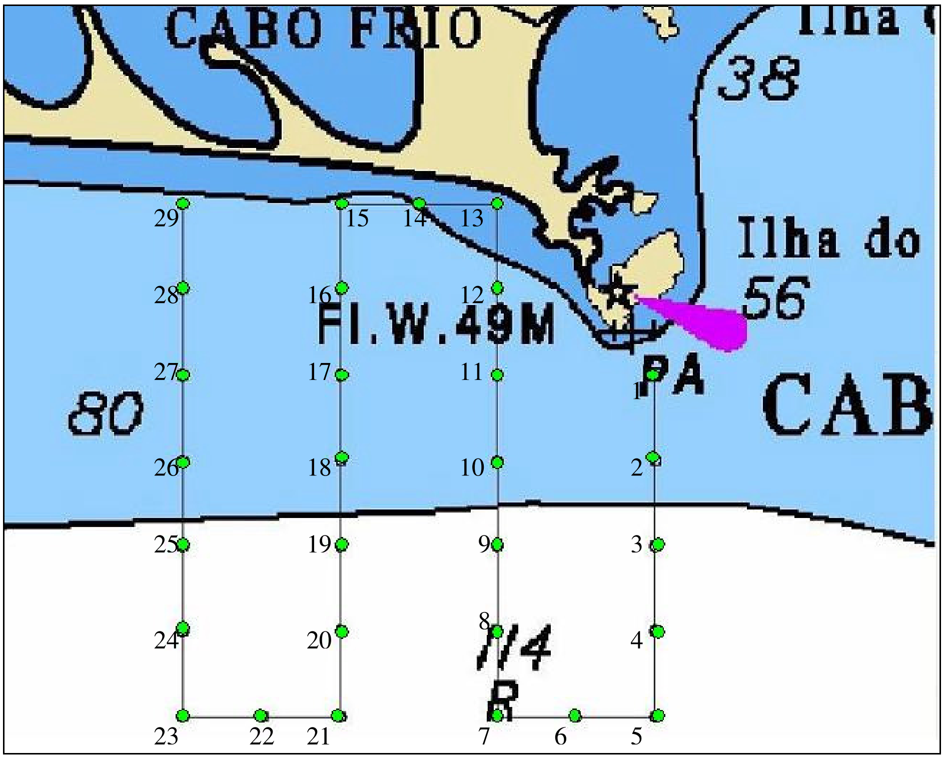

Figure 3 - Oceanographic Operation Area.

The CTD events have been planned to be performed on the following coordinates shown on Table 2. The coordinates of the actual points are described in the Chapter 4 along with all the other oceanographic data gathered in this sea trial.

Table 2 – Planned CTD's Events Coordinates

EVENTS	LATITUDE	LONGITUDE	EVENTS	LATITUDE	LONGITUDE	EVENTS	LATITUDE	LONGITUDE
1	23º02'000 S	41º59'000 W	11	23º02'000 S	42º03'000 W	21	23º10'000 S	42º07'000 W
2	23º04'000 S	41º59'000 W	12	23º00'000 S	42º03'000 W	22	23º10'000 S	42º09'000 W
3	23º06'000 S	41º59'000 W	13	22º58'000 S	42º03'000 W	23	23º10'000 S	42º11'000 W
4	23º08'000 S	41º59'000 W	14	22º58'000 S	42º05'000 W	24	23º08'000 S	42º11'000 W
5	23º10'000 S	41º59'000 W	15	22º58'000 S	42º07'000 W	25	23º06'000 S	42º11'000 W
6	23º10'000 S	42º01'000 W	16	23º00'000 S	42º07'000 W	26	23º04'000 S	42º11'000 W
7	23º10'000 S	42º03'000 W	17	23º02'000 S	42º07'000 W	27	23º02'000 S	42º11'000 W
8	23º08'000 S	42º03'000 W	18	23º04'000 S	42º07'000 W	28	23º00'000 S	42º11'000 W
9	23º06'000 S	42º03'000 W	19	23º06'000 S	42º07'000 W	29	22º58'000 S	42º11'000 W
10	23º04'000 S	42º03'000 W	20	23º08'000 S	42º07'000 W			

Chapter 2

Acoustic data set

2.1 - The Acquisition System

In this experiment two sets of equipments were used, one in the transmitting ship and other in the receiving one, as follows:

2.1.1 - Equipments of the transmitting ship

Ship: Aviso de Pesquisas "Aspirante Moura"

1. Notebook HP model Compaq 6710b, Intel Core2Duo T5470@1,60GHz, 1Gb RAM, HD 100Gb, Windows 7 Professional;
2. Lubell Underwater Acoustic Transducer, model LL-1424HP (Appendix B);
3. Lubell Bridging Transformer, model AC1424HP;
4. Harman Power Amplifier, line CROWN, model CDi2000;
5. ITC Hydrophone model 1032 (Appendix C);
6. GPS from M.E. Comp e Equip. Eletr., model ME-2000RW (Appendix D);
7. DATALOG pressure sensor.

2.1.2 - Equipments of the Receiving Ship

Ship: EDCG "Guarapari"

1. Vertical Array of 8 hydrophones model PI00-153-8229 at 3 meters of distance each other;
2. Signal Data Acquisition Equipment of Astro Med model DASH8HF-HS (Appendix E);
3. Notebook DELL model INSPIRON 15, Pentium 4 Dual Core@2.16GHz, 3Gb RAM, HD 250Gb, Windows Vista Professional;
4. GPS from M.E. Comp e Equip. Eletr., model ME-2000RW (Appendix D);
5. No-Break

Two different arrangements were performed, one in the transmitting ship and other in the receiving one, according to the purpose of each one, as follows:

2.1.3 - Transmitting Ship Arrangement

In order to perform the acoustic signal transmission the equipments of the transmitting ship were configured according to the Figure 4 below:

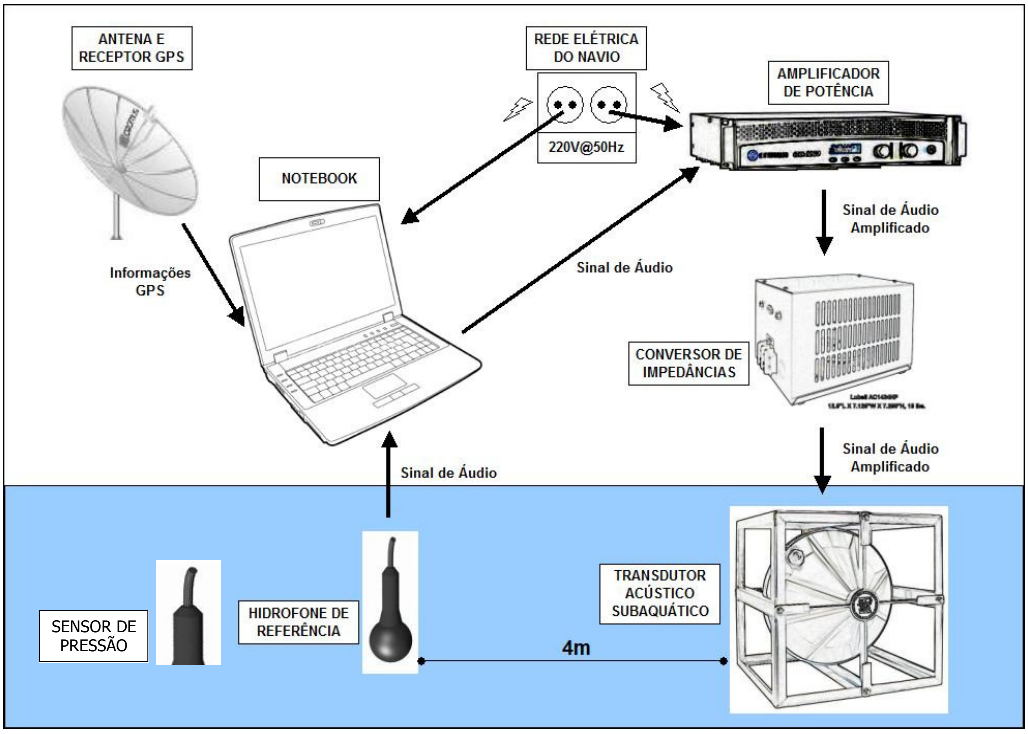

Figure 4 - Transmitting ship equipment's arrangement

We can see the notebook as signal generator at the same time that it receives and processes the GPS and the reference signals. The pressure sensor data is stored on an internal datalogger to be extracted later in a convenient time. This sensor was deployed at the transducer to log its actual depth that was intended to be 8 meters but had some variations due the water dynamics.

2.1.4 - Receiving Ship Arrangement

In the receiving ship, two independent systems were being used, one for the array's signal data acquisition and other for the GPS's data acquisition. The arrangement is as follows in the Figure 5:

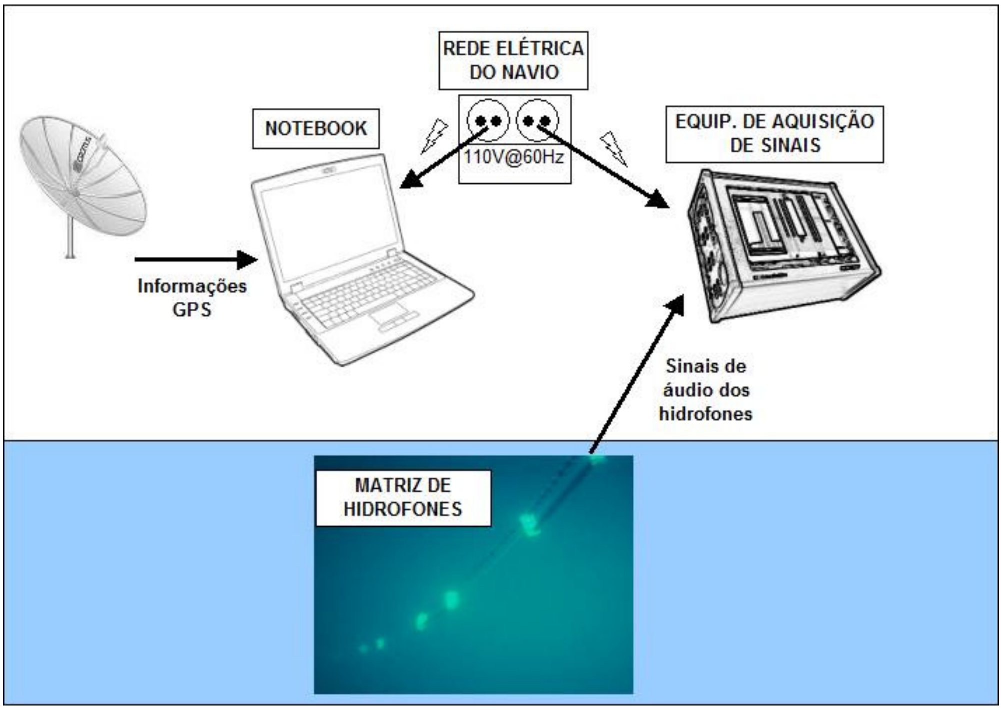

Figure 5 - Receiving ship equipment's arrangement

The array was composed by eight hydrophones, numbered from one to eight, whereas the deepest is numbered one and the shallowest is numbered eight. The predicted depths of each hydrophone are in the Table 3 bellow:

Table 3 - Array's Hydrophones depths.

Hydrophone number	Depth [m]
1	25
2	22
3	19
4	16
5	13
6	10
7	7
8	4

Since the acquisition system was a proprietary embedded system, the software used to perform the records was from the equipment supplier, namely Astromed. For each of the eight hydrophone's channels, the acquisition sample rate was 20,000 S/s, resolution of 16bits, anti-aliasing filter at 8 kHz and channel spam of 0.2V. The acquired data was stored in a proprietary binary file format with extension ".DCR" during the experiment and, after the conclusion of it, converted to wave files using a program called FlexPro8.

Furthermore, the GPS positioning system program used in the two ships to log their locations was a Simulink script running under MatLab program. This script performed the control and the interface between the GPS device and the PC computer, along with the properly organization of the GPS strings received every ten seconds. Figure 6 shows this Simulink model. Note that in this scheme, along with the modules to manage the GPS, there are another two modules to control and record the signal from an audio input port, this signal is from the reference hydrophone.

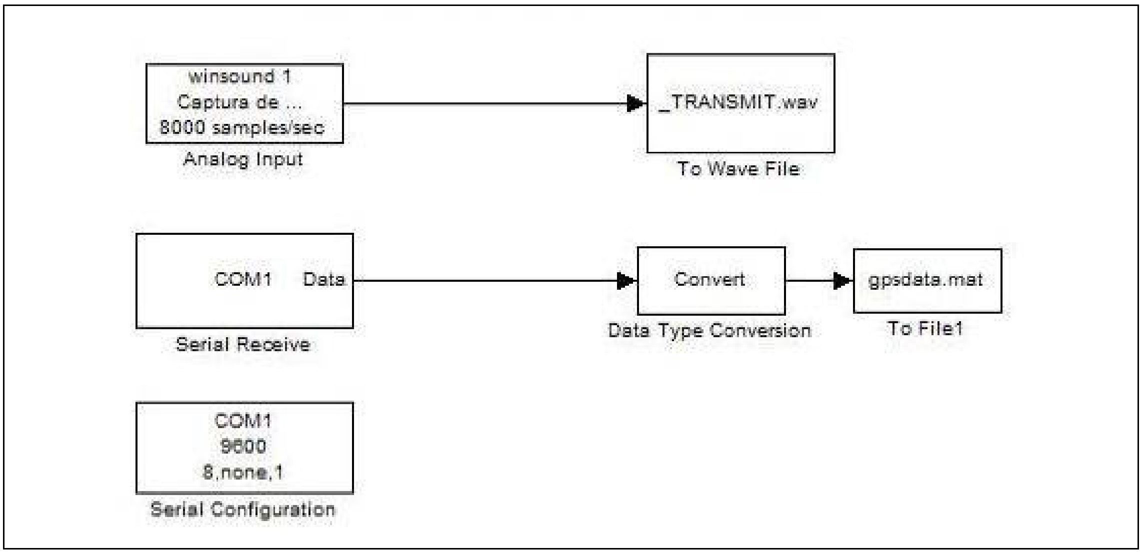

Figure 6 - Simulink model for GPS data control

2.2 - Calibration Information

In order to prevent equipment damage, the source was not used in its nominal full power, which is 13A. It was limited to a safe limit according to the signal being transmitted to prevent exceeding the maximum current in the transducer due to the different characteristics of the signals. The reference values of the output currents for each transmitted signal are in the Table 4 below. From these values it is possible to calculate the Sound Pressure Level (SL) produced at the source.

Table 4 - Reference Currents at the Source.

Output Current at Transmission		
Signal	**Current at the Source @ 1kHz [A]**	**SL @ 1kHz [dB] (1m dist.)**
ULB	3,74	184,60
UALG	2,87	182,35
IEAPM	5,14	187,29

Table 5 below presents the sensitivity data of the 8 hydrophones of the array. These values are in dB and are referred to a sensitivity of 1Volt/uPascal.

Table 5 - Array's Hydrophones Sensitivity

Freq. [Hz]	200	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	8500	9000
Hydro. 1 [dB]	-185	-179	-176	-175	-174	-174	-173	-173	-173	-175	-176	-177	-177	-178	-179	-182	-183
Hydro. 2 [dB]	-185	-180	-176	-176	-175	-175	-176	-175	-176	-176	-178	-178	-178	-179	-179	-181	-182
Hydro. 3 [dB]	-184	-179	-178	-176	-175	-176	-176	-175	-176	-178	-178	-177	-180	-180	-182	-182	-183
Hydro. 4 [dB]	-184	-178	-174	-173	-173	-173	-172	-173	-173	-173	-174	-174	-176	-176	-177	-178	-184
Hydro. 5 [dB]	-191	-181	-176	-176	-175	-175	-175	-175	-176	-176	-177	-178	-179	-180	-181	-185	-185
Hydro. 6 [dB]	-184	-178	-174	-173	-172	-172	-172	-172	-173	-173	-175	-175	-177	-177	-177	-180	-180
Hydro. 7 [dB]	-184	-179	-174	-173	-172	-173	-172	-173	-173	-175	-175	-176	-176	-177	-177	-179	-179
Hydro. 8 [dB]	-181	-176	-174	-174	-173	-173	-173	-174	-174	-175	-176	-176	-178	-178	-178	-179	-180

Figure 7 below shows the sensitivity data displayed at Table 5 plotted for graphical reference.

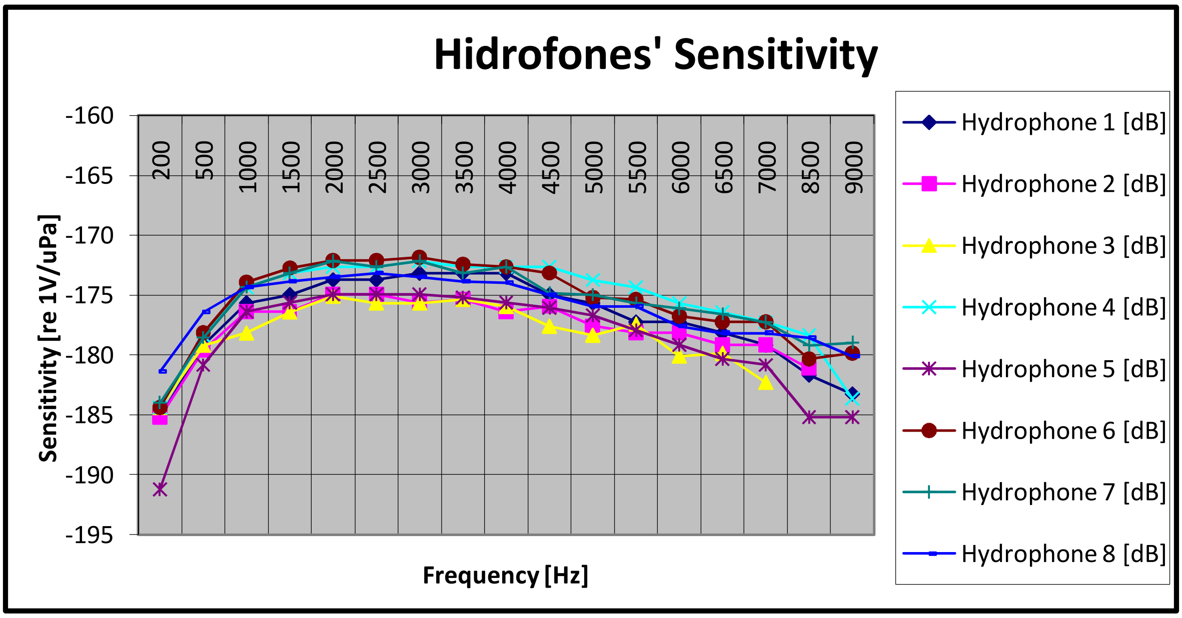

Figure 7 - Hydrophone's Sensitivity Response Curve

2.3 - Acoustic Signals

2.3.1 - Transmitted Signals

For this experiment, different signals were created by the participant institutes, according to the purposes of their experiments. Following, we can see the spectrogram and the description of these signals.

2.3.1a - Signal IEAPM (Sample Rate: 44100Samples/s; Resolution: 16bits):

This signal is a sequence of constant waves (CWs) at the frequency of 3500Hz with duration of 0.5s each CW and interval of 7s between two consecutive ones, as we can see in the Figure 8 below:

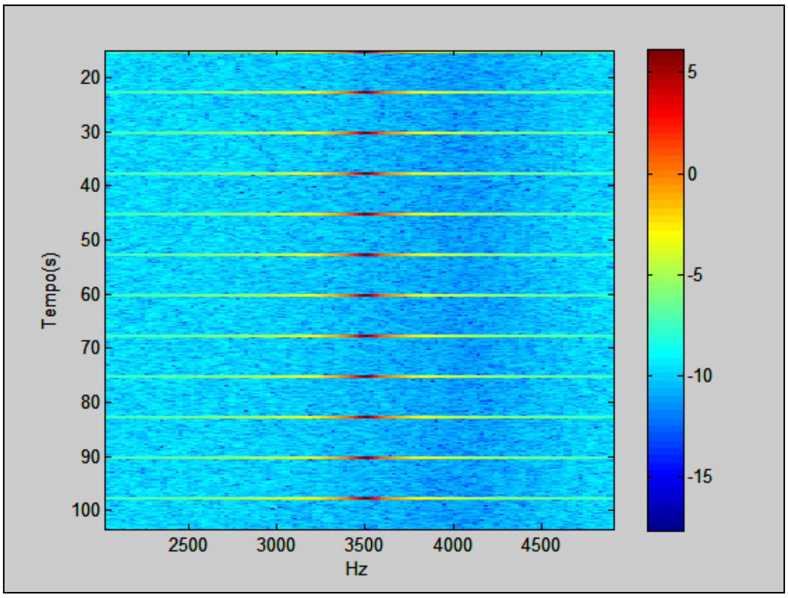

Figure 8 – Signal IEAPM, consecutive short time CWs of 3.5kHz.

2.3.1b - Signal LFM e Multi-tone, from ULB (Sample Rate: 44100Samples/s; Resolution: 16bits):

This is a sequence of two different types of signals alternated with intervals between them, Figure 9. One signal is a Linear Frequency Modulation (LFM) also called "chirp", that is a signal that starts with an initial frequency value of 400Hz and this value is shifted linearly during the time and reaches a final frequency of 800Hz.

The second signal, called Multi-tone, is composed by 20 frequencies equally spaced by 50Hz bands, using total frequency band of 500-1500 Hz.

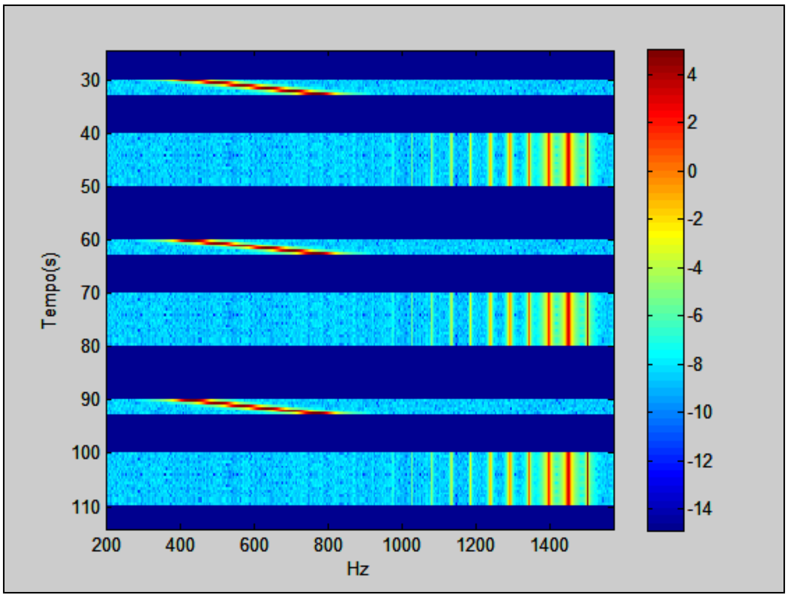

Figure 9 - LFM e Multi-tone from ULB

2.3.1c - Signal UALG (Sample Rate: 44100Samples/s; Resolution: 16bits):

This signal is shown here is divided in two groups, the first, shown in the Figure 10, is composed by a sequence of ten LFM patterns from 500Hz to 1kHz (lower frequencies), a sequence of LFM patterns from 1 to 2kHz (higher frequencies) and a Multi-tone from 500Hz to 2kHz with nine intermediate frequencies and the other, shown in the Figure 11, is an underwater communication signal that has some different types of modulations and rates of data transmission:

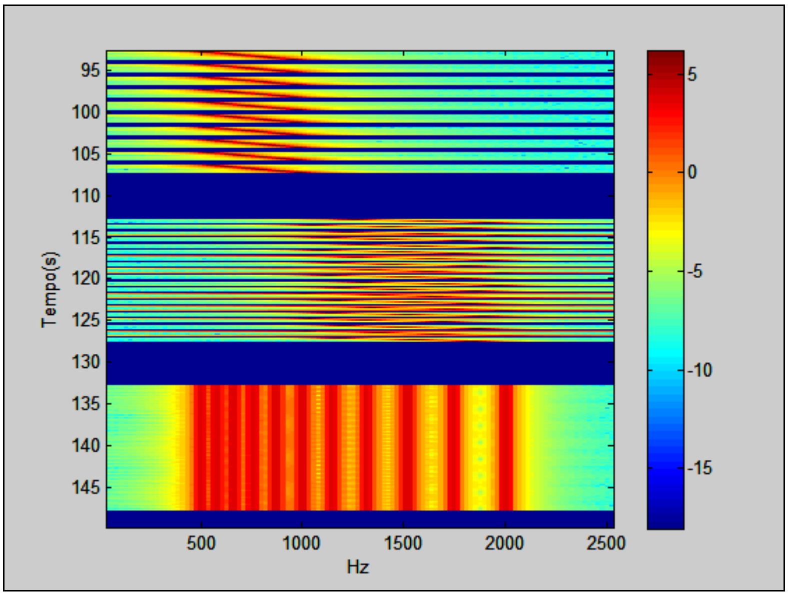

Figure 10 - LFM (2 bands) e Multi-tone from UAlg

2.3.1d - Underwater communications, from UAlg (Sample Rate: 44100Samples/s; Resolution: 16bits):

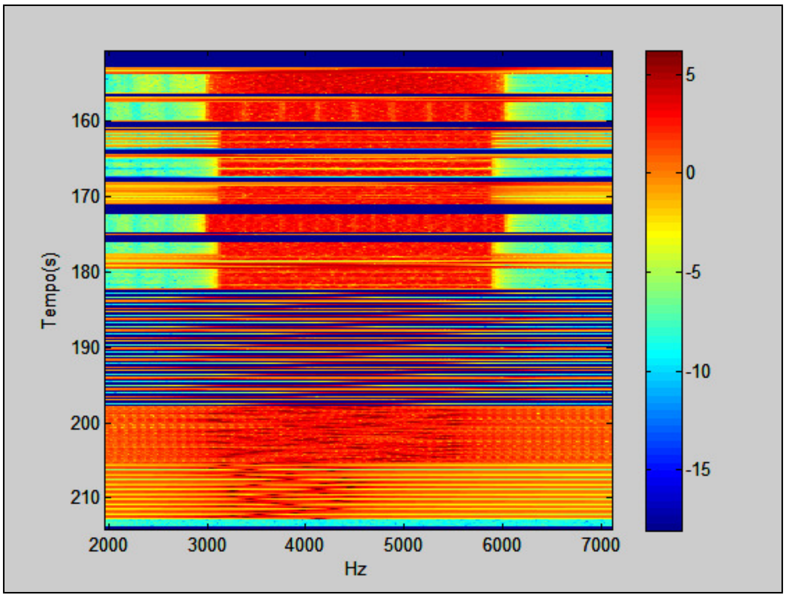

Figure 11 - Underwater communications from UALG.

2.4 - Received Signals

From the acoustic experiments performed in the task 2, a database has been created (Appendix A). First we have organized all the pairs of transmission and its reception in order to have all the metadata of them available for further analysis, doing this way, we have organized all the records of the hydrophone's received signals that have been acquired, along with its time, geographical location and original transmitted signal.

The signal received and stored during this experiment is in general of low amplitude, due to the absence of a pre-amplifier between each hydrophone and the recorder device. However, for small/medium ranges the S/N ratio is good, permitting to distinguish the transmitted signals from the ambient noise.

From the database created, it is possible to make many different kind of analysis such as the one we can see on Figure 12 below. There, we have in the same plot the spectrogram and two LFM arrival patterns plots of the signal from UAlg. The spectrogram, at the top, shows a fragment of the received signal covering the time of one block of the signal, consisting in a series of LFM of lower frequency and of higher frequency and a multi-tone pattern. In the middle plot we have the values of the convolution between the signal received by one hydrophone and the replica of the transmitted

LFM of lower frequency. From this plot we can see the moment of the arrivals of the LFM of lower frequency. A zooming in this plot would show the successive arrivals of the LFM chirp at the hydrophone, due to interactions with the frontiers, the bottom and the surface. This arrival pattern characterizes the acoustic channel and will be explored later. In the bottom plot, we have the same of the previous one, but related to the LFM of higher frequency band.

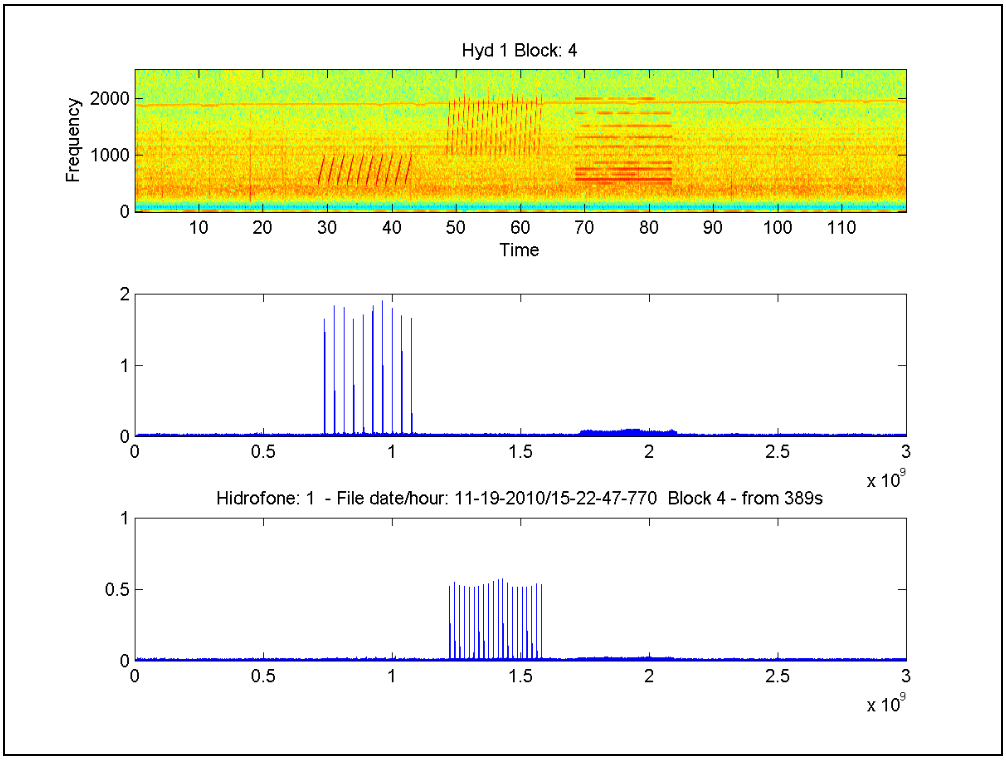

Figure 12 - Spectrogram and correlation analysis of the received signal

Another example of analysis is in Figure 13, there we can see the temporal evolution of successive arrivals of 20 LFMs from 1 to 2 kHz (equals to the LFM of higher frequencies of Figure 11), transmitted in a sequence. In the Y-axis, we have each of the 20 individual patterns, whereas in the X-axis we have the time, in milliseconds, referred to an arbitrary instant that is 20ms before each pattern arrive, doing this way we have all the patterns aligned in time and we can compare them in terms of amplitude and number of arrivals. The color, from blue (smallest) to red (greatest), represents the level of correlation between the received signal and the transmitted pattern.

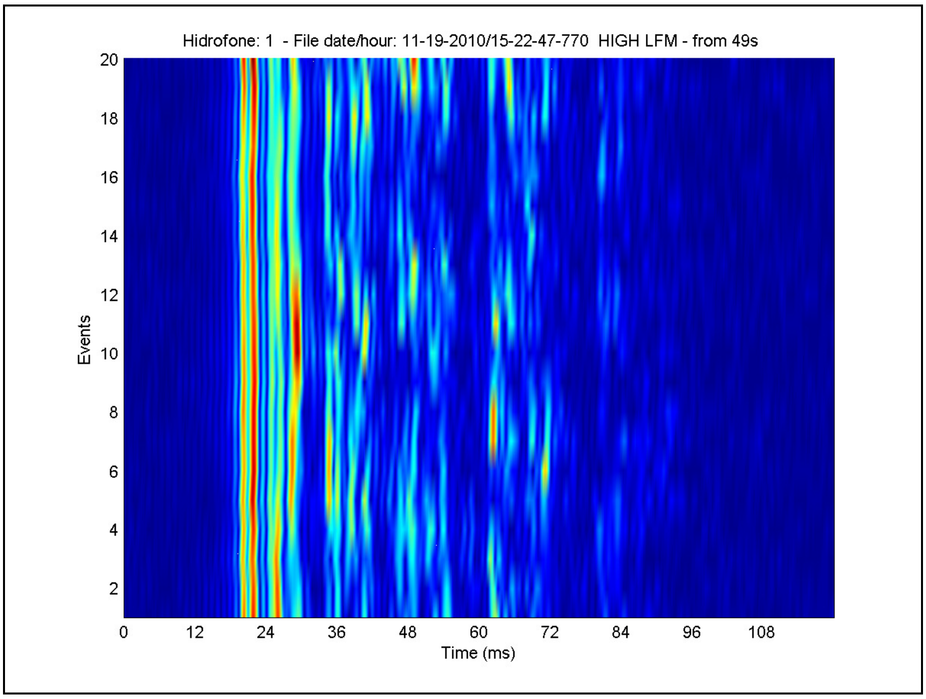

Figure 13 - Intensity and delay of the successive arrivals of the transmitted signal

Furthermore, it is possible to compare the data between different hydrophones, as we can see on Figure 14 where we have for each hydrophone the analysis of the Figure 12, considering the mean value between the 20 events for each instant of time, so each line in the Y-axis of the Figure 14 (from 1 to 8) represent one of these analysis for the respective hydrophone.

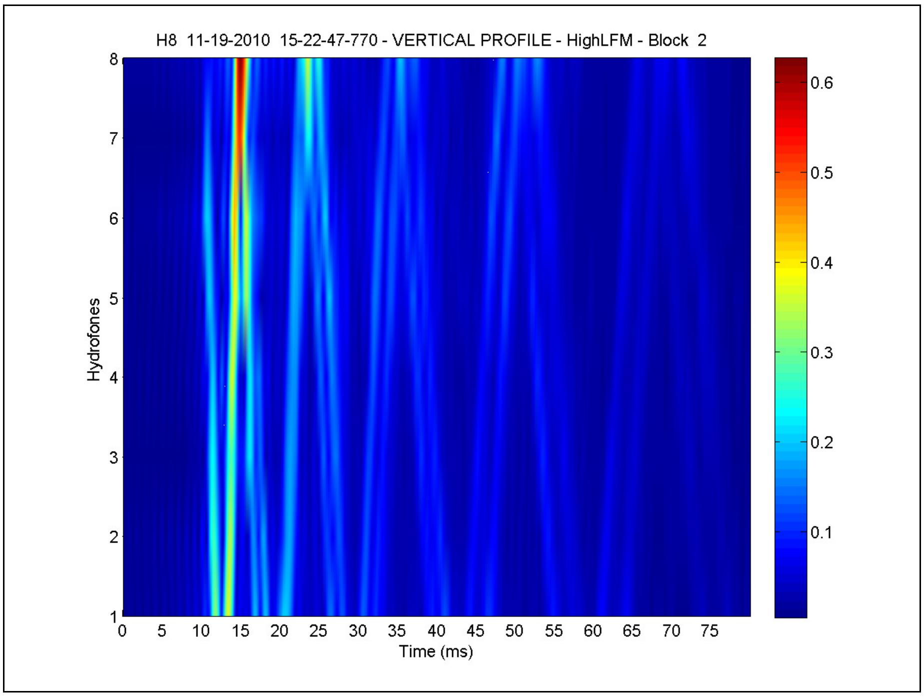

Figure 14 - Vertical Profile of the received signal

Chapter 3

Geological data set

This Chapter describes the geologic and geophysical data set provided in support to the acoustic experiment OAEx'10. The data set allowed the researchers to select the best locations to perform the acoustic transmission measurements, meaning range-dependent or range-independent. In the previous months of the experiment the geological cores were profiled and analyzed and this information has been helping to interpret the acoustic results. It is important to keep in mind that "the only utility in knowing the laboratory properties of sea floor sediments is to be able to predict them for the in situ conditions" (Hamilton & Bachman, 1982).

Acoustic propagation and reverberation in shallow waters is strongly influenced by interaction with the seabed (Hamilton, 1980). That is why geological information plays a key hole in define the geometry of acoustic experiments, improve the prediction of acoustic propagation and to validate and complement the geoacoustic inversion results.

This Chapter is divided in two parts. The first presents all the information gathered on the characteristics of seafloor and the second of the subbottom.

3.1 - General geological data

The area focused on OAEx Project is located inside the bigger one researched by IEAPM for the last ten years. It is near Cabo Frio cape (Figure 15), right in front of Arraial do Cabo city, over the inner (up to 30m of depth) and middle (up to 100 m of depth) continental shelf. The parallelism of bathymetry lines reflects the shoreline contour which, at this place, shows a strong change in direction, from NE/SW to E/W.

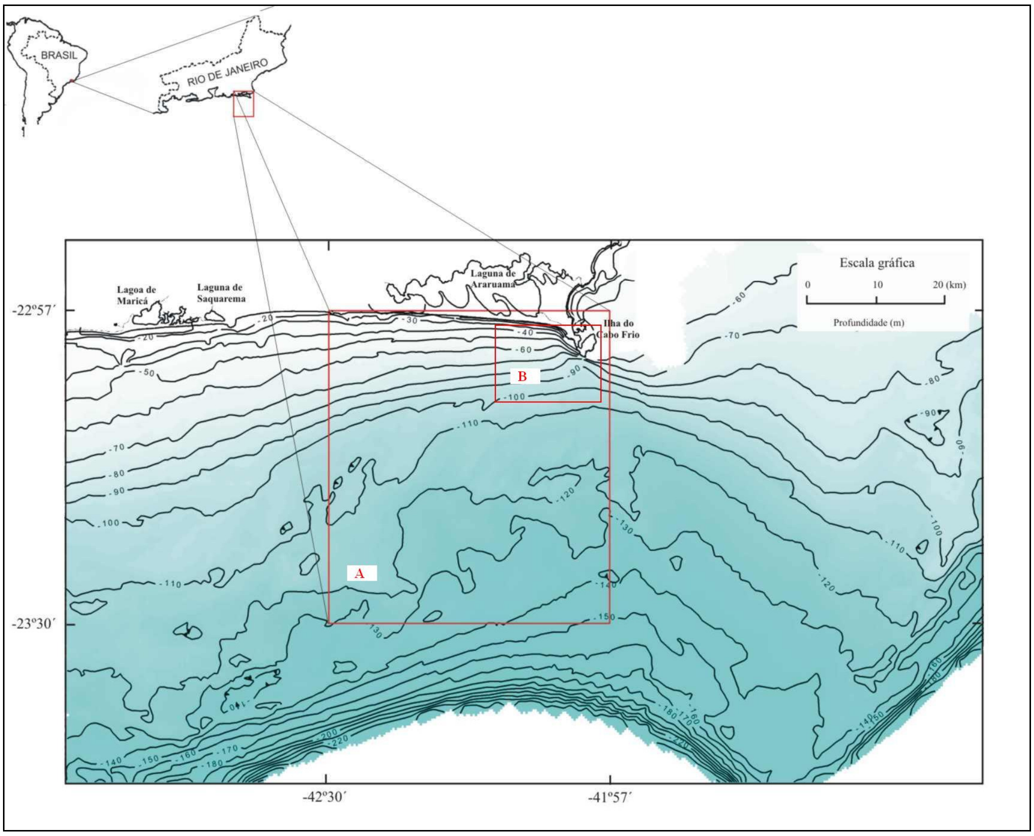

Figure 15 - Bathymetric map showing IEAPM's research area (square A) and OAEx's research area (square B).

3.2 – Seafloor

3.2.1 – Geomorphology

The bathymetry and sea floor morphology were defined using a bathymetric data set acquired with multibeam echosounder and side scan sonar.

The multibeam was a Simrad EM-1000 mounted on the hull of Taurus, a hydro-oceanographic ship owned by Brazilian Navy, on 2005. As related by Artusi (2004), the bathymetry varies between 0 and 120 m and the seafloor morphology does not presents remarkable features. Until 60 m the bathymetry lines are parallel to subparallel, becoming less parallel westward. Between 60 m and 100 m, the lines are regular and denote an homogeneous slope with gradient of 1:370 (0.15 º). After that depth the lines show irregularities meaning a more heterogeneous sea floor.

At the specific OAEx's area, the monotonous sea floor shows only two remarkable features. One is the steepy gradient of 1:25 (± 2º) at south of Cabo Frio island so that deeper depths are found closer than 300 m of distance from shore. The other feature are big old sand waves at 100 m depth, nearly symmetrical with average wave length of 2 km and maximum height of 3 m over the local sea floor (Simões, 2009) (Figure 16).

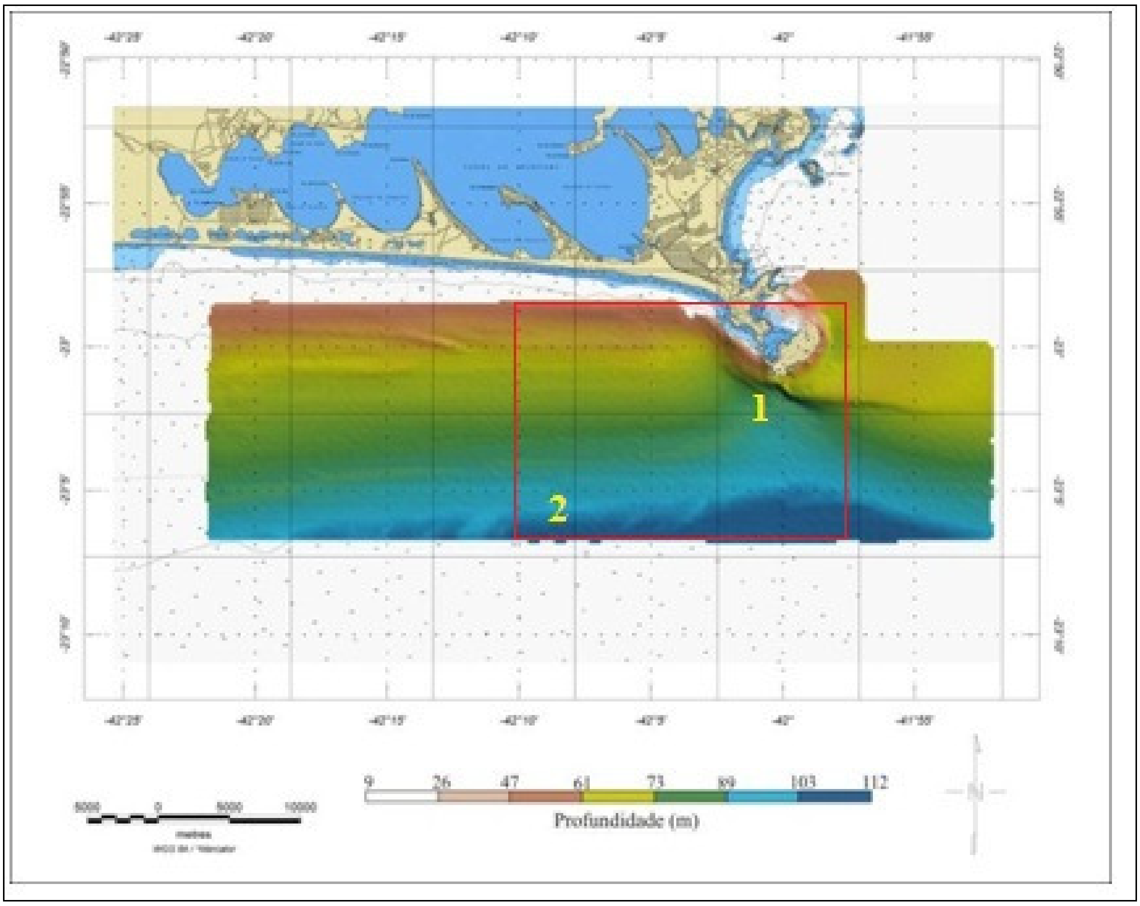

Figure 16 - Sea floor morphology at OAEx's Project (red rectangle). #1: steepy gradient; #2: big sand waves.

The sidescan sonar survey was planned to support the acoustic experiment. The dataset was acquired with a Klein sonar system serial 500 with two frequencies (100 kHz and 500 kHz), on board of Ocean Surveyor owned by Teledyne Technologies Company, in 2010, at 40 m and 60 m water depths. In both of them were observed sandy waves with ridges aligned NW/SE, distant from each other 5 m to 10 m. At 40 m depth, ripples were also identified in the NE/SW direction with length of 130 m and distance between ridges of 18 m (Figure 17).

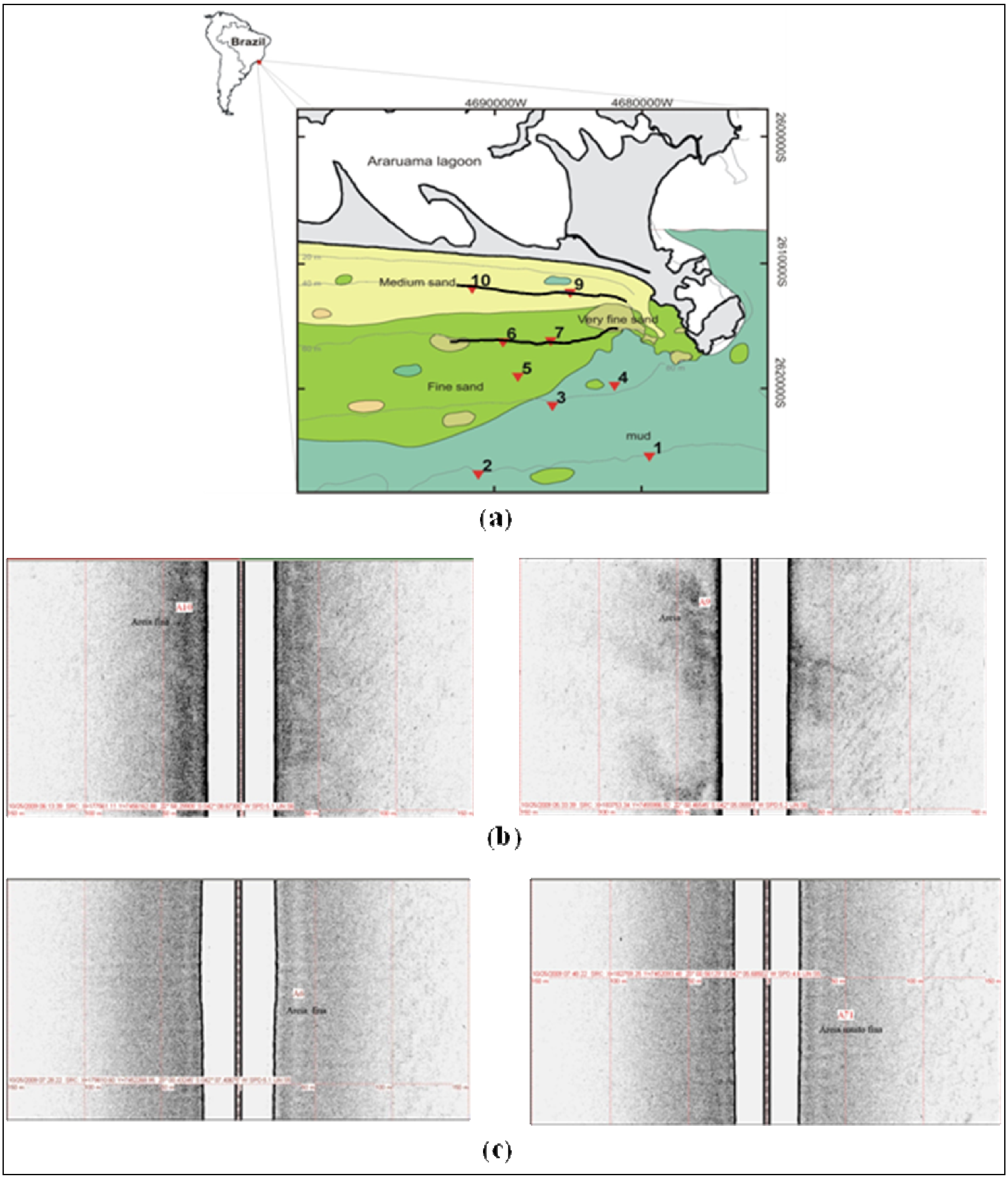

Figure 17 - Location of side-scan sonar data acquisition lines along the 40 m and 60 m isobars (a). Sonograms at the core positions 9 and 10 (b) and at the core positions 6 and 7 (c).

3.2.2 - Surface sediments

The surface sediment map of the seafloor was based on 217 grab samples (Van-Veen and Gibbs), stored in the *Banco Nacional de Dados Oceanográficos* (BNDO) of *Diretoria de Hidrografia e Navegação* (DHN). Besides these, were also considered information of the upper part of ten corers obtained for this project (Figure 18).

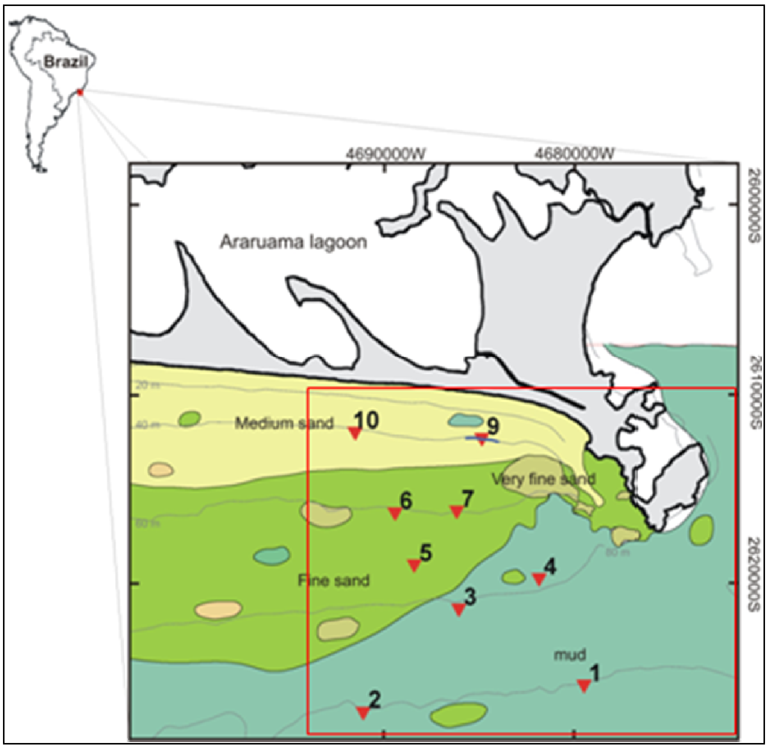

Figure 18 - Map of distribution of seabed sediments of the OAEx's project area (red rectangle) and location of sediment cores (inverted red triangles).

The distribution of sediments in inner and middle shelves, based on the average diameter, shows a distribution in concordance with the topography. There is a predominance of medium to coarse sand in the inner shelf. In the middle shelf the sediment changes from fine to very fine sand to mud (mainly silt) eastward. The content of the $CaCO_3$ is $< 20\%$ for all samples collected in this area.

Studies of ancient sea level stabilizations related to Holocene transgression, considering morphology and sediment distribution at the sea floor were done by many authors (Kowsmann & Costa, 1974 and 1978; Correa et al., 1980; Costa et al. 1988). These possible paleo-shorelines are located at approximately at 130, 110, 80-90, 60-75, 50, 32-45 and 20-25 m water depth. The identification of these paleo-shorelines should be considered in acoustic studies as it favours the consolidation of marine sediment and thus increase the compressional speed to levels characteristic of more solid material. Experiments of acoustic inversion can be compromised by incorrect identification of these layers.

3.3 - Subbottom

3.3.1 – Seismic profiles

The seismic data used are those obtained by GEOMAR XVI/1980, CENTRATLAN I/1981, GEOMAR XX/1982 and DIADORIM/2003 surveys. The analysis of seismic profiles allowed defining the acoustic basement in the inner and middle shelves. The acoustic basement consists of supposedly pre-Cambrian rock, similar to the continent emerged (Gorini et al, 1984), in this case, the rocks of the Complexo Região dos Lagos. The acoustic basement deepens eastward reaching about 60 m below the sedimentary layer near the Cabo Frio Island, and southward offshore. Its morphology, more irregular near the Cabo Frio Island, suggests that is probably composed of volcanic rocks similar to those found at emerged island (Artusi, 2007).

The seismic profiles show that the thickness of sediment increases towards the edge of the platform, while is constant laterally (Figure 19).

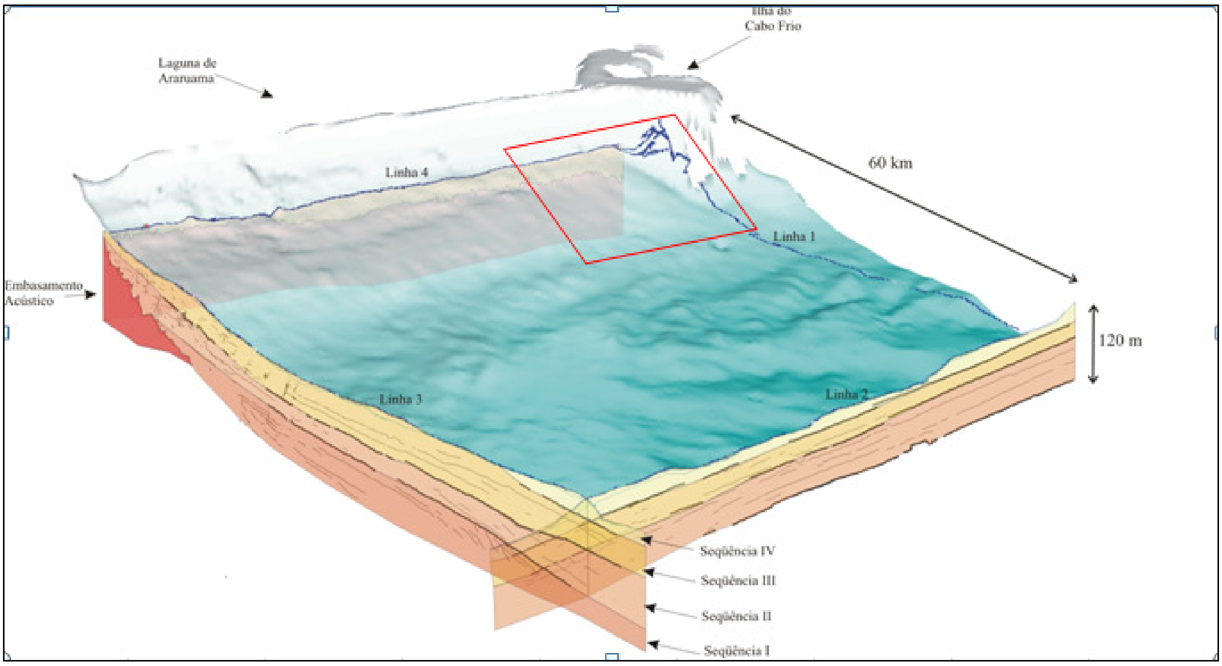

Figure 19 - Tridimensional scheme of IEAPM's research area showing the acoustic basement (red) and four sedimentary layers under the seafloor. The red rectangle represents the OAEx's Project area.

The high-resolution seismic lines obtained for the project were acquired simultaneously with the side-scan sonar, using the 3.5-kHz Geopulse Geoacoustic in the ship Ocean Surveyor, as explained previously. The maximum penetration of the seismic signal at 40 m water depth was 10 m where was resolved only one layer with a few strong and laterally discontinuous reflectors. At 60 m water depth, the maximum penetration was 6.9 m and revealed a parallel stratigraphy. At the top layer, with a 4-m thickness, were found scattered reflectors, while in the lower strata, with 2.9-m thickness, the reflectors are strong and well defined.

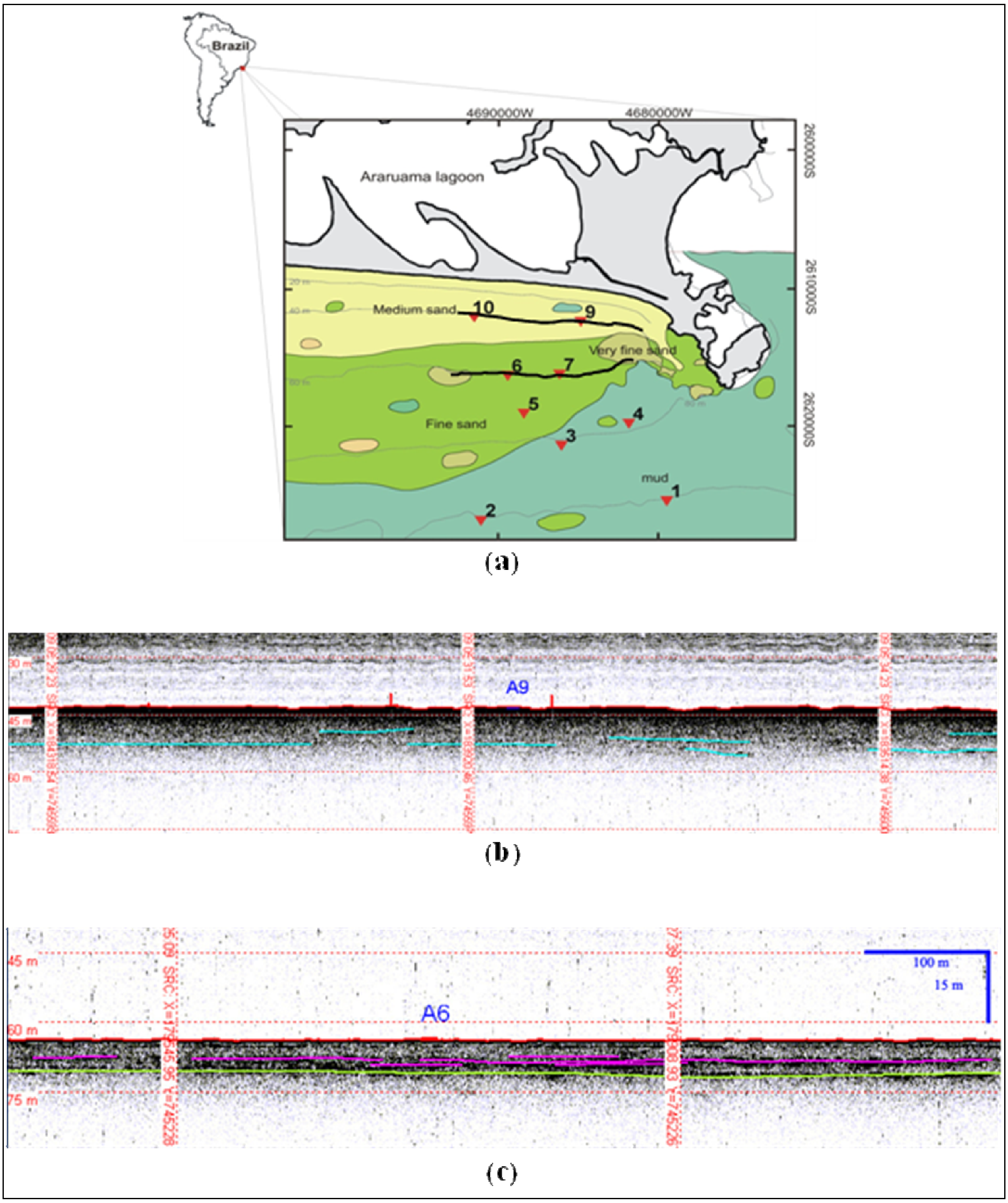

Figure 20 - Location of high resolution seismic data along the 40 m and 60 m isobaths (a). Profiles at core 9 (b) and at the core 6 (c) positions.

3.3.2 - Geological cores

Two campaigns were held to collect geological piston cores with Diadorim ship. The first one, in 2005, collected nine cores. Macedo (2009) obtained the compressional wave velocity and attenuation values for the sedimentary types found. The second campaign was in 2009 when the locations of corers were chosen taking account the local bathymetry and seafloor geology from 40 m to 100 m water depts (Figure 20), where the sediment varies from sand to mud. The longer core is 1.80-m long. All the cores were analyzed at the Universidade Federal Fluminense using the GEOTEK Multi-Sensor Core Logger (MSCL), a system to perform automated core logging that enables a number of geophysical measurements including compressional wave velocity (Vp), magnetic susceptibility and gamma ray attenuation (Figure 21).

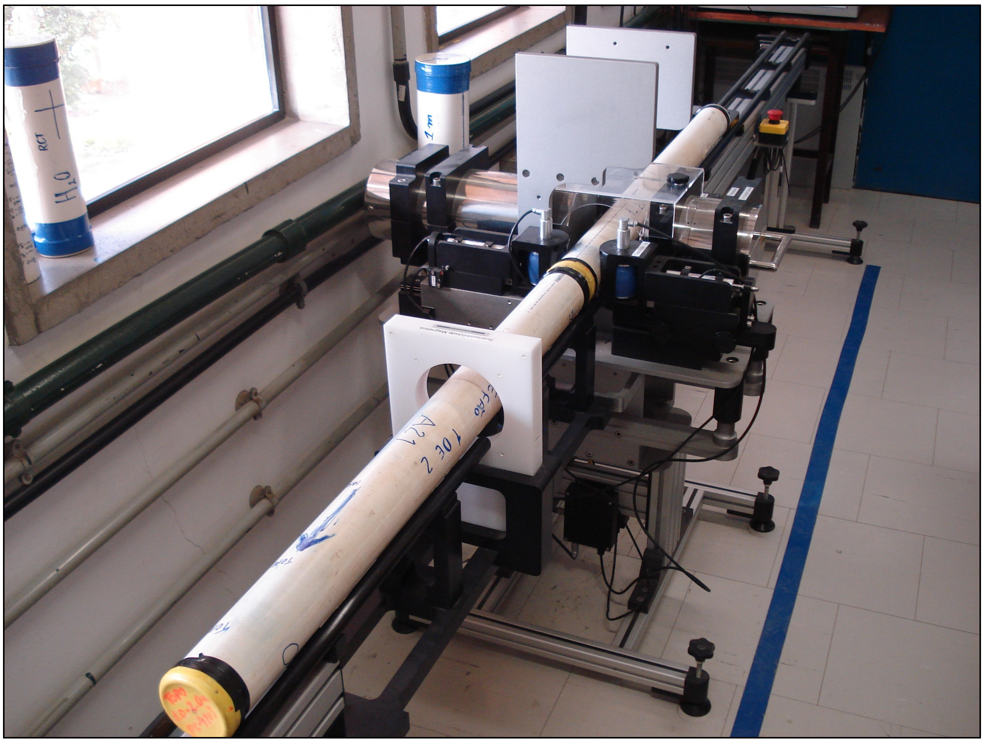

Figure 21 - GEOTEK Multi-Sensor Core Logger (MSCL).

After logging with multi sensor, the cores were sectioned in the longitudinal direction and sampled each 10 cm. The samples were divided into two fractions, one to determine CaCO3 content and other for the granulometric analys. The grain sizes were characterized following Folk&Ward (1957) methodology and Wentworth (1922) granulometric classification.

The core analysis indicated that mud content and porosity increase toward offshore and sand content, compressional wave velocity, density and impedance decrease in this direction. As indicated in the map of sediment particle size classes found were medium sand, fine sand, very fine sand, coarse silt and medium silt. For these classes average values of geacoustic parameters are listed below (Tables 6 to 9).

Table 6 - Average compressional wave velocity obtained from the sediment cores.

Sediment	Average Vp (m/s)
Medium sand (1 to 2 Φ)	1671
Fine sand (2 to 3 Φ)	1684
Very fine sand (3 to 4 Φ)	1606
Coarse silt (4 to 5 Φ)	1551
Medium silt (5 to 6 Φ)	1544

Table 7 - Average density for the sediment cores.

Sediment	Average Density (g/cm^3)
Medium sand (1 to 2 Φ)	2.191
Fine sand (2 to 3 Φ)	1.996
Very fine sand (3 to 4 Φ)	1.869
Coarse silt (4 to 5 Φ)	1.770
Medium silt (5 to 6 Φ)	1.674

Table 8 - Average acoustic impedance for the sediment cores.

Sediment	Acoustic Impedance
Medium sand (1 to 2 Φ)	3755.41
Fine sand (2 to 3 Φ)	3312.24
Very fine sand (3 to 4 Φ)	2948.03
Coarse silt (4 to 5 Φ)	2709.76
Medium silt (5 to 6 Φ)	2732.54

Table 9 - Average porosity for the sediment cores.

Sediment	Porosity (%)
Medium sand (1 to 2 Φ)	32.4
Fine sand (2 to 3 Φ)	43.7
Very fine sand (3 to 4 Φ)	51.1
Coarse silt (4 to 5 Φ)	56.2
Medium silt (5 to 6 Φ)	56.7

Chapter 4

TASK 1: Oceanographic Survey

This Chapter describes the oceanographic activities and the collected data in order to environmental characterization of the experimental area, according to the Task 1 of the OAEx'10 Test Plan. Oceanographic data were collected (raw data files) in summer local time (-2 hours from Greenwich - "O"), but they were processed (mat files) in to GMT. The CTD on board at EDCG did not work property.

4.1 - Data acquisition

Equipments:
. CTD Midas SVX 5000
. XBT T10 (6 units)

Along the trial OAEx'10, 100 oceanographic stations were performed in 4 different steps, being 6 stations profiled by XBTs and the others by CTD. The sampling period started on November 18th 2010, at 9:30pm, and ended on the 22nd, at 2:50pm. The planned oceanographic station collect grid can be observed on Figure 22.

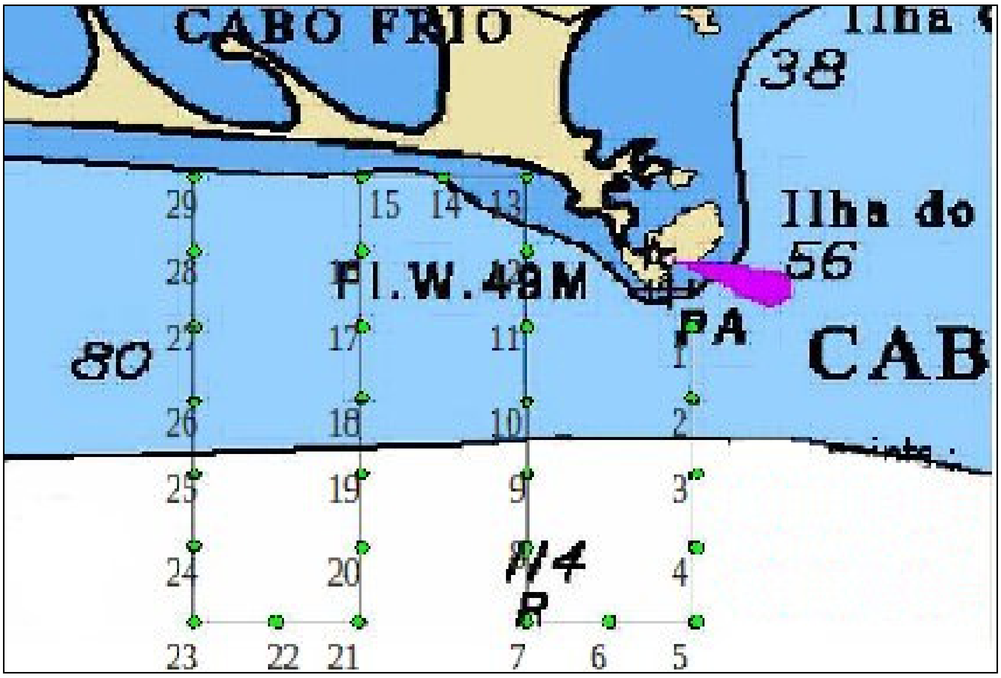

Figure 22 - Grid planned for oceanographic stations.

1st step

The activities started collecting oceanographic data at the grid area (Figure 22). At 21:30 of 18th, began with Point 01, and finished at 07:30, of 19th, at Point 26. Following the determination from the cruise coordination, the stations at points 27, 28 and 29 were aborted. At points 6, 11, 16, 18, 20 and 23, the sampling was performed with XBTs. In the Figure 23 we can se the grid for this step:

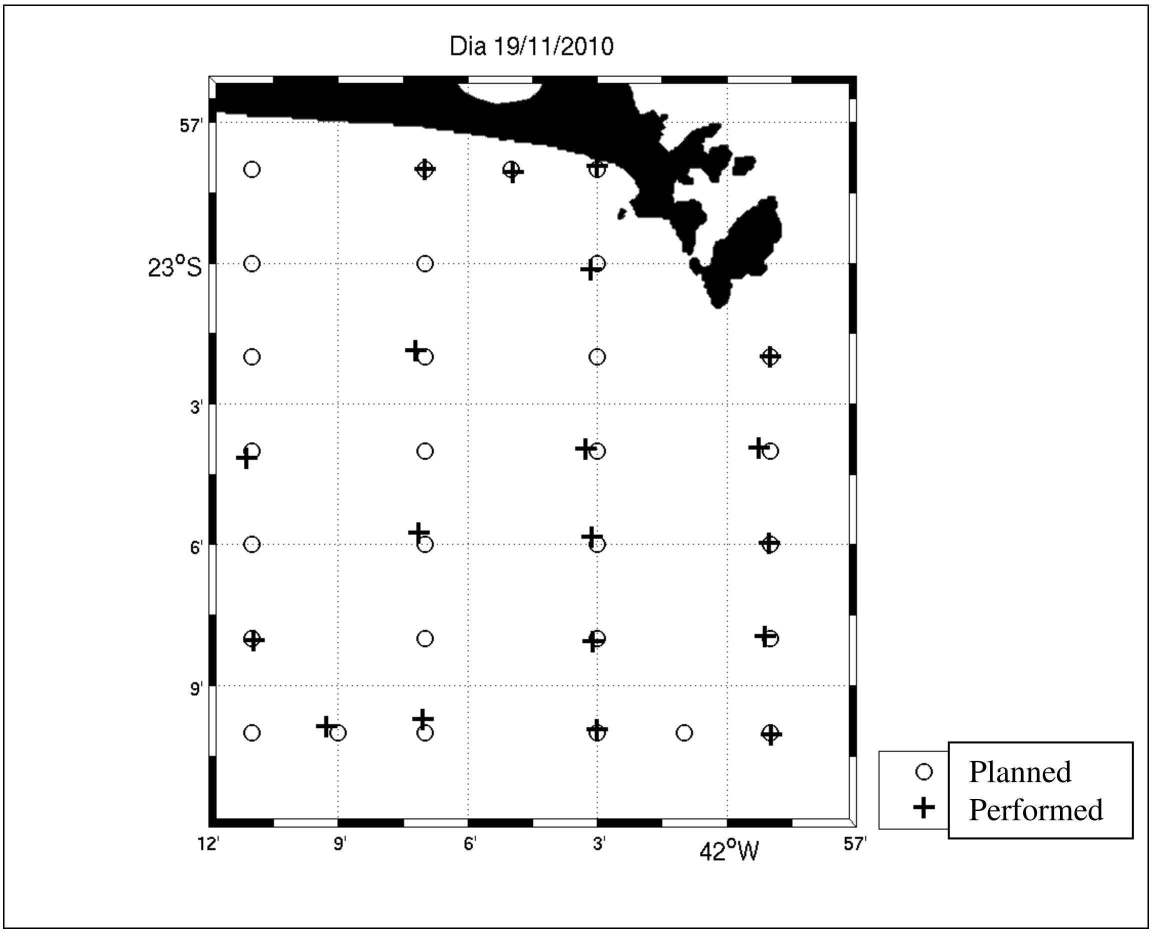

Figure 23 – Grid of the oceanographic stations performed in the first step.

From 10:20am until 05:27pm of 19th, CTDs sampling were performed to support the acoustic experiments. Initially, we planned to use XBTs to optimize collected time. However, there were no significant difference in the sampling time between the stations carried out with XBT and CTD. Thus, the planned XBTs oceanographic stations in the other stages were canceled and replaced by CTD stations.

2nd step

The second phase of data collection began at 06:44pm, on 19th, with CTD sampling at point 29.

This was covered on the reverse, being completed on Point 1, at 05:58am, on 20th. According to the relative available time, regarding previous stages, only the point 6 was aborted. The performed grid in this step is in the Figure 24?

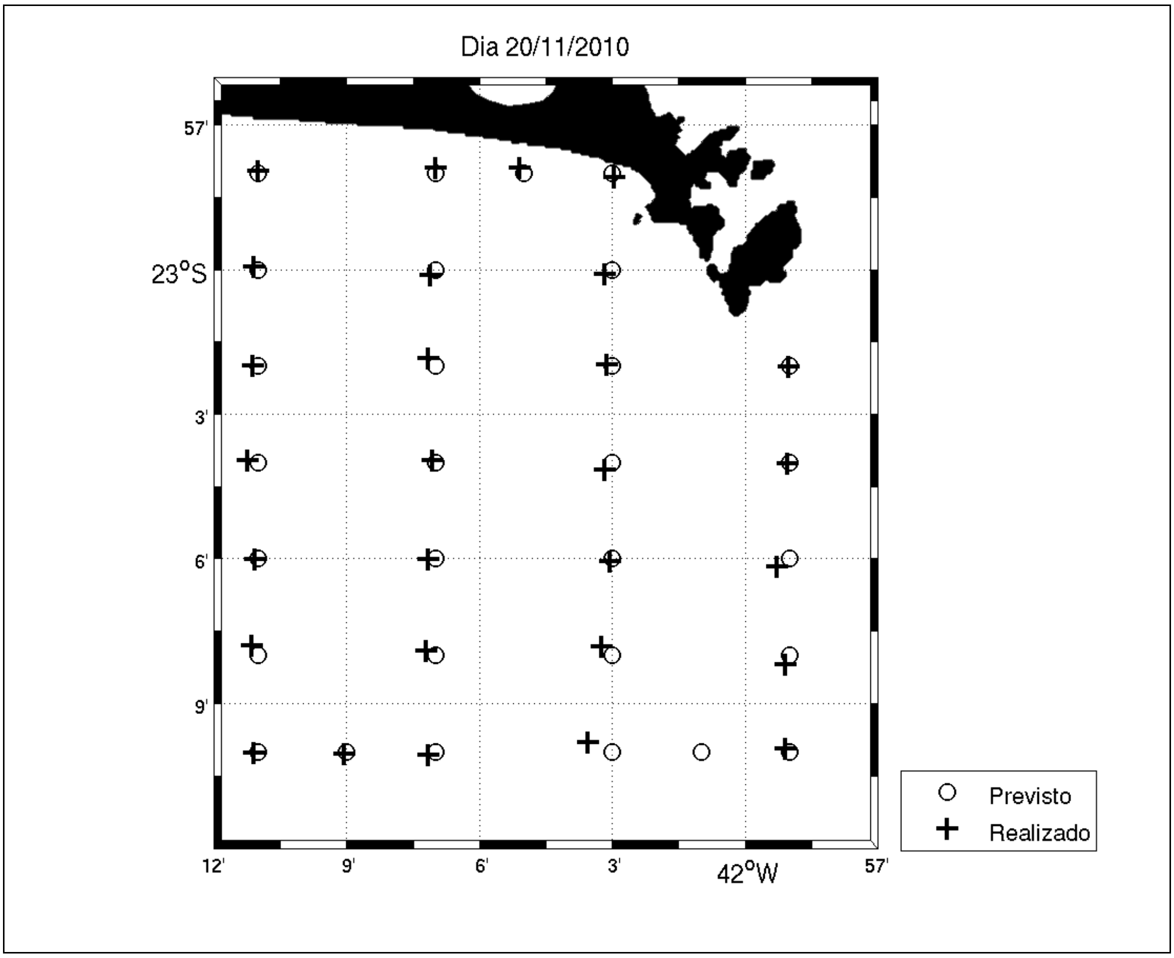

Figure 24 – Grid of the oceanographic stations performed in the second step.

The temperature and salinity profiles, collected to support the acoustic experiments, began at 09:28am, on 20th, and ended at 06:04pm, at the same day, with a total of 7 samples in this interval.

3rd step

For the third step, the grid of oceanographic sampling was changed to optimize the available time. In this new grid, points 5, 6, 7, 14, 21, 22 and 23 were aborted. The sampling started at 07:57pm, on 20th, at point 29, and was finished at 01:00am, on 21st. At point 15; the sampling was stopped because of weather conditions. At 05:00am, on the same day, samples were restarted at point 13 and ended at 07:48am. Since time became a constraint due bad weather; points 8, 4 and 2 were aborted. The grid performed in this step is in Figure 25:

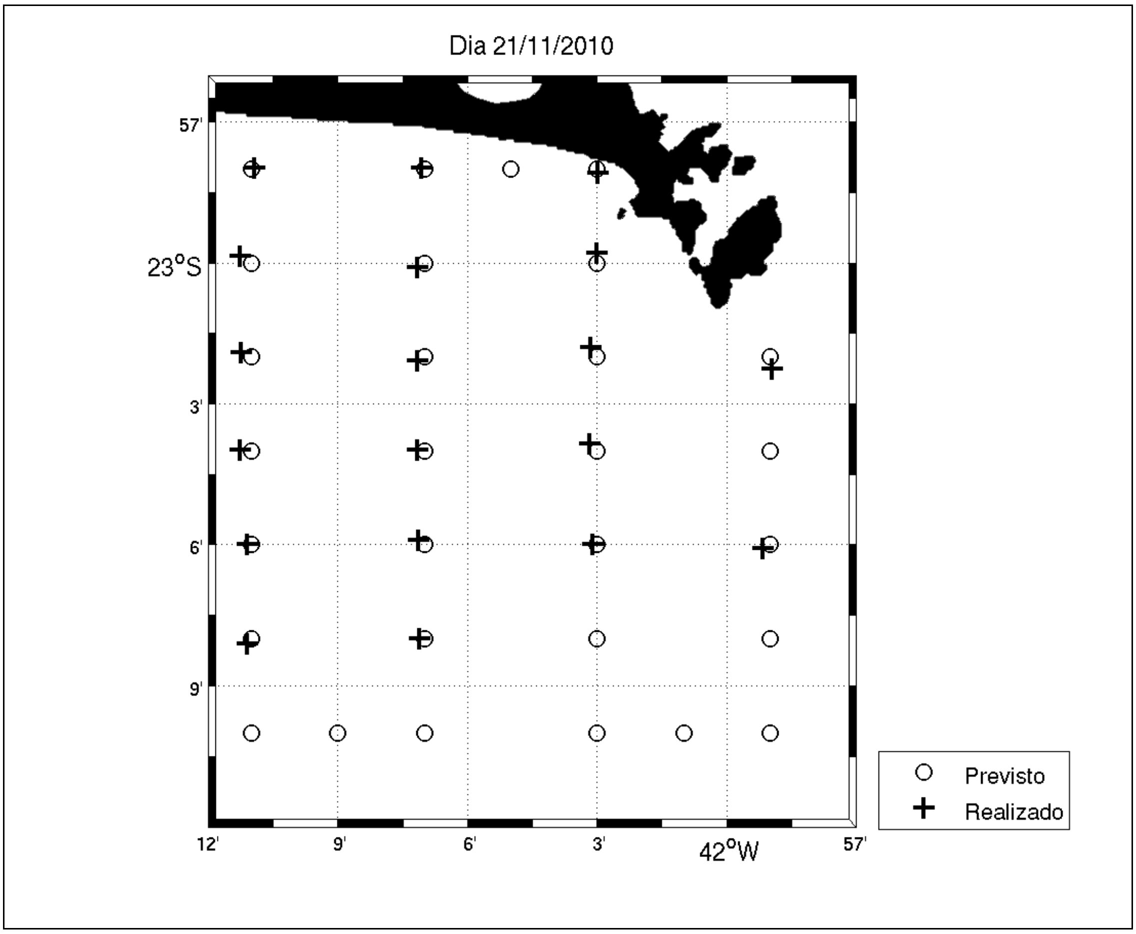

Figure 25 – Grid the oceanographic stations performed in the second step

The CTD sampling to support the acoustic experiments began at 00:40pm, on 21st, and ended at 06:30pm, summing 7 samples.

4th step

In this last stage, no samples were taken at the oceanographic grid. The performed samples were only to support the acoustic experiments. Three (3) stations were performed between 11:23am and 02:48pm, on 22nd.

4.1.1- CTD

At "Aspirante Moura", it was used the CTD Valeport, model MIDAS SVX 5000, which acquired temperature, salinity, pressure and sound speed propagation data, at a of 8 Hz sampling rate. The CTD was launched from the back of the vessel, supported by mechanical winch on 18, 19, 20, 21 and 22 November 2010.

Collected data at "Aspirante Moura" and their plots (Appendix F) were performed by CTD's software manufacturer. It is also available an explained file ("header") and a file containing collected data positions. Calibration data provided according to the records in Annex A.

4.1.2 - XBT

Were conducted 6 samples of XBT data acquisition, performed only in "Aspirante Moura" at points 6, 11, 16, 18, 20 and 23, on November 19th, 2010. It was used the MK 21 Sippican, with specific probes according to the depth. These data and their stations' times and positions are available in Appendix G.

4.1.3 - ROMS - Circulation model

The Regional Ocean Modeling System (ROMS) was used to simulate the thermohaline circulation field with the following characteristics:

• horizontal resolution was approximately 1000 m;
• vertical resolution of 25 levels;
• the open boundary conditions were applied;
• forcing:
i. wind: data from the Advanced Scatterometer (ASCAT), in periods of 12 hours;
ii. tide: global model of ocean tides TPXO7.2;
• initial conditions: feature model based on the World Ocean Atlas 2005 (Antonov et al., 2006) climatological thermohaline structure reshaped to match the Sea Surface Temperature (SST) from satellite for the day 09112010;
• bathymetry: obtained from nautical charts and interpolated to 1 minute of degree resolution (data from REMO Project).

4.1.4 - Satellite

Satellite images were obtained by MODIS sensor aboard the Aqua satellite, acquired from the Ocean Color Group, National Space Agency (NASA), during the preparation and execution of the cruise OAEx. Near-real time images are available after 6 to 10 hours the satellite overpasses Cabo Frio.

4.2 - Data processing

4.2.1 – *In situ* data processing

The CTD and XBT data processing consisted of some stages, following procedures recommended by UNESCO (1988): acquisition and translation of files generated by the equipments, definition of interested thermohaline profiles and application of filters (described below):

First Filter – Removal of spurious data. This filter scans the profile and identifies outliers present in the record (they disagree with the adjacent peaks). This is done identifying values within a 3 meters sliding window that are absolutely bigger than the window's average value plus 3 standard deviations.

Second Filter – Binning. This filter organizes high frequency samples in values regularly spaced every meter of the profile. This is done by calculating the average value for each meter of water column.

Third Filter – Smoothing by moving window. This filter removes the variability that occurs in an interval shorter than the window size. It consists in applying a weighted mean sample in records present in the window. The weight was based on a Hanning curve.

4.2.2 - Satellites images processing

Level 2 images were acquired from NASA, after radiometric calibration, atmospheric correction, cloud masking and biogeophysical parameters estimated by specific algorithms. The SeaDAS software (SeaWiFS Data Analysis System) was used to cut the area of the experiment, to set the images projection, to extract biogeophysical parameters of interest, such as chlorophyll-a (Chl-a) and sea surface temperature (SST).
During the cruise preparation, the SST images were used as input parameters of ROMS (Regional Ocean Modeling System). Daily, during the cruise period, images of Chl-a and SST were processed and, according to the cloud cover level, sent to researchers on board to assist "Aspirante Moura"

observational interpretations of the experimental area. Due to cloud coverage, only the image of 19^{th} November 2010 presented good conditions over the experiment area (free of clouds).

4.2.2a - Preliminary analysis

One hundred (100) profiles were collected during the cruise, which 92 were from CTD and 8 from XBT, covering depths between 12 and 120 meters.

Throughout the cruise, surface temperatures were recorded between 17 and 23.8°C, while salinity ranged between 35 and 36.5. All profiles showed a well defined thermocline occurring between 5 and 50 meters deep.

During the cruise, it was registered the occurrence of oceanographic phenomenon known as coastal upwelling. In this phenomenon the denser bottom water rises to the surface near the coast. It was also found that the thermohaline index from water samples at these stations corresponded to the South Atlantic Central Water (ACAS) water mass index, according to Miranda (1985) (Figure 26). The temperature vertical sections drawn for the 2^{nd} step clearly demonstrate the rise of this water mass towards the coast (Figure 27).

Additionally, there was a temporal evolution of upwelling along the days of the survey. This was recorded by the displacement of the upwelling front toward the ocean and the cooling of surface waters at stations closer to the coast, which can be observed on the evolution of the interpolated SST maps generated from *in situ* data (Figure 28).

The images of Chl-a and TSM on 19^{th} November 2010 also show a rather characteristic of the Cabo Frio upwelling and mesoscale dynamics in the adjacent oceanic region (Figure 29).

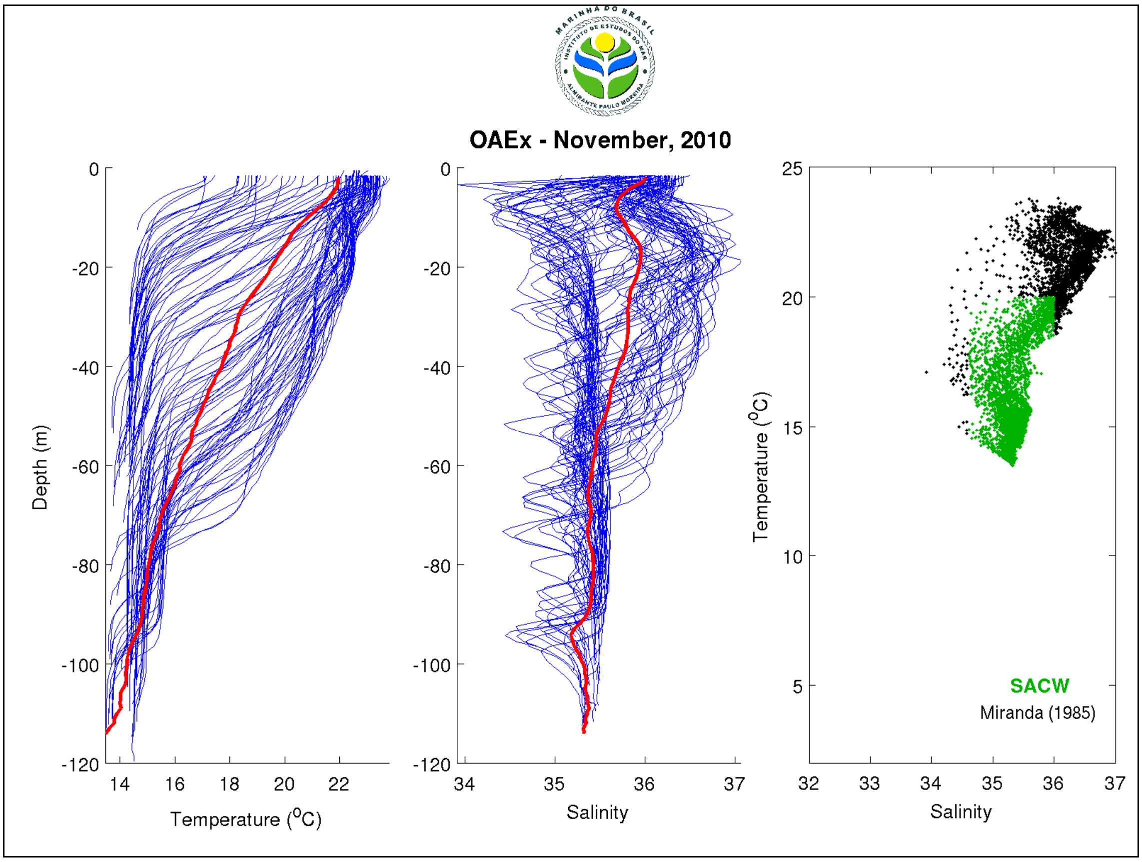

Figure 26 - Temperature and salinity profiles from the CTD stations and respective TS diagram.

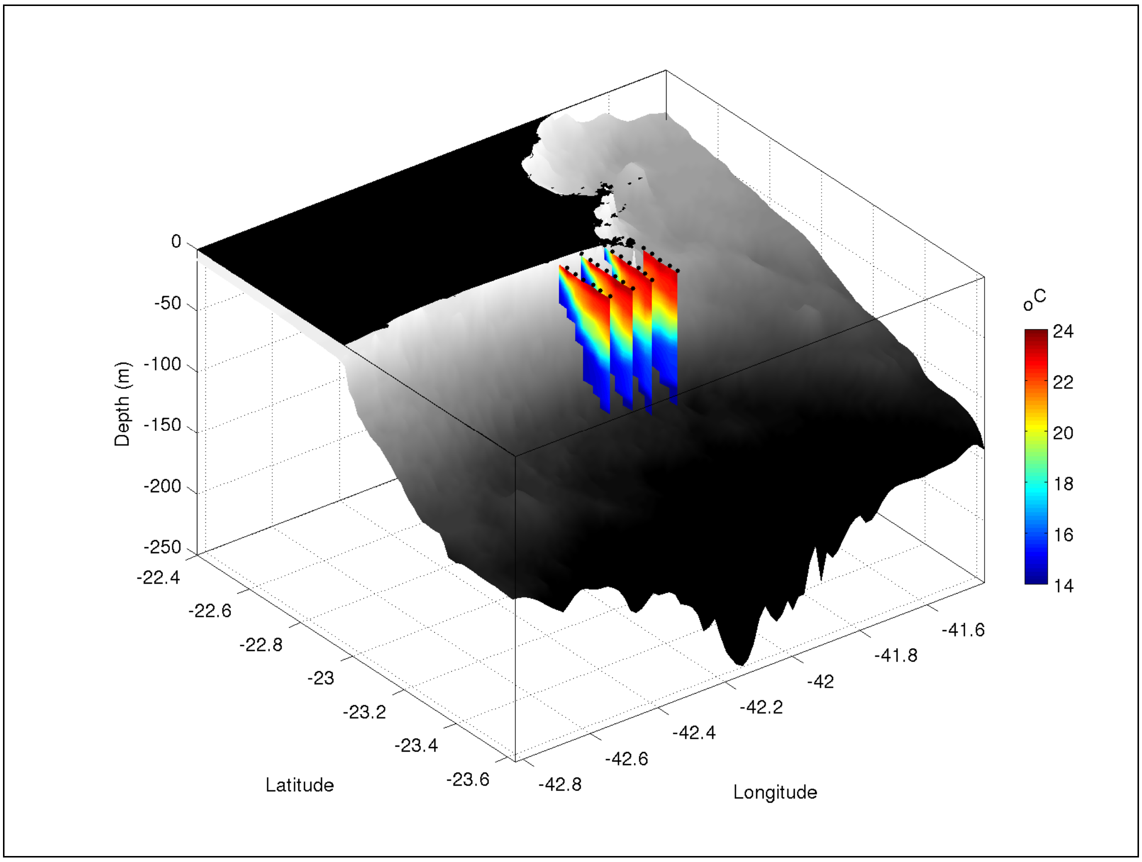

Figure 27 - Temperature vertical sections for 2nd step.

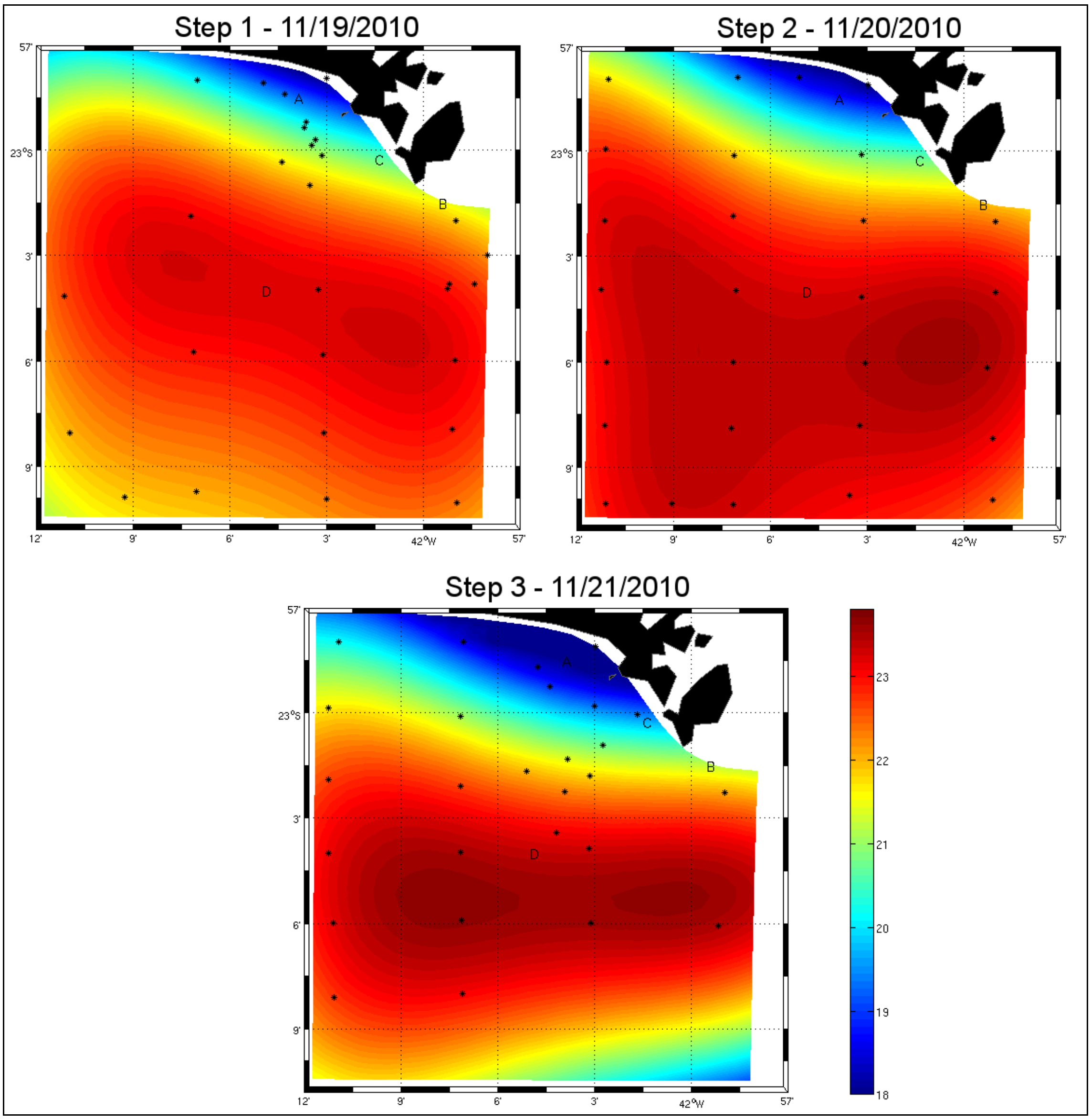

Figure 28 - Interpolated SST based on data collected on the steps 1, 2 and 3.

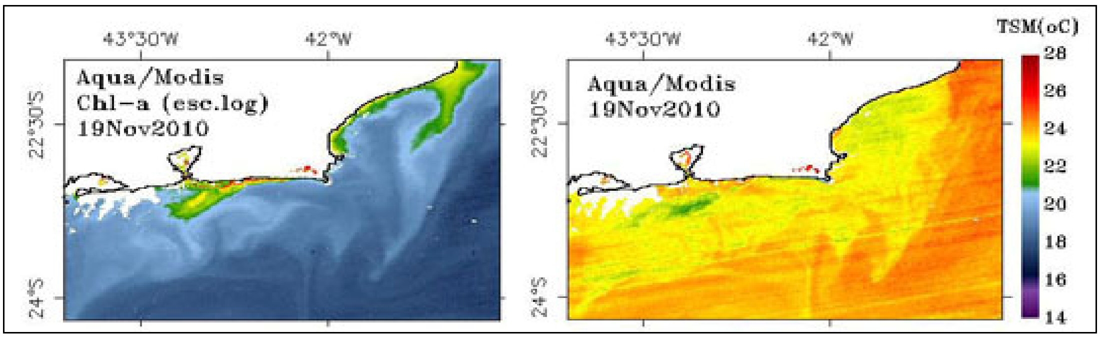

Figure 29 - Images of chlorophyll-a (logarithmic scale) and Sea Surface Temperature.

Chapter 5

TASK 2: Upwelling Tracking and Communication

The OAEx partners are interested in test the feasibility of upwelling dynamics tracking through acoustic monitoring. The geometry configured to do it during this trial was to keep a fixed source/receiver array position both along the Range-Independent (RI) and Range-Dependent (RD) tracks as much time as possible while transmitting LFMs in two frequency bands 500-1000Hz and 1000-2000Hz and multi-tones covering the 500-2000Hz band. For the communication purpose, signals at various data rates and modulations (4, 8, 16 PSK, OFDM, etc) were been also transmitted. In this case, the maximum distance of transmission was the one were a significant SNR was maintained.

The experiments were conducted on days 1 and 2, holding the positions shown in Figure 30 and, in tabular form, in Appendix A.

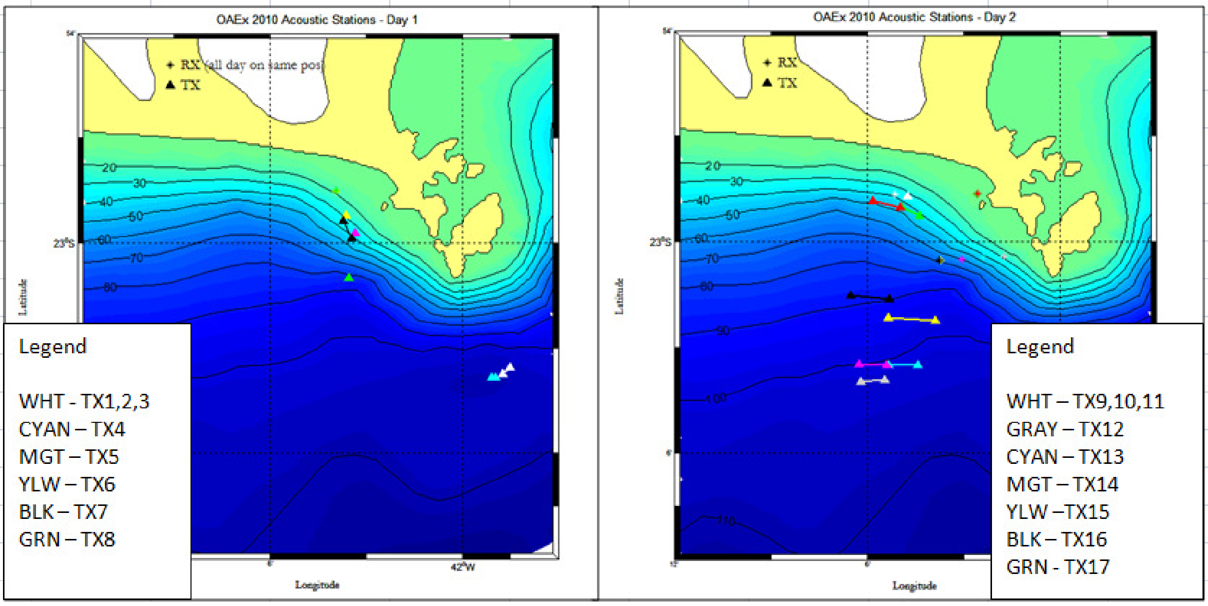

Figure 30 - Positioning of the ships during the first and second days.

Examples of LFMs and multi-tones received signals can be seen in the Figure 31 (left) where the spectrograms and the arrival correlation of each LFM pattern, in time domain, is plotted. On the right of the figure, the arrival patterns for the low LFM were plotted as a temporal evolution within its 10 repetitions.

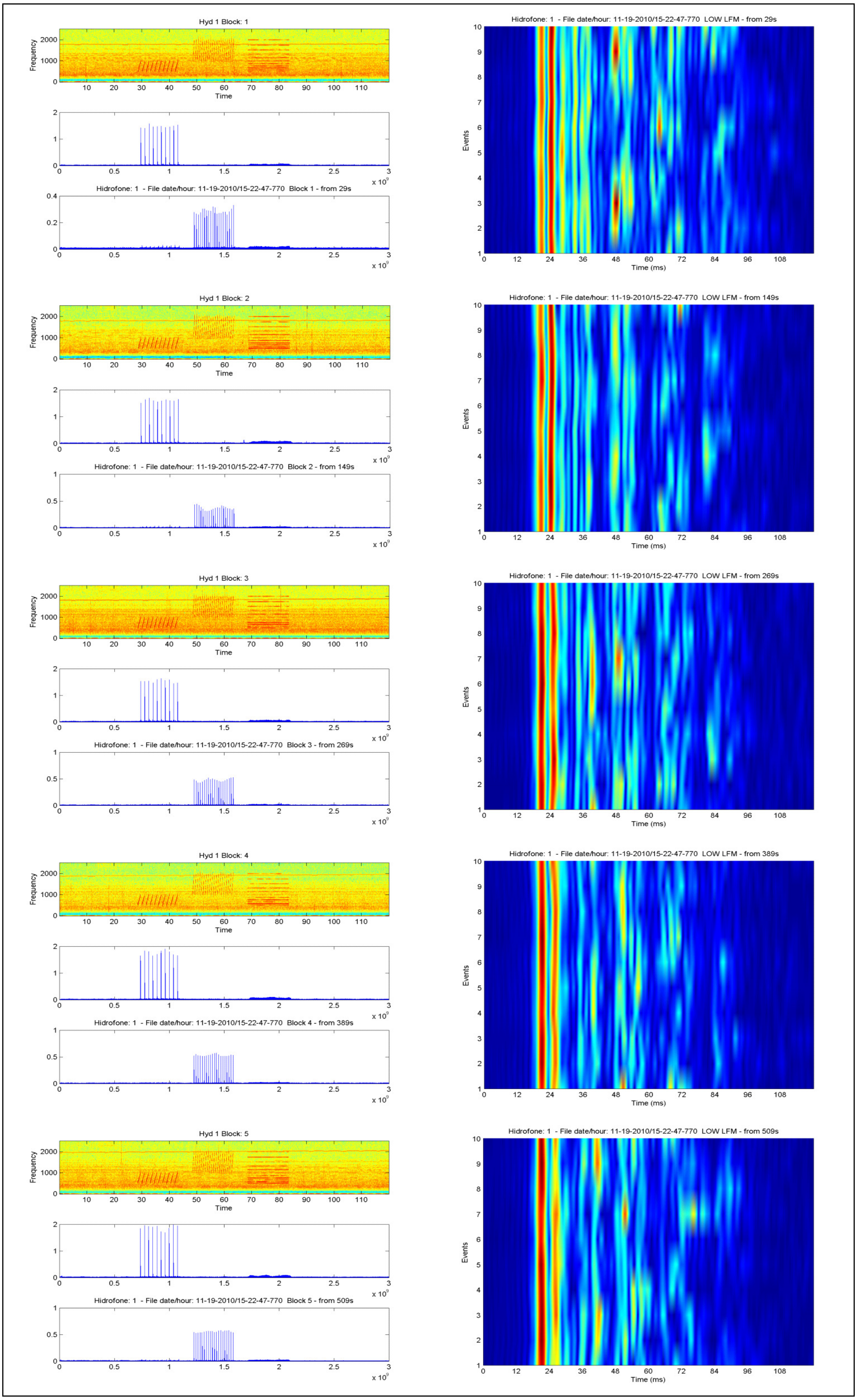

Figure 31 - LFMs and multi-tones received signals.

From Figure 32 to Figure 36 we can see the amplitude of the arriving signal in function of time for each of the 8 hydrophones of the array, characterizing the vertical profile of propagation of the channel in different blocks.

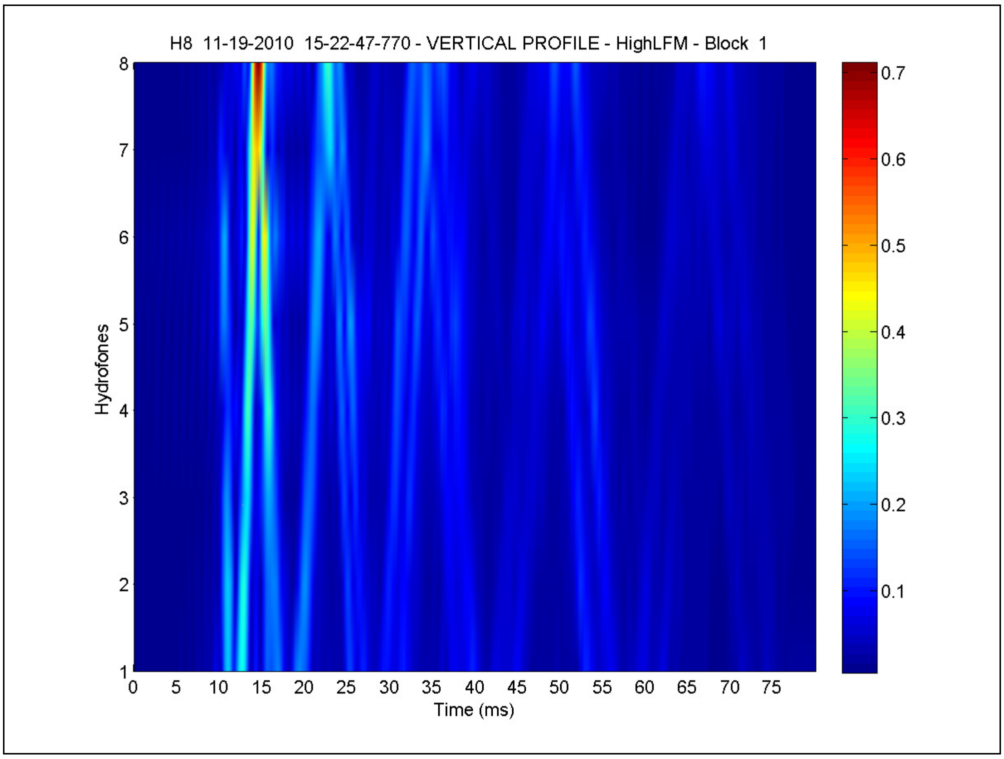

Figure 32 - Vertical profile of the received signals, block 1.

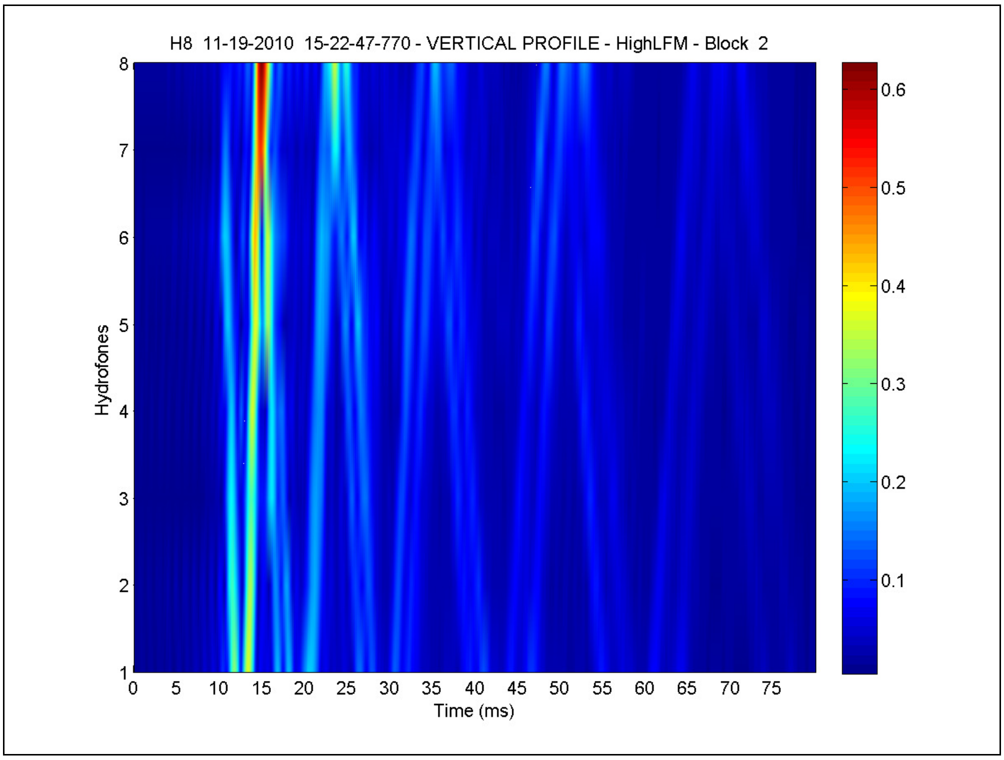

Figure 33 - Vertical profile of received signals, block 2.

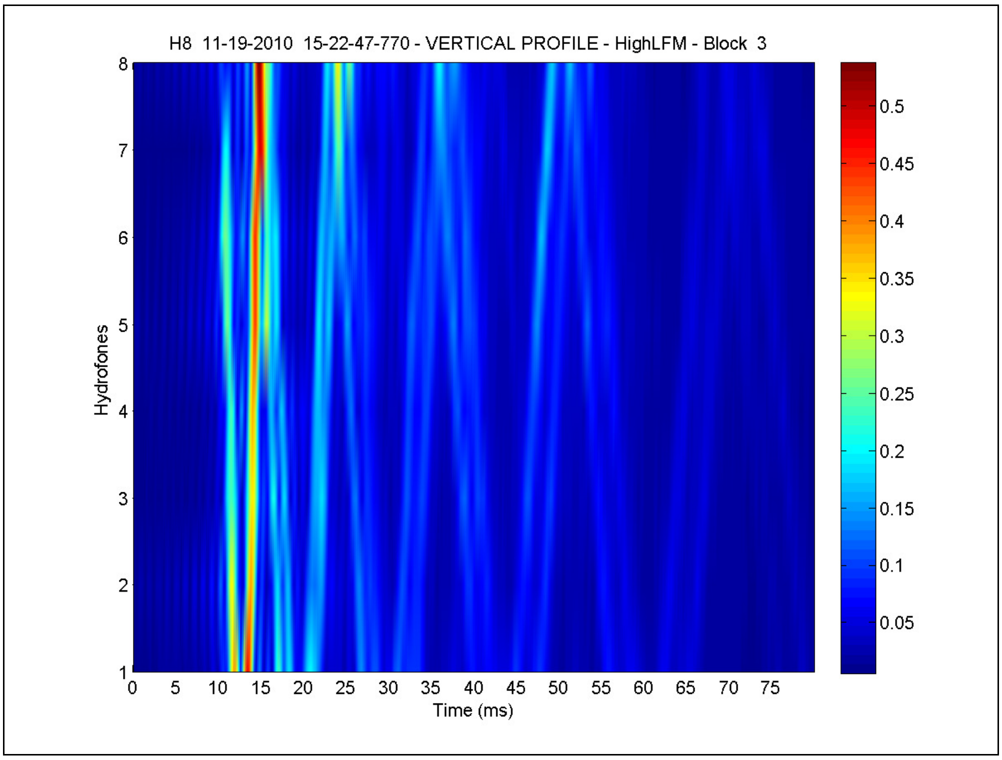

Figure 34 - Vertical profile of the received signals, block 3.

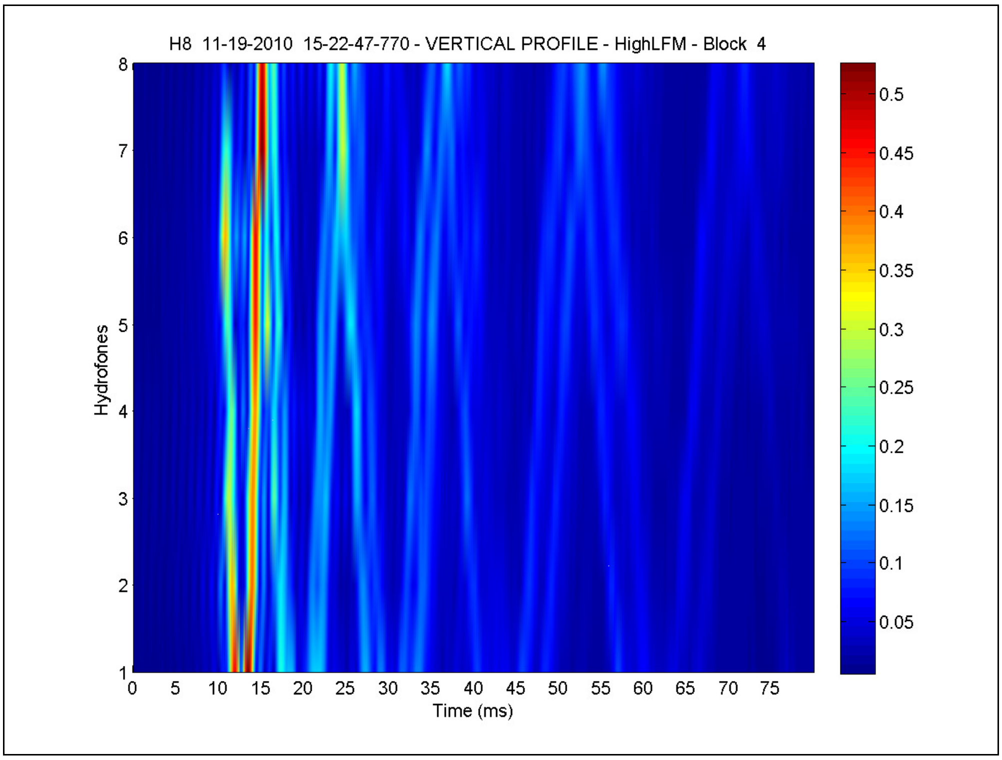

Figure 35 - Vertical profile of the received signals, block 4.

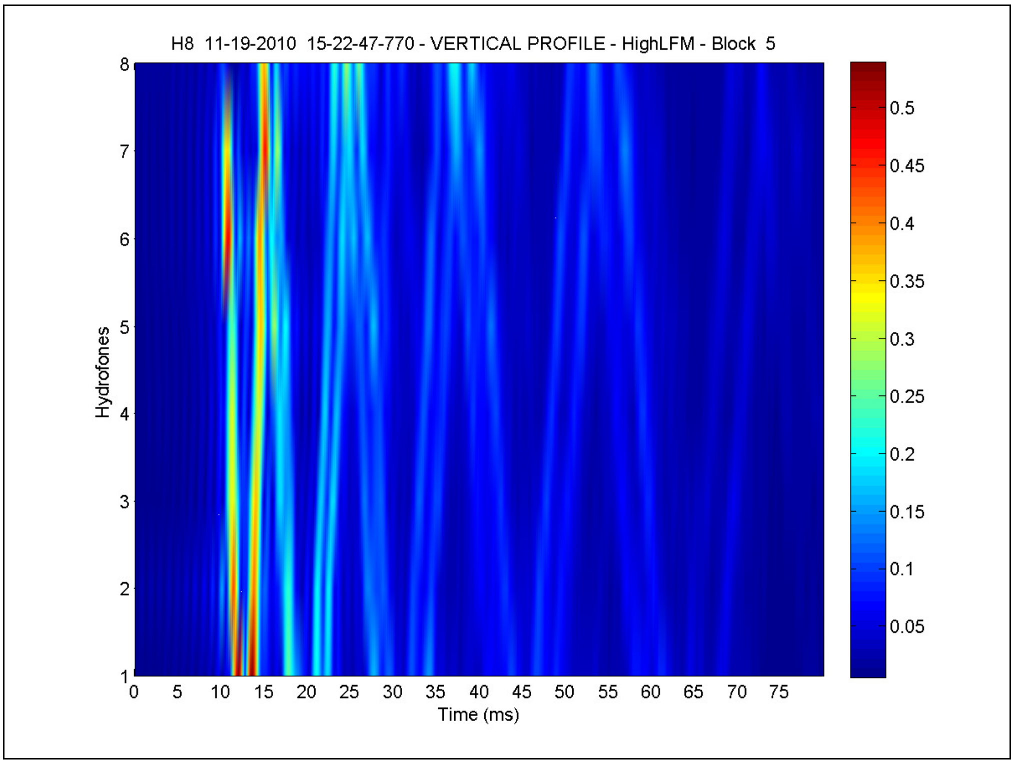

Figure 36 - Vertical profile of the received signals, block 5.

In the Figure 37 below, the prediction of the above signal generated by the Bellhop model can be seen. In it, one can devise a reasonable agreement between field and modeled data. Although there are still significant amplitude differences between de model plotted and the actual signal received, the shapes are very similar, in other words, there is a qualitative agreement and we need to improve the quantitative one.

Changes in the environmental parameters file for Bellhop initialization will be performed to better correlate the prediction field with the observed one. That's the starting point for the use of inversion methods.

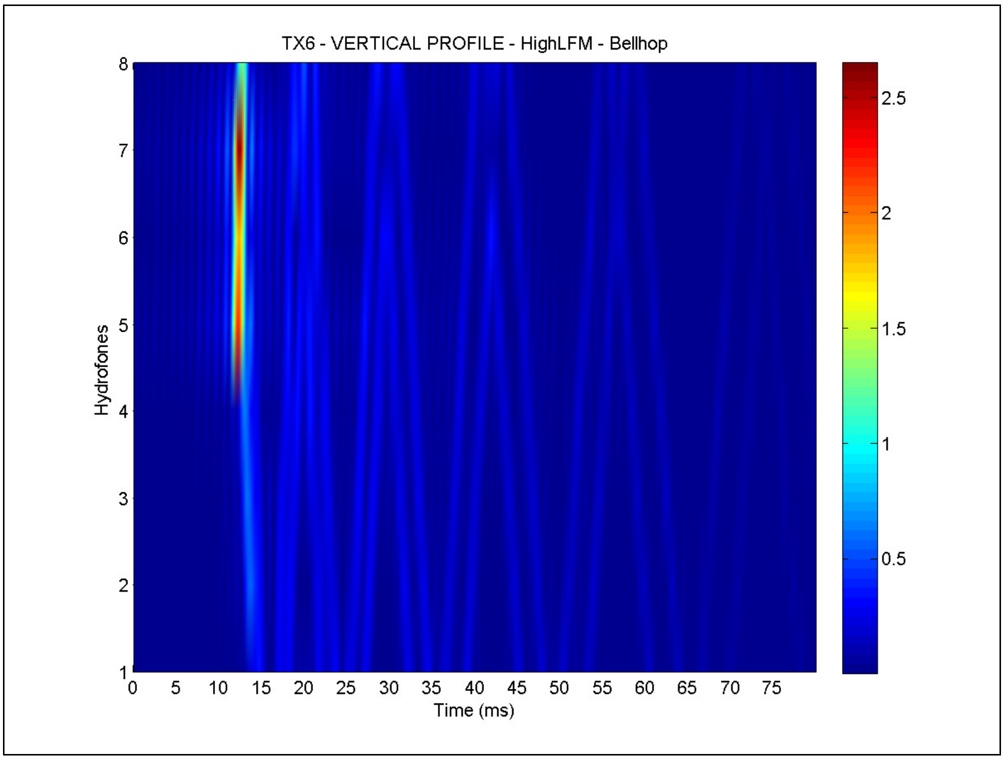

Figure 37 - Bellhop modelled vertical profile

The parameter used to run the model were: Compression Velocity c= 1626m/s; Mean Density ρ=1.9g/cm³; Attenuation = 0.8dB/λ and the vertical sound speed profile is as follows in the Figure 38 bellow:

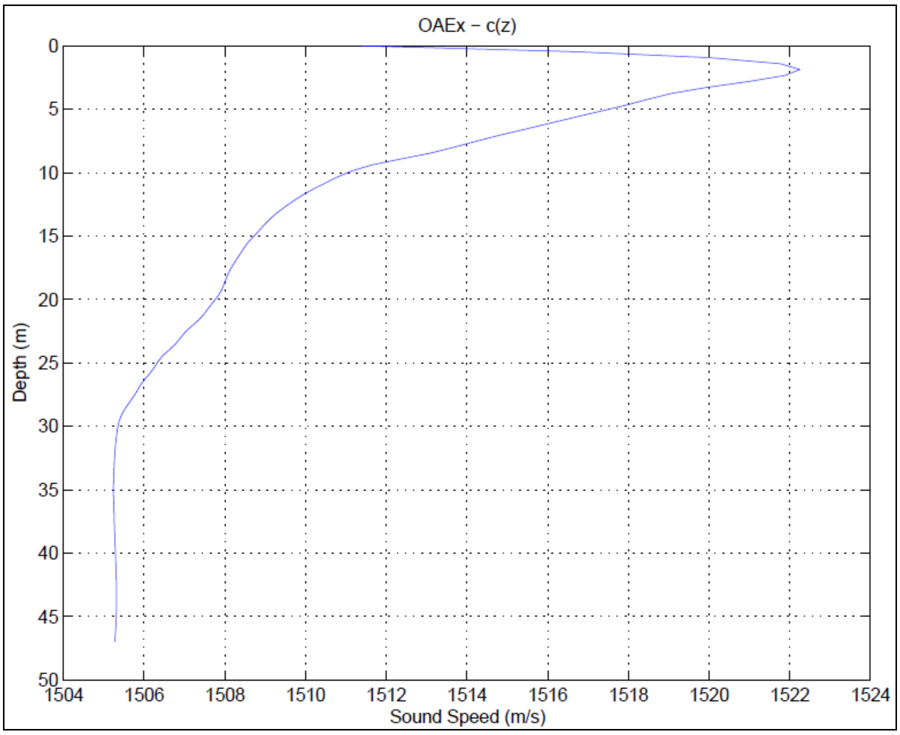

Figure 38 - Vertical Sound Speed Profile at the trial's site.

Chapter 6

TASK 3: Invariant Parameter

One important characteristic of the sound field in the ocean is the horizontal scales of its variability. This variability is mainly due to mutual interference of different modes of neighboring orders. Beta is the invariant of an interference pattern within a group of modes. Determining it, we may calculate the distance between the source and receiver for a range-independent waveguide in shallow waters.

$$\beta = \frac{r}{\omega}\frac{d\omega}{dr}$$

Were:

β - Invariant Parameter;

r – Distance between the source and the receiver;

ω - Angular frequency.

In the Figure 39 bellow, we can see the feature of the specter (x-axis) of a cavitation noise related to the distance between the source and the receiver (y-axis). Notice the red line, indicating the invariant of the interference pattern. From this line one can derive the β invariant parameter,

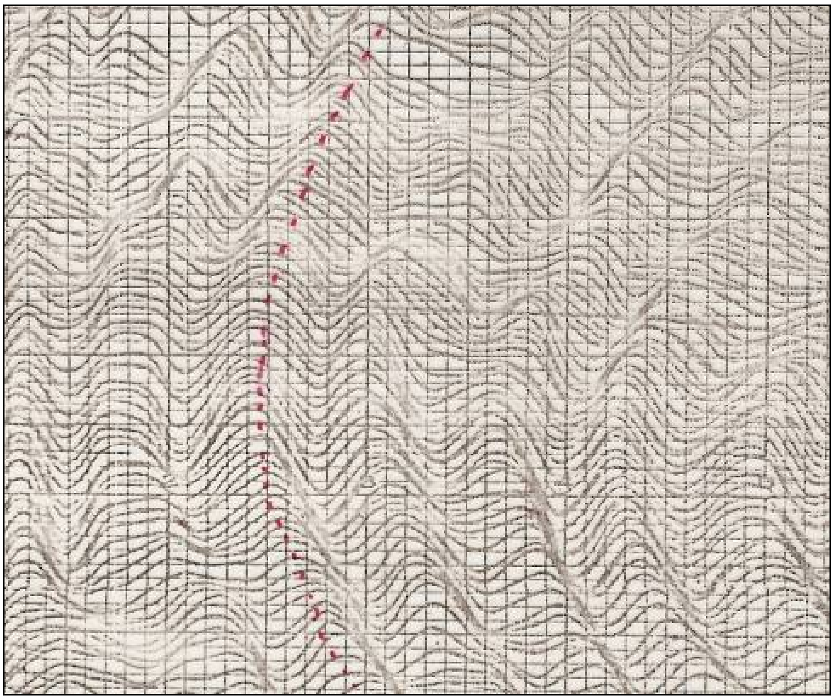

Figure 39 – Cavitation noise espectrum.

demonstrated in the Figure 40, were the y-axis represents the distances between the source and the receiver, and the x-axis represents the frequencies. In this way, one can see that the region denoted in the red line on Figure 39 represents an approximate straight line which inclination constant is the β parameter.

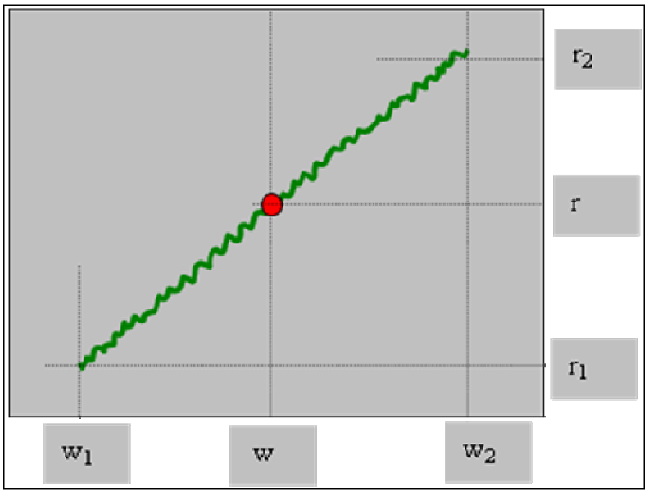

Figure 40 – Graphical representation of the Beta invariant parameter.

During the data acquisition, the focus was on the determination of the beta invariant parameter for low frequency mode propagation in shallow water. The "Aspirante Moura" propeller cavitations broadband noise at maximum speed has been used as acoustic source and the EDCG held the receiving array. This experiment demanded two runs in range-independent and range-dependent transects. We can see i*Figure 41*n Figure 41 the trajectory of the "Aspirante Moura" (white path) along with the location of the "EDCG" (black dot).

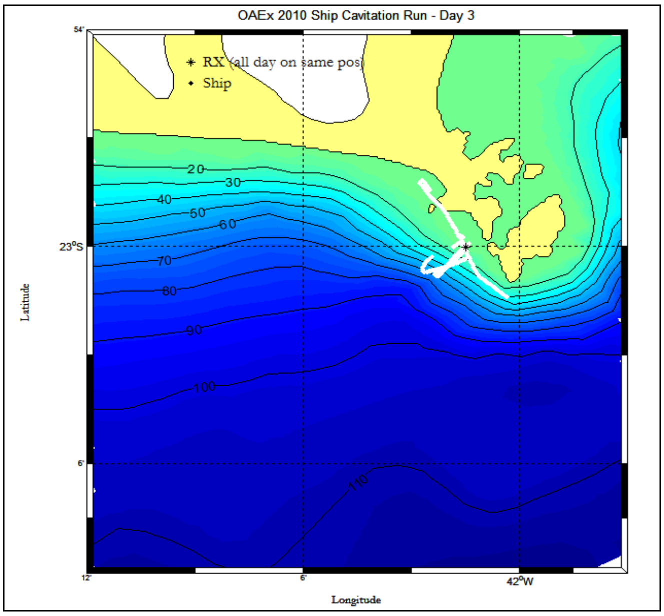

Figure 41 - Positioning of the ships during the cavitation experiment.

Chapter 7

TASK 4: Calibration of Kraken, Bellhop and RAM Models

In order to collect data to calibrate the Kraken, Bellhop and RAM acoustic propagation models, used at IEAPM/IPqM for Arraial do Cabo Site, the ship transmitting the signal followed the transect CD as planned according to the Figure 42 and performed according to the registered in Figure 43, with the receiving ship staying moored at position C, performing acoustic station apart 1km each. In every station it was transmitted a CW signal of 3.5kHz with 500ms (TX) and 7s (pause) in a loop during 5min along with CTD or XBT.

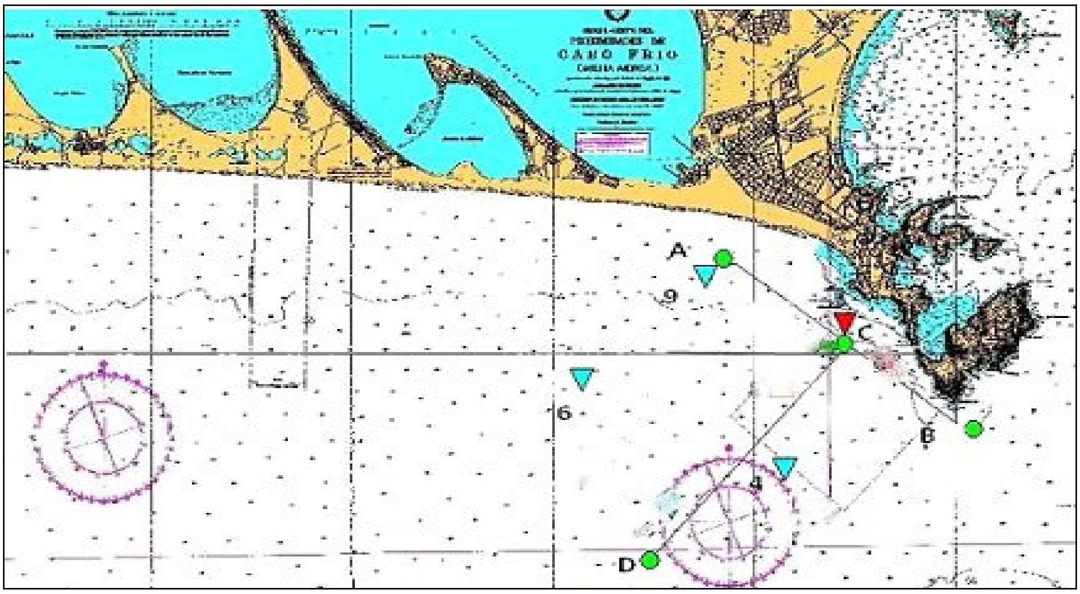

Figure 42 - Geological cores and acoustic transects.

The points in Figure 39 have the following coordinates of the Table 10:

Table 10 - Coordinates of the experiment for the task 4.

POSITIONS	LAT	LONG	DEPTH (m)
4	23º 02',3 S	042º 03',3 W	78
6	23º 00',5 S	042º 07',4 W	63
9	22º 58',6 S	042º 05',0 W	44
A	22º58'500 S	42º04'000 W	30
B	23º01'500 S	41º59'500 W	80
C	23º00'250 S	42º01'500 W	50
D	23°04´000 S	42º05´000 W	90

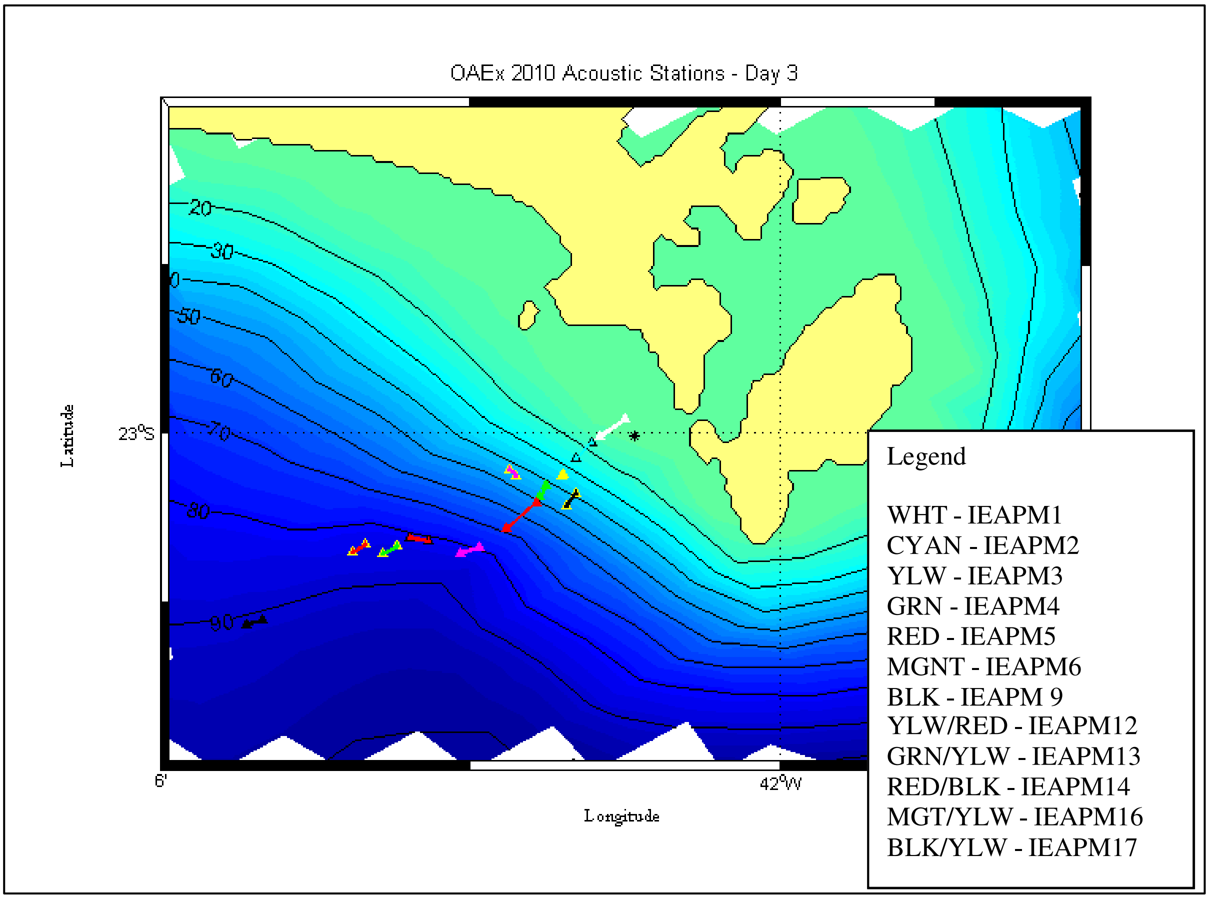

Figure 43 - Positioning points during the task 4, according to GPS data acquired.

In the Figure 43, all the pairs of transmissions/receptions are represented by different colors. The coordinates of these pairs can be seen at Appendix A, on day 3, from the filenames prefixes of the receptions, which are the same of the listed in the legend.

Chapter 8

TASK 5: Geoacoustic Inversion

The sea trials occurred in November 20 and 22 included acoustic run emitting multi-tone signal from the source set to 10-m depth and recording acoustic pressure data in the 8-hydrophones array positioned at 700-m, 1200-m and 1600-m from source, respectively, for the runs near over the cores 9, 6 and 4 sites.

The signals expressed in item 2.4.1 from CASOP, UAlg and ULB contain multi-tones which can be used for MFP inversion purposes. Until the present moment, it was analyzed by the CASOP invited member the signals from ULB recorded on run number 1 of the core 9 site. These multi-tones chosen are composed of 24 frequencies with band 250—1000Hz. The tones are selectioned in a criterion of 1/12 octave scale. Ten sequences containing this signal was repeated every minute. The transect for this case had source-receiver range of 700-m, in a considered range-independent environment with 48-m depth, parallel to the 40-m isobath.

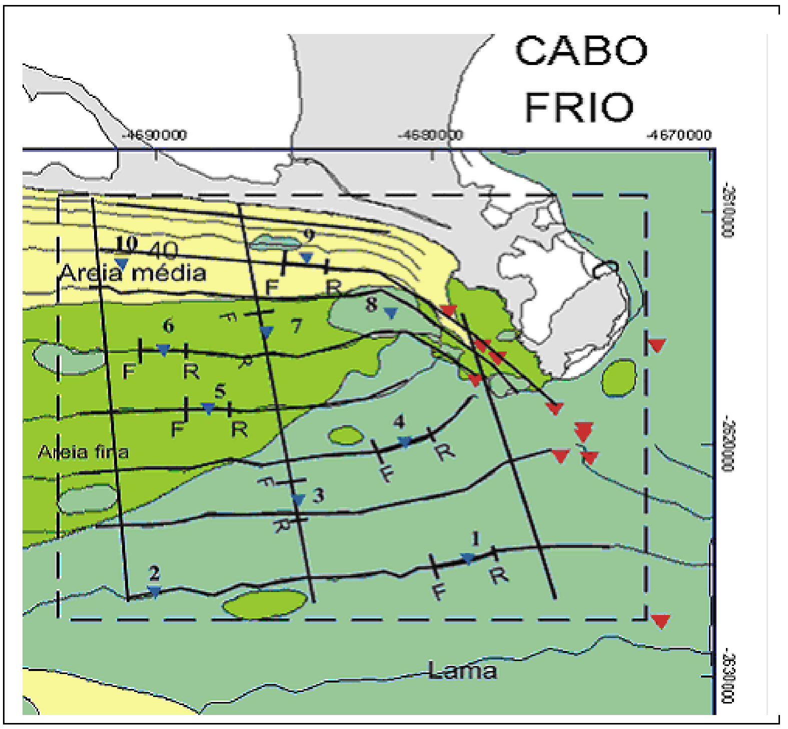

Figure 44 - Geological cores and acoustic transects.

For run #1 the source is positioned on coordinates 22º 58',6 S – 042º 05',0 W (the acoustic emissions near over Core 9 site r was done in the 2nd day of experiment.) by the AvPq "Asp Moura"

and the array of 8 hydrophones are positioned by EDCG at 900m in the true bearing 275. The run #2 will be done in the same position but with the acoustic data acquisition equipment provided from IPqM. After that, for run #3 the source is over coordinates 23º 00',5 S – 042º 07',4 W (core 6) and the array of 8 hydrophones are positioned by EDCG at 1200-m in the true bearing 270. Finally for the run#4 the source is over coordinates 23º 02',3 S – 042º 03',3 W (core 4) and the array is at 1600-m from the source in the true bearing 260.
The Figure 44 above shows the sites of the experiments conducted for geoacoustic inversion. In the core9 site was realized acoustic records for that purpose in the second day of the sea trial.

The sound speed profile of water column was measured just before the acoustic records employing CTD, getting a downward behavior for the acoustic energy, as showed in Figure 45.

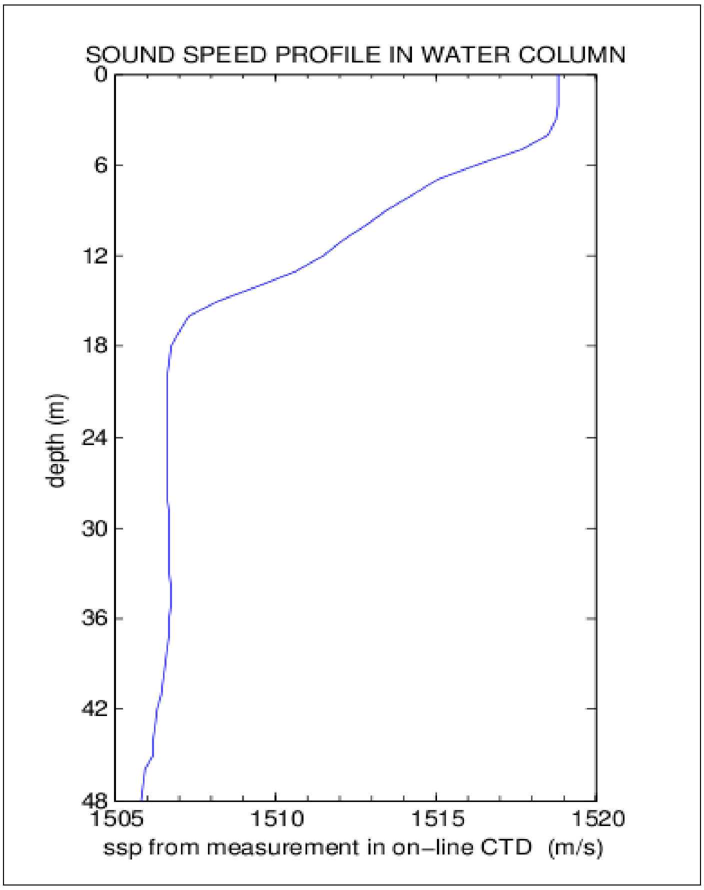

Figure 45- Sound Speed Profile in Water Column.

The core 9 gives analysis of 1,4-m depth in sediment layer. It indicates a sand layer with the detailed sound speed profile for this short range showed in Figure 46.

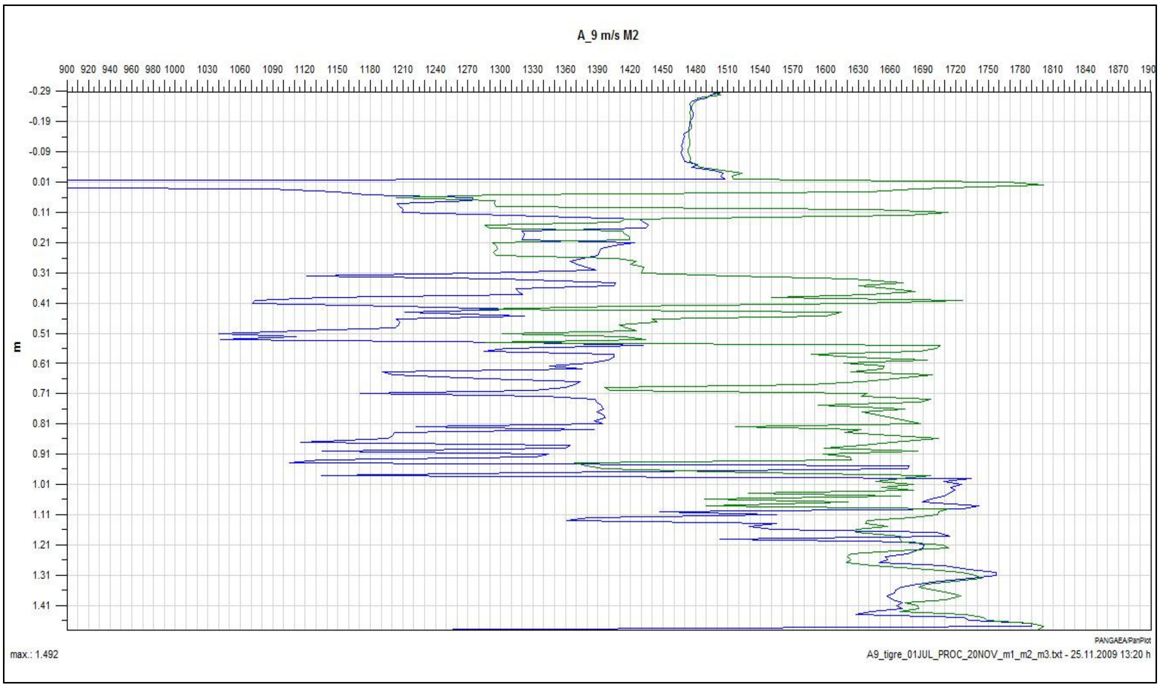

Figure 46 - Analysis of 1.4m depth in sediment layer.

Earlier seismic assessment suggests that the sand layer have thickness between 10-m and 40-m and density of 1,4 g/cm³. It was observed small influence of current over the slope of the array. It is expected small array tilt, with position nearly vertical.

Finally, these descriptions given above shows in resume the environmental data, chosen signals and a priori information that are been applied for acoustic inversion work which aims to estimate geoacoustic parameters from seabed and geometric parameters for focalization. In near future scientific paper will be present for explanation of results and conclusions.

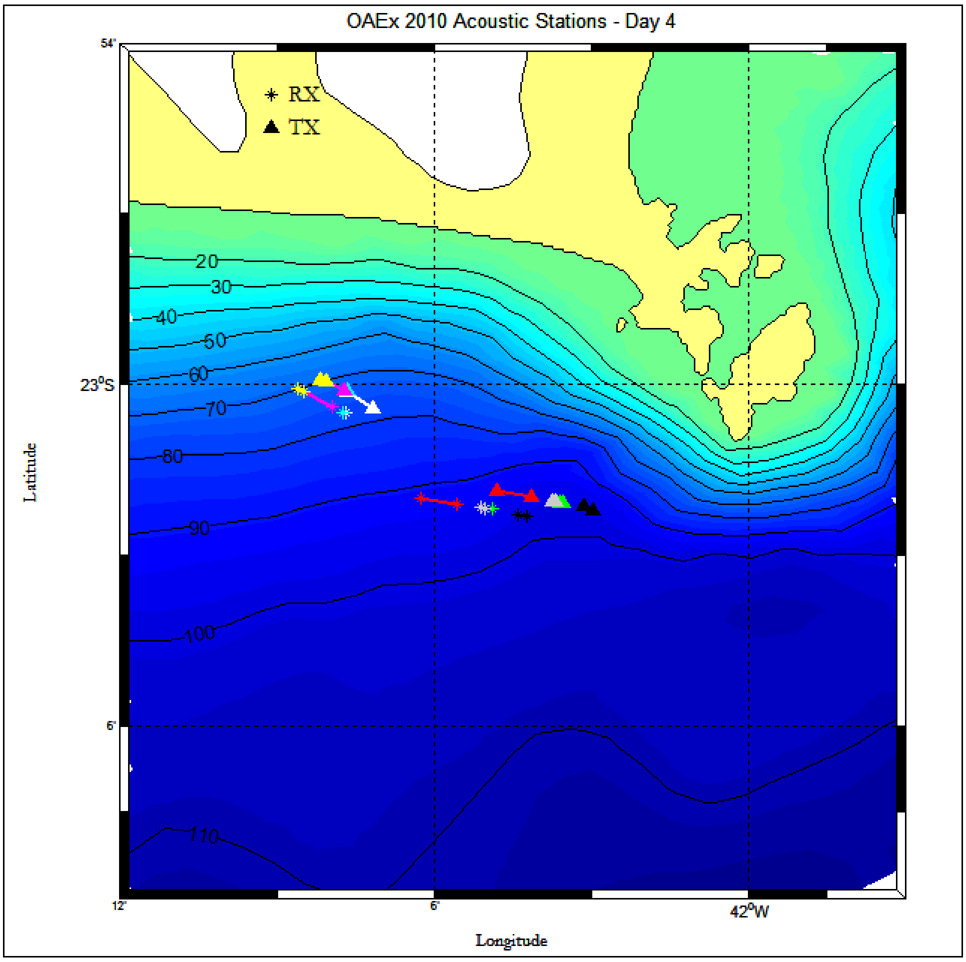

Figure 47 - Geological cores and acoustic transects from GPS.

The Figure 47 above shows the geometry of the experiments conducted on the fourth day of the sea trial.

Chapter 9

Conclusion and Future Work

The OAEX'10 sea trial has accomplished its desired goals.

Quality of equipments, specially the non-amplified hydrophones used on the vertical array, must be improved in future works in order to allow experiments with longer range. Another aspect to be improved is the control of experiments timing and positioning from GPS. In turn, for ranges up to 2km the received signals reach a reasonable SNR and processing were successfully performed, yielding interesting results that meet the main objectives of the project, strong suggesting that the upwelling plume of cold water can indeed be monitored by acoustical means. Geo-acoustic inversion has been implemented also with good results.

A complete processing of the acquired data should follow this preliminary data report in order to apply the best methodologies in data processing and to reach more sound results. The preliminary data analysis presented showed good initial results and a good set of possibilities.

A workshop to be hosted by *Universidade do Algarve* – UALG on July 2011 should present some detailed processing results of this large amount of data.

Although the choice of area for the acoustic experiment was made based on the occurrence of upwelling phenomenon, the geology and geophysics of the site show a classic marine environment of the passive continental margin, under the influence of waves and without structural complex, highly appropriate for the initial studies of geoacoustics.

Due to limited range of sediments occurring in the area, it was not possible to characterize all grain sizes classes, restricting the definition of geoacoustic parameters only for sand medium to medium silt (Φ 1 to 6). However, considering the limited mineral composition of marine surface sediments in the terrigenous environment (quartz, feldspar, mica, clay minerals sometimes, heavy minerals), the physical properties of sediments can be extrapolated for other similar environments at Brazilian coast.

The authors would like to suggest some ideas for future works:

1 - surveys should be carried out in the west part of the IEAPM's study area (Figure 20 (A)) for to characterization of other classes of sediment and rock;

2 - seismic data survey should be obtained in the perpendicular direction to bathymetric lines for range-dependent acoustic experiments;

3 - for marine sediments, collect compressional and shear velocities data *in situ* (15 cm); and

4 - scaling the influence of morphology on acoustic propagation.

5 - further study the attenuation in marine sediment.

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OCEANCOLOR GROUP, available at http://oceancolor.gsfc.nasa.gov/.

REMO – Rede de Modelagem e Observação Oceanográfica, available at http://www.rederemo.org/.

SeaDAS – SeaWiFS Data Analysis System software, available at http://seadas.gsfc.nasa.gov/.

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Appendix A

Guide to the acoustic data files, every Tx/Rx filename is a link that leads to the actual folder of the corresponding file where you can find the wave file and its corresponding GPS data file (see more at Appendix I):

1	Day	Month	Year	TX		RX		Signal
	19	11	2010	2010_11_19_T12_17_59_433_TRANSMIT	Length: 24:18	tx1_11-19-2010_12-14-03-678 tx2_11-19-2010_12-34-52-253 tx3_11-19-2010_12-37-46-294	Length: 15:00 01:07 15:00	2/3
	GPS	Hour	Start	12:18:21		12:12:04		
			End	12:50:11		12:34:04		Dist. (m)
		POS	Start	23 3,5533 S 41 58,4957 W -23,05922 -41,97493		22 58,506 S 42 3,937 W -22,9751 -42,06562		13161
			End	23 3,7253 S 41 58,7396 W -23,06209 -41,97899		22 58,5066 S 42 3,9382 W -22,97511 -42,06564		13103

2	Day	Month	Year	TX		RX		Signal
	19	11	2010	2010_11_19_T13_20_42_782_TRANSMIT	Length: 16:30	tx3_11-19-2010_13-10-23-698 tx4_11-19-2010_13-25-41-087	Length: 14:52 Length: 13:07	3
	GPS	Hour	Start	13:20:51		13:10:34		
			End	13:37:41		13:38:34		Dist. (m)
		POS	Start	23 3,834 S 41 58,9662 W -23,0639 -41,98277		22 58,5074 S 42 3,9434 W -22,97512 -42,06572		12999
			End	23 3,8405 S 41 59,094 W -23,06401 -41,9849		22 58,5065 S 42 3,9401 W -22,97511 -42,06567		12864

3	Day	Month	Year	TX		RX		Signal
	19	11	2010	2010_11_19_T14_58_07_076_TRANSMIT	Length: 08:10	tx5_11-19-2010_14-48-55-699	Length: 15:00	3
	GPS	Hour	Start	15:05 (CTD)		14:53:24		
			End			15:07:44		Dist. (m)
		POS	Start	22 59,703 S 42 3,35 W -22,99505 -42,05583		22 58,5067 S 42 3,9437 W -22,97511 -42,06573		2430
			End			22 58,5066 S 42 3,9445 W -22,97511 -42,06574		

4	Day	Month	Year	TX		RX		Signal
	19	11	2010	2010_11_19_T15_21_59_727_TRANSMIT	Length: 25:00	tx6_11-19-2010_15-22-47-770 tx6_11-19-2010_15-41-19-819	Length: 15:00 Length: 17:06	2/3
	GPS	Hour	Start	15:43 (CTD)		15:21:34		
			End			15:43:54		Dist. (m)
		POS	Start	22 59,2 S 42 3,626 W -22,98667 -42,06043		22 58,5051 S 42 3,9473 W -22,97509 -42,06579		1395
			End			22 58,5047 S 42 3,9489 W -22,97508 -42,06582		

5	Day	Month	Year	TX		RX		Signal
	19	11	2010	2010_11_19_T16_12_35_109_TRANSMIT	Length: 40:00	tx7_11-19-2010_16-03-05-667 tx7_11-19-2010_16-36-15-038	Length: 30:00 Length: 20:16	2/3
	GPS	Hour	Start	16:17 (CTD)		16:43:24		
			End	16:48 (CTD)		16:56:24		Dist. (m)
		POS	Start	22 59,847 S 42 3,453 W -22,99745 -42,05755		22 58,5022 S 42 3,9511 W -22,97504 -42,06585		2623
			End	22 59,347 S 42 3,703 W -22,98912 -42,06172		22 58,5007 S 42 3,9497 W -22,97501 -42,06583		1618

6	Day	Month	Year	TX		RX		Signal
	19	11	2010	2010_11_19_T17_35_25_851_TRANSMIT	Length: 55:50	tx8_11-19-2010_17-16-41-196 tx8_11-19-2010_17-50-10-886 tx8_11-19-2010_18-14-22-543	Length: 30:00 23:56 30:00	2/3
	GPS	Hour	Start	17:39 (CTD)		-		
			End					Dist. (m)
		POS	Start	23 1,003 S 42 3,532 W -23,01672 -42,05887		22 58,5022 S 42 3,9511 W -22,97504 -42,06585		4671
			End					

7	Day	Month	Year	TX		RX		Signal
	19	11	2010	Environmental Noise		ruido ambiental fim1o dia_11-19-2010_18-54-40-220 ruido ambiental fim1o dia moura_11-19-2010_19-09-25-262	Length: 13:34 48:46	-
	GPS	Hour	Start			-		
			End					Dist. (m)
		POS	Start			22 58,5022 S 42 3,9511 W -22,97504 -42,06585		-
			End					

1	Day	Month	Year	TX								RX								Signal
	20	11	2010									pesqueiro_11-20-2010_14-42-29-896					Length:	05:00		-
		Hour	Start	Fishing Boat passing by											-					
	GPS		End																	Dist. (m)
		POS	Start									23	0,3687	S	42	1,7151	W	-23,0061	-42,0286	-
			End																	

2	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T11_33_28_475_TRANSMIT					Length:	21:30		tx9_11-20-2010_11-33-47-706					Length:	22:34		2/3
		Hour	Start				11:33:34								11:34:15					
	GPS		End				12:00:04								11:54:15					Dist. (m)
		POS	Start	22	58,6843	S	42	4,7408	W	-22,9781	-42,079	22	58,6405	S	42	5,1462	W	-22,9773	-42,0858	702
			End	22	58,698	S	42	4,7434	W	-22,9783	-42,0791	22	58,6457	S	42	5,1451	W	-22,9774	-42,0858	694

3	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T12_01_53_604_TRANSMIT					Length:	19:50		tx10_11-20-2010_12-01-38-298					Length:	23:41		2/3
		Hour	Start				12:02:14								12:02:05					
	GPS		End				12:25:34								12:22:05					Dist. (m)
		POS	Start	22	58,7001	S	42	4,7441	W	-22,9783	-42,0791	22	58,6472	S	42	5,1451	W	-22,9775	-42,0858	692
			End	22	58,6992	S	42	4,7458	W	-22,9783	-42,0791	22	58,647	S	42	5,144	W	-22,9775	-42,0857	682

4	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T12_38_08_908_TRANSMIT					Length:	21:20		tx11_11-20-2010_12-38-55-204					Length:	27:32		2/3
		Hour	Start				12:38:24								12:39:25					
	GPS		End				13:04:44								12:57:05					Dist. (m)
		POS	Start	22	58,7019	S	42	4,7468	W	-22,9784	-42,0791	22	58,6473	S	42	5,1439	W	-22,9775	-42,0857	684
			End	22	58,7092	S	42	4,7451	W	-22,9785	-42,0791	22	58,6474	S	42	5,1463	W	-22,9775	-42,0858	695

5	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T15_03_36_116_TRANSMIT					Length:	23:20		tx12_11-20-2010_15-10-21-169					Length:	23:57		2/3
		Hour	Start				15:03:44								15:10:45					
	GPS		End				15:33:54								15:26:25					Dist. (m)
		POS	Start	23	3,9082	S	42	5,4529	W	-23,0651	-42,0909	23	0,4032	S	42	1,7497	W	-23,0067	-42,0292	9045
			End	23	3,9636	S	42	6,2069	W	-23,0661	-42,1034	23	0,4111	S	42	1,7494	W	-23,0069	-42,0292	10041

6	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T16_22_58_767_TRANSMIT					Length:	19:40		tx13_11-20-2010_16-22-35-632					Length:	24:42		2/3
		Hour	Start				16:23:04								-					
	GPS		End				16:45:54													Dist. (m)
		POS	Start	23	3,4771	S	42	4,4274	W	-23,058	-42,0738				-			-23,0074	-42,0401	6583
			End	23	3,4791	S	42	5,331	W	-23,058	-42,0889									7511

7	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T16_47_38_858_TRANSMIT					Length:	18:50		tx14_11-20-2010_16-47-30-791					Length:	30:00		2/3
		Hour	Start				16:47:44								-					
	GPS		End				17:09:04													Dist. (m)
		POS	Start	23	3,477	S	42	5,4031	W	-23,058	-42,0901				-			-23,008	-42,051	6835
			End	23	3,4711	S	42	6,2715	W	-23,0579	-42,1045									7785

8	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T18_04_19_090_TRANSMIT					Length:	27:20		tx15_11-20-2010_18-06-25-560 tx16_11-20-2010_18-31-58-454					Length:	21:58 04:44		2/3
		Hour	Start				18:04:34								18:06:52					
	GPS		End				18:42:24								18:36:42					Dist. (m)
		POS	Start	23	2,2328	S	42	3,8915	W	-23,0372	-42,0649	23	0,5225	S	42	3,6522	W	-23,0087	-42,0609	3128
			End	23	2,1373	S	42	5,3383	W	-23,0356	-42,089	23	0,5133	S	42	3,7722	W	-23,0086	-42,0629	4012

9	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T18_55_50_384_TRANSMIT 2010_11_20_T19_15_04_954_TRANSMIT 2010_11_20_T19_22_20_732_TRANSMIT 2010_11_20_T19_23_08_658_TRANSMIT					Length:	17:20 02:09 00:20 00:20		tx16_11-20-2010_18-56-06-396					Length:	30:00		2/3
		Hour	Start				18:56:14								18:56:32					
	GPS		End				19:23:24								19:15:02					Dist. (m)
		POS	Start	23	1,6343	S	42	5,3195	W	-23,0272	-42,0887	23	0,5135	S	42	3,7719	W	-23,0086	-42,0629	3352
			End	23	1,5112	S	42	6,53	W	-23,0252	-42,1088	23	0,5111	S	42	3,7718	W	-23,0085	-42,0629	5055

10	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T20_03_23_253_TRANSMIT					Length:	22:20		tx17_11-20-2010_20-17-31-370					Length:	21:51		3
		Hour	Start				20:03:44								20:19:51					
	GPS		End				20:28:04								20:39:51					Dist. (m)
		POS	Start	22	59,2437	S	42	4,3673	W	-22,9874	-42,0728	22	58,6582	S	42	2,5864	W	-22,9776	-42,0431	3233
			End	22	59,0217	S	42	4,9045	W	-22,9837	-42,0817	22	58,6547	S	42	2,5873	W	-22,9776	-42,0431	4015

11	Day	Month	Year	TX								RX								Signal
	20	11	2010	2010_11_20_T20_30_29_745_TRANSMIT					Length:	23:40		tx18_11-20-2010_20-39-36-616					Length:	27:12		2/3
		Hour	Start				20:30:44								20:40:11					
	GPS		End				21:02:04								21:00:11					Dist. (m)
		POS	Start	22	59,008	S	42	4,9697	W	-22,9835	-42,0828	22	58,6552	S	42	2,5874	W	-22,9776	-42,0431	4123
			End	22	58,8415	S	42	5,818	W	-22,9807	-42,097	22	58,6545	S	42	2,5905	W	-22,9776	-42,0432	5527

1	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T14_54_25_795_TRANSMIT				Length:		15:28		ieapm1_11-21-2010_14-56-45-629				Length:		06:59 02:22		1/4
	GPS	Hour	Start	14:54:33								14:57:34								
			End	15:08:33								15:09:14								Dist. (m)
		POS	Start	22	59,872	S	42	1,4927	W	-22,997867	-42,024878	23	0,0192	S	42	1,4025	W	-23,00032	-42,023375	307
			End	23	0,0205	S	42	1,7447	W	-23,000342	-42,029078	23	0,0199	S	42	1,4023	W	-23,000332	-42,023372	584

2a	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T15_12_54_323_TRANSMIT				Length:		01:09:00		ieapm2_11-21-2010_15-12-02-778				Length:		00:08:10		1
	GPS	Hour	Start	15:13:03								15:12:24								
			End	15:20:03								15:20:04								Dist. (m)
		POS	Start	23	0,0752	S	42	1,8293	W	-23,001253	-42,030488	23	0,0194	S	42	1,4046	W	-23,000323	-42,02341	733
			End	23	0,2182	S	42	1,9751	W	-23,003637	-42,032918	23	0,0203	S	42	1,4027	W	-23,000338	-42,023378	1044

2c	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T15_12_54_323_TRANSMIT				Length:		01:09:00		ieapm3_11-21-2010_15-25-51-139				Length:		00:05:30		1
	GPS	Hour	Start	15:25:53								15:25:54								
			End	15:31:23								15:31:24								Dist. (m)
		POS	Start	23	0,3671	S	42	2,1037	W	-23,006118	-42,035062	23	0,0201	S	42	1,4025	W	-23,000335	-42,023375	1358
			End	23	0,3763	S	42	2,1074	W	-23,006272	-42,035123	23	0,0206	S	42	1,4014	W	-23,000343	-42,023357	1373

2e	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T15_12_54_323_TRANSMIT				Length:		01:09:00		ieapm4_11-21-2010_15-37-35-642				Length:		00:05:56		1
	GPS	Hour	Start	15:37:53								15:37:44								
			End	15:43:43								15:43:34								Dist. (m)
		POS	Start	23	0,4546	S	42	2,2601	W	-23,007577	-42,037668	23	0,02	S	42	1,4031	W	-23,000333	-42,023385	1670
			End	23	0,5625	S	42	2,3239	W	-23,009375	-42,038732	23	0,0181	S	42	1,404	W	-23,000302	-42,0234	1865

2g	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T15_12_54_323_TRANSMIT				Length:		01:09:00		ieapm5_11-21-2010_15-49-05-284				Length:		00:08:03		1
	GPS	Hour	Start	15:49:23								15:49:24								
			End	15:57:33								15:58:14								Dist. (m)
		POS	Start	23	0,608	S	42	2,361	W	-23,010133	-42,03935	23	0,0185	S	42	1,404	W	-23,000308	-42,0234	1964
			End	23	0,8425	S	42	2,6467	W	-23,014042	-42,044112	23	0,0168	S	42	1,4062	W	-23,00028	-42,023437	2368

2i	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T15_12_54_323_TRANSMIT				Length:		01:09:00		ieapm6_11-21-2010_16-13-27-416				Length:		00:07:11		1
	GPS	Hour	Start	16:13:33								16:13:34								
			End	16:20:53								16:20:44								Dist. (m)
		POS	Start	23	1,0121	S	42	2,9155	W	-23,016868	-42,048592	23	0,0173	S	42	1,4053	W	-23,000288	-42,023422	3168
			End	23	1,062	S	42	3,0918	W	-23,0177	-42,05153	23	0,0178	S	42	1,4054	W	-23,000297	-42,023423	3468

3a	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T17_19_05_036_TRANSMIT				Length:		0:18:30		ieapm9_11-21-2010_17-26-18-662				Length:		00:06:33		1
	GPS	Hour	Start	17:26:43								18:01:14								
			End	17:31:53								18:01:14								Dist. (m)
		POS	Start	23	1,6591	S	42	5,0074	W	-23,027652	-42,083457	23	0,0181	S	42	1,4055	W	-23,000302	-42,023425	6861
			End	23	1,6972	S	42	5,1669	W	-23,028287	-42,086115	23	0,0181	S	42	1,4055	W	-23,000302	-42,023425	7137

4b	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T18_37_18_548_TRANSMIT				Length:		0:25:40		ieapm12_11-21-2010_18-58-57-915				Length:		00:05:56		1
	GPS	Hour	Start	18:59:13								18:59:14								
			End	19:05:13								19:05:04								Dist. (m)
		POS	Start	23	0,9829	S	42	4,0126	W	-23,016382	-42,066877	23	0,0193	S	42	1,404	W	-23,000322	-42,0234	4799
			End	23	1,0567	S	42	4,1342	W	-23,017612	-42,068903	23	0,0204	S	42	1,4038	W	-23,00034	-42,023397	5043

5a	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T19_13_23_983_TRANSMIT				Length:		0:36:00		ieapm13_11-21-2010_19-15-30-863				Length:		00:06:53		1
	GPS	Hour	Start	19:15:53								19:15:54								
			End	19:22:23								19:22:23								Dist. (m)
		POS	Start	23	0,9947	S	42	3,7069	W	-23,016578	-42,061782	23	0,019	S	42	1,4047	W	-23,000317	-42,023412	4328
			End	23	1,0731	S	42	3,8406	W	-23,017885	-42,06401	23	0,018	S	42	1,4068	W	-23,0003	-42,023447	4596

5c	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T19_13_23_983_TRANSMIT				Length:		0:36:00		ieapm14_11-21-2010_19-34-27-958				Length:		00:06:33		1
	GPS	Hour	Start	19:34:53								19:34:44								
			End	19:41:03								19:41:14								Dist. (m)
		POS	Start	23	0,9585	S	42	3,4063	W	-23,015975	-42,056772	23	0,0181	S	42	1,4066	W	-23,000302	-42,023443	3836
			End	23	0,9235	S	42	3,5861	W	-23,015392	-42,059768	23	0,018	S	42	1,4072	W	-23,0003	-42,023453	4085

6a	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T20_15_47_393_TRANSMIT				Length:		0:30:50		ieapm16_11-21-2010_20-17-30-922				Length:		00:05:56		1
	GPS	Hour	Start	20:17:53								20:17:44								
			End	20:23:33								20:23:34								Dist. (m)
		POS	Start	23	0,3221	S	42	2,6224	W	-23,005368	-42,043707	23	0,0185	S	42	1,4071	W	-23,000308	-42,023452	2156
			End	23	0,3694	S	42	2,5534	W	-23,006157	-42,042557	23	0,0182	S	42	1,4053	W	-23,000303	-42,023422	2068

6c	Day	Month	Year	TX								RX								Signal
	21	11	2010	2010_11_21_T20_15_47_393_TRANSMIT				Length:		0:30:50		ieapm17_11-21-2010_20-38-44-073				Length:		00:06:18		1
	GPS	Hour	Start	20:38:03								20:38:14								
			End	20:45:13								20:45:04								Dist. (m)
		POS	Start	23	0,5334	S	42	1,9817	W	-23,00889	-42,033028	23	0,017	S	42	1,4062	W	-23,000283	-42,023437	1370
			End	23	0,647	S	42	2,0737	W	-23,010783	-42,034562	23	0,0179	S	42	1,4053	W	-23,000298	-42,023422	1630

1a	Day	Month	Year	TX								RX								Signal
	22	11	2010	2010_11_22_T12_43_01_211_TRANSMIT						Length:	33:10:00	geo1_11-22-2010_12-54-46-789						Length:	21:46	2/3
		Hour	Start					12:54:40								12:55:01				
	GPS		End					13:15:10								13:15:01				Dist. (m)
		POS	Start	23	0,4165	S	42	7,1772	W	-23,00694	-42,11962	23	0,4786	S	42	7,7592	W	-23,00798	-42,12932	1001
			End	23	0,1205	S	42	7,6499	W	-23,00201	-42,1275	23	0,4788	S	42	7,7593	W	-23,00798	-42,12932	686

2a	Day	Month	Year	TX								RX								Signal
	22	11	2010	2010_11_22_T14_08_07_729_TRANSMIT						Length:	25:40:00	geo2_11-22-2010_13-59-02-263						Length:	22:17	2/3
		Hour	Start					14:08:30								13:59:11				
	GPS		End					14:22:00								14:21:51				Dist. (m)
		POS	Start	23	0,0987	S	42	7,7069	W	-23,00165	-42,12845	23	0,3919	S	42	7,9489	W	-23,00653	-42,13248	680
			End	22	59,9494	S	42	8,0634	W	-22,99916	-42,13439	23	0,1151	S	42	8,4762	W	-23,00192	-42,14127	768

3	Day	Month	Year	TX								RX								Signal
	22	11	2010	2010_11_22_T15_45_10_304_TRANSMIT						Length:	35:20:00	geo3_11-22-2010_16-14-31-092						Length:	22:36	3
		Hour	Start					16:14:10								16:14:51				
	GPS		End					16:20:30								16:20:41				Dist. (m)
		POS	Start	23	2,201	S	42	2,9579	W	-23,03668	-42,0493	23	2,3042	S	42	4,2277	W	-23,0384	-42,07046	2177
			End	23	2,132	S	42	3,13	W	-23,03553	-42,05217	23	2,2711	S	42	4,4065	W	-23,03785	-42,07344	2195

4a	Day	Month	Year	TX								RX								Signal
	22	11	2010	2010_11_22_T16_34_11_030_TRANSMIT						Length:	38:55	geo3_11-22-2010_16-14-31-092						Length:	22:36	2
		Hour	Start					16:34:20								16:35:00				
	GPS		End					16:37:00												Dist. (m)
		POS	Start	23	2,0683	S	42	3,5287	W	-23,03447	-42,05881	23	2,182	S	42	4,885	W	-23,03637	-42,08142	2327
			End	23	2,056	S	42	3,6096	W	-23,03427	-42,06016									2191

4c	Day	Month	Year	TX								RX								Signal
	22	11	2010	2010_11_22_T16_34_11_030_TRANSMIT						Length:	38:55	geo4_11-22-2010_16-54-28-299						Length:	24:19	2
		Hour	Start					16:54:20								16:54:41				
	GPS		End					17:15:00								17:15:01				Dist. (m)
		POS	Start	23	1,966	S	42	4,148	W	-23,03277	-42,06913	23	2,0946	S	42	5,5673	W	-23,03491	-42,09279	2436
			End	23	1,8531	S	42	4,8055	W	-23,03089	-42,08009	23	1,9958	S	42	6,2496	W	-23,03326	-42,10416	2481

Appendix B

Lubell.com Presents

Lubell LL-1424HP Underwater Acoustic Transducer

High-Power Broadband Piezoelectric Underwater transducer for Military and Scientific Applications

SPECIFICATIONS

- **Frequency Range:** 200Hz - 9kHz (+/-4dB between 400Hz - 8kHz)
- **SPL:** 197dB/uPa/m @ 600Hz (80V rms applied at cable end)
- **Maximum Voltage:** 80 Vrms
- **Duty Cycle:** 100%/10A, 50%/14A
- **Impedance:** 8 ohms nominal (including AC1424HP xfmr box)
- **Depth Rating:** 6' - 40'
- **Dimensions:** 16.5" x 16.5" x 16.5"
- **Ducer/Cage Wt:** 61 lbs/air, 33 lbs/water
- **Finish:** 10-mil epoxy on MIL-C-5541 Class 1-A (transducer); 304SS cage
- **Connector:** Seacon XSEE3BCR
- **Cable:** Seacon XSEE3CCP molded to one end of 50 meter 14/3 SO cable (32 lbs)
- **Data:** Guide, TVR, SPL, Z, tabular
- **Included:** AC1424HP bridging xfmr box
- **Price:** $6925
- **Warranty:** 2 year limited
- **Amplifier:** FR2500 $699 or CDi2000 $1373

lubell_labs@wowway.com
Tel: (614) 235-6740, 9:00am-5:00pm EST
Printable PDF brochure
Complete instructions and test data

DESCRIPTION

The LL-1424HP is a piezoelectric underwater acoustic transducer designed for general purpose military and scientific applications. The LL-1424HP may also be used as an underwater speaker when high power is required.

The LL-1424HP has a useful frequency range of 200Hz-9kHz (400Hz-8kHz +/-4dB), a maximum SPL of 197dB/uPa/m @ 600Hz w/80V rms applied, and a nominal impedance of 8 ohms. The LL1424HP is provided with an AC1424HP bridging transformer box allowing connection to amplifiers up to 2500 watts at 4 ohms bridged mono.

The LL-1424HP is built to withstand ocean environments by virtue of its 10 mil epoxy finish and cage mounting system. The LL-1424HP is fitted with a Seacon bulkhead connector and includes a mating 50 meter Seacon cable.

UNCLASSIFIED

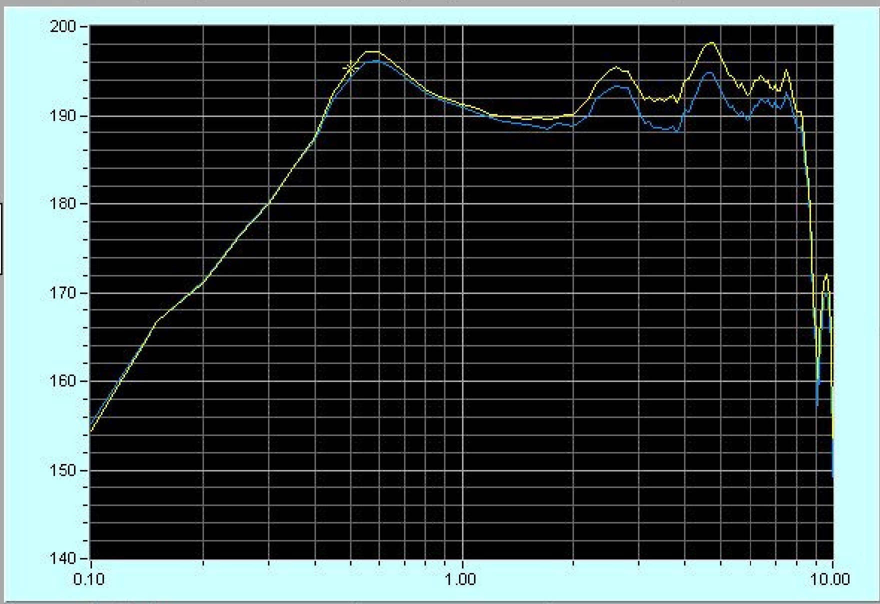
Graph Label

LL1424HP -B, with 1 and 2 - Ohm Resistor
DRIVE VOLTS: 80 Vrms
TEST DISTANCE: 2 meters
TEST DEPTH: 8.5 meters
WATER TEMP: 6.0 DEG C.
ORIENTATION: Horizontal

NUWC-Dodge Pond
6 Dodge Court
Niantic, CT
Thursday, August 14, 2003 3:35:50 PM

Sound pressure level vs Frequency

Sound pressure level (dB//uPa @1m)



1 ohm
2 ohm

Next

Frequency (kHz)

	Xaxis	Yaxis
CURSOR	0.50	195.32

index to selected graphs 0

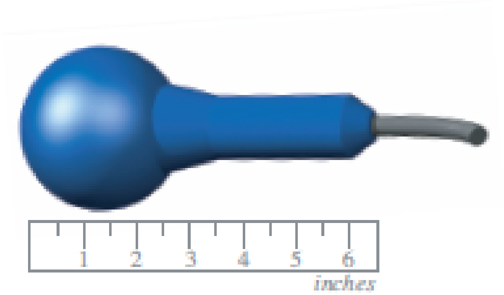
Appendix C

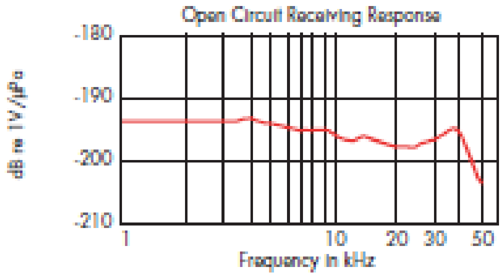
Model ITC-1032

Deep Water Omnidirectional Transducer

Model ITC-1032

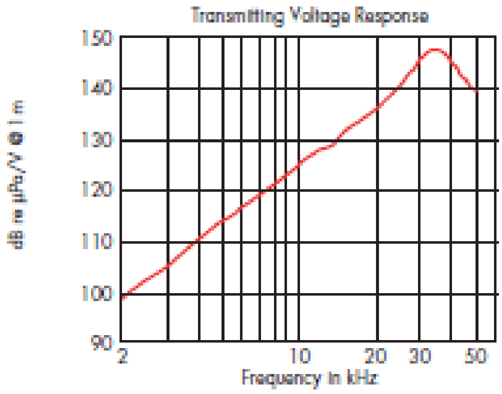
The Model ITC-1032 spherical transducer offers broadband omnidirectional transmitting and receiving response with efficiencies of over 50%. This transducer is fabricated of Channelite-5400 lead zirconate titanate ceramic and is particularly well suited for noise sources as a broadband hydrophone and applications where an omnidirectional response is required.

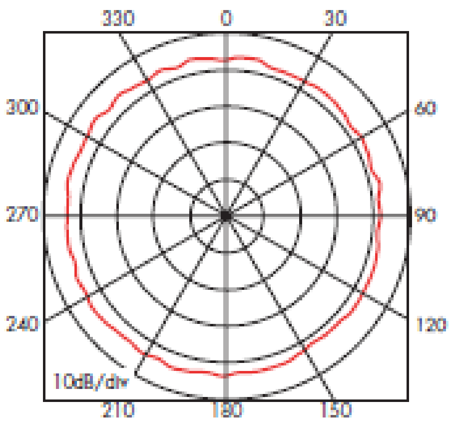




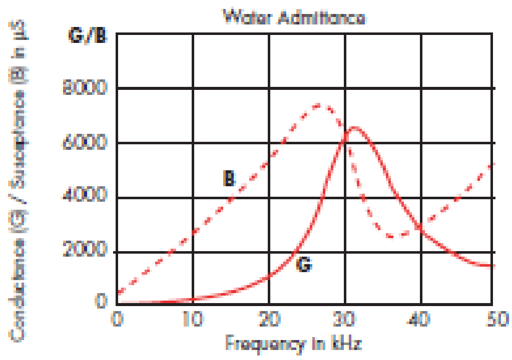
Specifications (Nominal)

Type	Projector/Hydrophone
Resonance Frequency f_r	33 kHz
Depth	1250 meters
Envelope Dimensions (in.)	2.7D
TVR at f_r	149 dB//µPa/V@1m
Midband OCV	-194 dB//1V/µPa
Suggested Band	.01 - 50 kHz
Beam Type	Spherical
Input Power	800 watts





Directivity Pattern at 10.0 kHz



International Transducer Corporation
869 Ward Drive, Santa Barbara, CA 93111
805.683.2575 • 805.967.8199 FAX
www.itc-transducers.com

Appendix D

RECEPTOR GPS MOUSE
USB OU SERIAL COM PS2

ME-2000RW

ME Componentes e Equipamentos Eletrônicos Ltda
Brasilia - DF – BRASIL Telefone/Fax: 55 61 3202 7170 / / http://www.mecomp.com.br

1. Sumário

O **ME-2000RW** é um receptor GPS" com antena acoplada. A antena é conectada ao receptor através de um LNA. (Amplificador de Baixo Ruído). O receptor tem 51 canais de aquisição e 14 canais de de rastreamento que são capazes de receber sinais de até 65 satélites GPS e informar a posição e o tempo precisos para serem lidos na porta USB. O equipamento tem baixo consumo e a faixa de tensão suportada vai de 3.3V~6.0V.

O Receptor GPS ME-2000RW é um componente externo 100% testado, para ser usado em conjunto com outros aparelhos.

2. Aplicação

- Notebooks;
- Netbooks e
- Sistemas embarcados que possuam interface USB.

3 . Descrição do Hardware

Face Frontal

Face Traseira

Embalagem

Conector

4 . Especificação

Item	Especificação
Canais	65 Canais
Sensibilidade	- 161 dBm
Frequência	1.575,42MHz
Código	C/A"
Tempo de Inicio	Inicio Frio 35 seg. Inicio Intermediário 5 seg. Inicio Quente 1 seg.
Reaquisição de Sinal	< 1 seg.
Precisão	Posição 5 metros Velocidade 0,1 m/seg
Taxa de Atualização	1 Hz
Limites operacionais	Altitude < 18.000 m Velocidade < 500 m/s
Dinâmica	4G (39.2m/sec²)
Datum	WGS-84(Padrão)"
Protocolo	NMEA-0183 V3.01
Sistema	SBAS (WAAS/EGNOS)"
Sinal de Saida	USB
Dimensão	60mm x 40 mm x 14 mm
Peso	14 g
Conector	USB ou PS2
Faixa de Tensão	3.6V a 6V
Temperatura de Armazenamento	-40°C até +80°C
Temperatura de operação	-20°C até +60°C
Umidade	5% a 95% não condensado

ME Componentes e Equipamentos Eletrônicos Ltda
Brasilia - DF – BRASIL Telefone/Fax: 55 61 3202 7170 / / http://www.mecomp.com.br

5 Especificações sobre a Comunicação

Item	Descrição
Interface	Interface Serial Full Duplex
Bit rate	9600bps
Start bit	1
Stop bit	1
Data bit	8
Paridade	None
Dados transmitidos	SACII NMEA0183 Ver. 3.01
Taxa de Atualização	1 Hz
Sentença de Saída	GPGGA, GPGSA, GPRMC, GPVTG

```
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$GPRMC,120353.000,V,0000.0000,N,00000.0000,E,000.0,000.0,280606,,,N*7A
```

Figura XX – Sentenças NMEA

6 Driver para Interface USB

O Receptor GPS ME-2000RW é fabricado com o chipset USB da Prolific, modelo PL-2303. Para o uso do equipamento será necessário instalar em seu PC, o driver para interface USB que pode ser obtido em nossa página na Internet.

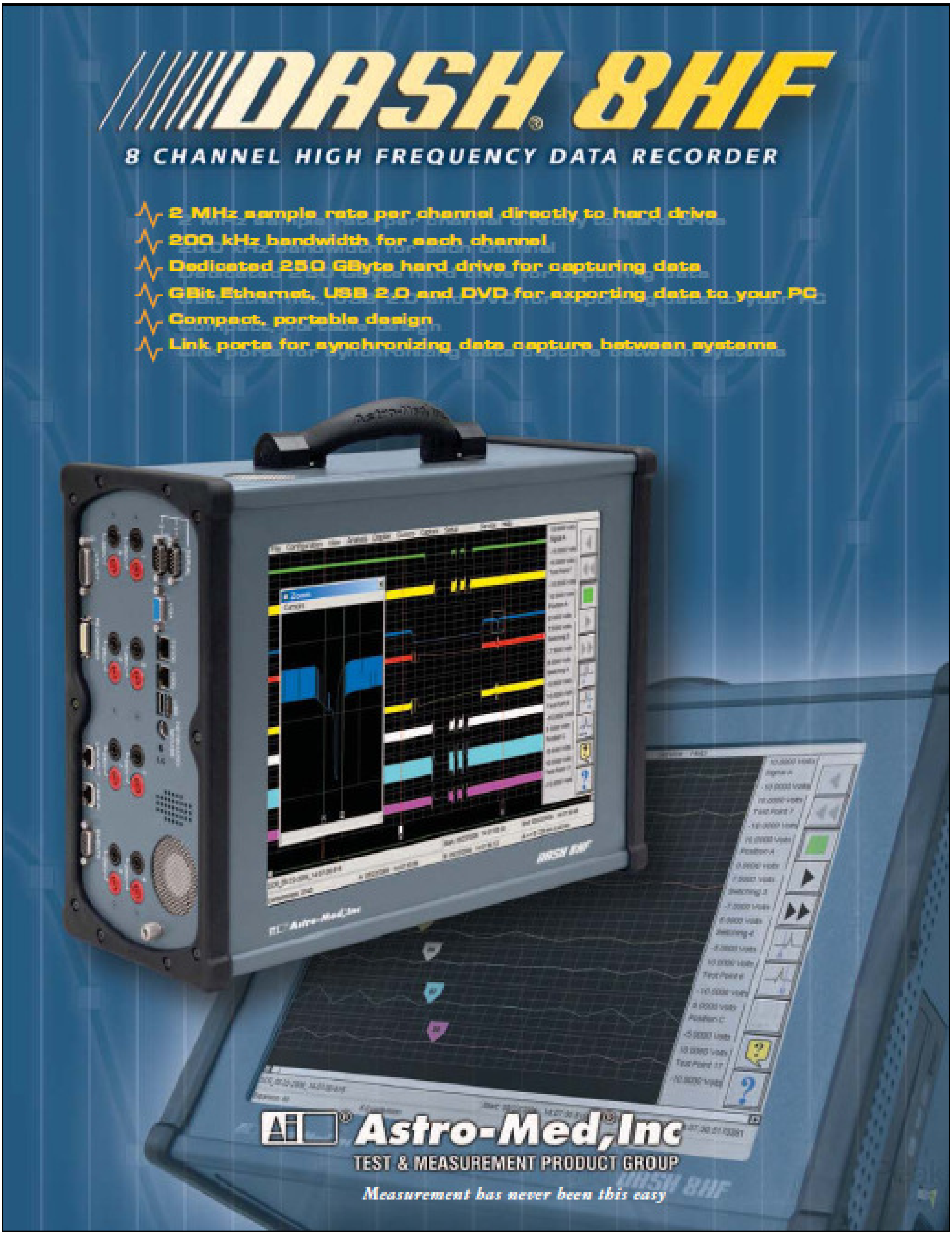
O Driver é o *PL2303_Prolific_GPS_1013_20090319*

Todos os principais sistemas operacionais são suportados.

- Windows 98SE
- Windows ME
- Windows 2000 SP4
- Windows XP SP2 and above (32 bit)
- Windows Server 2003 (32 bit)
- Windows Vista (32 & 64 bit)
- Windows Server 2008 (32 & 64 bit)
- Windows 7 (32 & 64 bit)

NOTA: Para o Windows 7, favor usar RC build 7100 ou acima.

Appendix E


DASH 8HF
8 CHANNEL HIGH FREQUENCY DATA RECORDER
2 MHz sample rate per channel directly to hard drive
200 kHz bandwidth for each channel
Dedicated 250 GByte hard drive for capturing data
GBit Ethernet, USB 2.0 and DVD for exporting data to your PC
Compact, portable design
Link ports for synchronizing data capture between systems
Astro-Med, Inc
TEST & MEASUREMENT PRODUCT GROUP
Measurement has never been this easy

SPECIFICATIONS

Color Display

Type	Active matrix color LCD (TFT)
Viewing Area	15.0 inch (diagonal)
Resolution	1024 x 768
Touch	Full screen, resistive

A/D Modules

Maximum Waveforms	8
Event Inputs	8
User Engineering Units	yes
Calibration	Semi-automated to external reference
Pre and Post-capture Filter	Advanced lowpass, highpass, band pass and bandstop filtering
A/D	16 bit SAR per channel

Isolated Input Module

Connector	Guarded banana jack
Bandwidth	200 KHz
Maximum Rated Input	+/- 250 Vrms
Maximum Transient Input	+/- 800 V
Isolation	250 Vrms, channel to channel, channel to chassis
Specified Ranges	100 mVFS to 800 VFS (0V offset for 800 VFS range)
Attenuator Ranges	1, 10, 50, 200 and 400 Volt
Anti-Aliasing Filter	200 kHz 4 pole Bessel
Accuracy (25°C)	+/- 0.07% of attenuator
Intrinsic Noise (pk-pk)	<0.2% of attenuator
Minimum Input Impedance	1 Megohm
Frequency Counter	Yes, on channels 1 & 5
Frequency Accuracy	+/- 0.005% of measurement

Recording

Operational Modes	Scope, Review, Real-time (strip-chart)
Recording Method	Internal 250 GByte disk drive, optionally removable (HS version)
Maximum Sample Rate	2,000,000 samples/second per channel (2 MHz per channel)
Minimum Sample Rate	100 samples/second per channel (100 Hz per channel)
Total Capacity	Over 100 billion samples
Maximum Record	Up to the drive capacity (250 GByte)
Data Stored	Raw (unfiltered) data is saved to the drive when the data capture filters are disabled
Time Stamp	Time and Date automatically saved with data
Header	Information on units, range, sample rates, etc, saved with data
Data Filtering	Post capture filtering changes can be made in Review Mode
Events	Stored with data
Trigger Point	Amount of pre and post trigger data is user adjustable (0-100%)
Auto Re-Arm	Automatic stacking of captures

Interface

Ethernet	10/100/1000BaseT
DVD	Supports archive of data to CD-R, CD-RW, DVD-R, DVD+R & DVD+RW
VGA	For displaying data on external monitor
Link Ports	For synchronizing data capture for multiple systems
USB 2.0	For connecting external hard drives, Flash Drives, etc.
Recorder	For interfacing to optional strip chart recorder

Power

Input Voltage Range	102 to 264 VAC
Frequency Range	47 Hz to 63 Hz
Power Factor	0.99

Physical

Enclosure	Aluminum, with armored endcaps
Dimensions	12.1" H x 16.0" W x 6.6" D (not including handle)
Weight	22.5 lbs.

Environmental

Operating Temperature	5 to 40°C (40 to 105°F)
Operating Humidity	10% to 90% non condensing

Compliance

Safety	EN 61010-1:2001, UL 61010A-1, CSA C22.2 No. 1010.1-92
EMC	FCC Part 15, Subpart B, Class A, EN 61326
Power Harmonics	IEC1000-3-2

OTHER EXCITING PRODUCTS AVAILABLE FROM ASTRO-MED

Dash 18X: Features 18 channels of universal inputs, data acquisition to internal hard drive at 100 kHz sample rate per channel.

Dash 8Xe: Features 8 channels of modular inputs, data acquisition to internal hard drive at 200 kHz sample rate per channel.

Dash 8XPM: Features the capabilities of a three phase power monitor and high end data acquisition recorder in one useful tool!

Astro-Med, Inc
TEST & MEASUREMENT PRODUCT GROUP

World Headquarters
Astro-Med Industrial Park
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Appendix F

Guide to the CTD Data Files (more information in the Appendix I):

Data	Hora (UTC)	Latitude	Longitude	Arquivo	Figura	Comentários
18-nov-10	11:38:13 PM	23o02.006'S	041o58.993'S	FILE1.000	OAEX_2010_FILE1.000_23hrs40min.png	Grade Oc. Dia 1
19-nov-10	12:09:51 AM	23o03.948'S	041o59.263'S	FILE2.000	OAEX_2010_FILE2.000_00hrs12min.png	Grade Oc. Dia 1
19-nov-10	12:41:42 AM	23o05.979'S	041o59.018'S	FILE3.000	OAEX_2010_FILE3.000_00hrs45min.png	Grade Oc. Dia 1
19-nov-10	1:11:40 AM	23o07.953'S	041o59.106'S	FILE4.000	OAEX_2010_FILE4.000_01hrs15min.png	Grade Oc. Dia 1
19-nov-10	2:00:14 AM	23o10.054'S	041o58.966'S	FILE5.000	OAEX_2010_FILE5.000_02hrs03min.png	Grade Oc. Dia 1
19-nov-10	2:36:49 AM	23o09.929'S	042o03.007'S	FILE6.000	OAEX_2010_FILE6.000_02hrs40min.png	Grade Oc. Dia 1
19-nov-10	3:00:18 AM	23o08.062'S	042o03.098'S	FILE7.000	OAEX_2010_FILE7.000_03hrs04min.png	Grade Oc. Dia 1
19-nov-10	3:27:57 AM	23o05.840'S	042o03.125'S	FILE8.000	OAEX_2010_FILE8.000_03hrs31min.png	Grade Oc. Dia 1
19-nov-10	3:51:09 AM	23o03.967'S	042o03.271'S	FILE9.000	OAEX_2010_FILE9.000_03hrs54min.png	Grade Oc. Dia 1
19-nov-10	4:25:18 AM	23o00.144'S	042o03.154'S	FILE10.000	OAEX_2010_FILE10.000_04hrs27min.png	Grade Oc. Dia 1
19-nov-10	4:45:36 AM	22o57.944'S	042o03.001'S	FILE11.000	OAEX_2010_FILE11.000_04hrs46min.png	Grade Oc. Dia 1
19-nov-10	5:08:07 AM	22o58.064'S	042o04.960'S	FILE12.000	OAEX_2010_FILE12.000_05hrs08min.png	Grade Oc. Dia 1
19-nov-10	5:24:50 AM	22o58.000'S	042o07.000'S	FILE13.000	OAEX_2010_FILE13.000_05hrs26min.png	Grade Oc. Dia 1
19-nov-10	6:05:02 AM	23o01.871'S	042o07.206'S	FILE14.000	OAEX_2010_FILE14.000_06hrs07min.png	Grade Oc. Dia 1
19-nov-10	6:47:52 AM	23o05.755'S	042o07.138'S	FILE15.000	OAEX_2010_FILE15.000_06hrs50min.png	Grade Oc. Dia 1
19-nov-10	7:30:59 AM	23o09.730'S	042o07.037'S	FILE16.000	OAEX_2010_FILE16.000_07hrs34min.png	Grade Oc. Dia 1
19-nov-10	7:58:00 AM	23o09.883'S	042o09.271'S	FILE17.000	OAEX_2010_FILE17.000_08hrs02min.png	Grade Oc. Dia 1
19-nov-10	8:34:54 AM	23o08.052'S	042o10.956'S	FILE19.000	OAEX_2010_FILE19.000_08hrs37min.png	Grade Oc. Dia 1
19-nov-10	9:20:33 AM	23o04.162'S	042o11.130'S	FILE20.000	OAEX_2010_FILE20.000_09hrs22min.png	Grade Oc. Dia 1
19-nov-10	12:20:57 PM	23o03.000'S	041o58.000'S	FILE21.000	OAEX_2010_FILE21.000_12hrs23min.png	Suporte acústica
19-nov-10	12:49:55 PM	23o03.000'S	041o58.000'S	FILE22.000	OAEX_2010_FILE22.000_12hrs52min.png	Suporte acústica
19-nov-10	1:19:19 PM	23o03.800'S	041o58.400'S	FILE23.000	OAEX_2010_FILE23.000_13hrs22min.png	Suporte acústica
19-nov-10	1:51:21 PM	23o03.800'S	041o59.200'S	FILE24.000	OAEX_2010_FILE24.000_13hrs54min.png	Suporte acústica
19-nov-10	3:05:21 PM	22o59.703'S	042o03.350'S	FILE25.000	OAEX_2010_FILE25.000_15hrs07min.png	Suporte acústica
19-nov-10	3:43:37 PM	22o59.200'S	042o03.626'S	FILE26.000	OAEX_2010_FILE26.000_15hrs44min.png	Suporte acústica
19-nov-10	4:17:47 PM	22o59.847'S	042o03.453'S	FILE28.000	OAEX_2010_FILE28.000_16hrs19min.png	Suporte acústica
19-nov-10	4:48:24 PM	22o59.347'S	042o03.703'S	FILE29.000	OAEX_2010_FILE29.000_16hrs50min.png	Suporte acústica
19-nov-10	5:39:23 PM	23o01.003'S	042o03.532'S	FILE30.000	OAEX_2010_FILE30.000_17hrs41min.png	Suporte acústica
19-nov-10	6:15:37 PM	23o00.343'S	042o04.380'S	FILE31.000	OAEX_2010_FILE31.000_18hrs17min.png	Suporte acústica
19-nov-10	7:27:47 PM	22o58.401'S	042o04.304'S	FILE32.000	OAEX_2010_FILE32.000_19hrs28min.png	Suporte acústica
19-nov-10	8:43:47 PM	22o57.945'S	042o11.006'S	FILE33.000	OAEX_2010_FILE33.000_20hrs44min.png	Grade Oc. Dia 2
19-nov-10	9:09:24 PM	22o59.940'S	042o11.107'S	FILE34.000	OAEX_2010_FILE34.000_21hrs11min.png	Grade Oc. Dia 2
19-nov-10	9:34:20 PM	23o01.985'S	042o11.128'S	FILE35.000	OAEX_2010_FILE35.000_21hrs36min.png	Grade Oc. Dia 2
19-nov-10	10:11:41 PM	23o03.952'S	042o11.244'S	FILE36.000	OAEX_2010_FILE36.000_22hrs14min.png	Grade Oc. Dia 2
19-nov-10	10:36:54 PM	23o06.017'S	042o11.083'S	FILE38.000	OAEX_2010_FILE38.000_22hrs39min.png	Grade Oc. Dia 2
19-nov-10	11:03:28 PM	23o07.808'S	042o11.147'S	FILE39.000	OAEX_2010_FILE39.000_23hrs06min.png	Grade Oc. Dia 2
19-nov-10	11:30:28 PM	23o10.034'S	042o11.101'S	FILE40.000	OAEX_2010_FILE40.000_23hrs33min.png	Grade Oc. Dia 2
20-nov-10	11:53:42 PM	23o10.055'S	042o09.053'S	FILE41.000	OAEX_2010_FILE41.000_23hrs56min.png	Grade Oc. Dia 2
20-nov-10	12:19:44 AM	23o10.071'S	042o07.154'S	FILE42.000	OAEX_2010_FILE42.000_00hrs23min.png	Grade Oc. Dia 2
20-nov-10	12:45:14 AM	23o07.905'S	042o07.200'S	FILE43.000	OAEX_2010_FILE43.000_00hrs48min.png	Grade Oc. Dia 2
20-nov-10	1:09:00 AM	23o06.009'S	042o07.147'S	FILE44.000	OAEX_2010_FILE44.000_01hrs11min.png	Grade Oc. Dia 2
20-nov-10	1:32:06 AM	23o03.965'S	042o07.057'S	FILE45.000	OAEX_2010_FILE45.000_01hrs34min.png	Grade Oc. Dia 2
20-nov-10	1:54:09 AM	23o01.845'S	042o07.158'S	FILE46.000	OAEX_2010_FILE46.000_01hrs56min.png	Grade Oc. Dia 2
20-nov-10	2:14:23 AM	23o00.117'S	042o07.116'S	FILE47.000	OAEX_2010_FILE47.000_02hrs15min.png	Grade Oc. Dia 2
20-nov-10	2:38:17 AM	22o57.900'S	042o07.000'S	FILE48.000	OAEX_2010_FILE48.000_02hrs39min.png	Grade Oc. Dia 2
20-nov-10	2:58:56 AM	22o57.900'S	042o05.100'S	FILE50.000	OAEX_2010_FILE50.000_02hrs59min.png	Grade Oc. Dia 2
20-nov-10	3:18:18 AM	22o58.090'S	042o02.958'S	FILE51.000	OAEX_2010_FILE51.000_03hrs18min.png	Grade Oc. Dia 2
20-nov-10	3:38:38 AM	23o00.093'S	042o03.180'S	FILE52.000	OAEX_2010_FILE52.000_03hrs40min.png	Grade Oc. Dia 2
20-nov-10	4:01:28 AM	23o01.972'S	042o03.117'S	FILE53.000	OAEX_2010_FILE53.000_04hrs03min.png	Grade Oc. Dia 2

20-nov-10	4:24:39 AM	23o04.159'S	042o03.180'S	FILE54.000	OAEX_2010_FILE54.000_04hrs27min.png	Grade Oc. Dia 2
20-nov-10	4:49:59 AM	23o06.047'S	042o03.057'S	FILE55.000	OAEX_2010_FILE55.000_04hrs52min.png	Grade Oc. Dia 2
20-nov-10	5:12:55 AM	23o07.826'S	042o03.245'S	FILE56.000	OAEX_2010_FILE56.000_05hrs16min.png	Grade Oc. Dia 2
20-nov-10	5:39:00 AM	23o09.810'S	042o03.559'S	FILE57.000	OAEX_2010_FILE57.000_05hrs42min.png	Grade Oc. Dia 2
20-nov-10	6:20:25 AM	23o09.949'S	041o59.100'S	FILE58.000	OAEX_2010_FILE58.000_06hrs23min.png	Grade Oc. Dia 2
20-nov-10	6:40:50 AM	23o08.191'S	041o59.099'S	FILE59.000	OAEX_2010_FILE59.000_06hrs44min.png	Grade Oc. Dia 2
20-nov-10	7:05:16 AM	23o06.163'S	041o59.278'S	FILE60.000	OAEX_2010_FILE60.000_07hrs08min.png	Grade Oc. Dia 2
20-nov-10	7:32:36 AM	23o04.017'S	041o59.034'S	FILE61.000	OAEX_2010_FILE61.000_07hrs35min.png	Grade Oc. Dia 2
20-nov-10	7:59:04 AM	23o02.007'S	041o59.011'S	FILE62.000	OAEX_2010_FILE62.000_08hrs01min.png	Grade Oc. Dia 2
20-nov-10	11:28:47 AM	22o58.683'S	042o04.747'S	FILE63.000	OAEX_2010_FILE63.000_11hrs29min.png	Suporte acústica
20-nov-10	4:16:40 PM	23o03.423'S	042o04.179'S	FILE68.000	OAEX_2010_FILE68.000_16hrs18min.png	Suporte acústica
20-nov-10	5:58:46 PM	23o02.232'S	042o03.935'S	FILE70.000	OAEX_2010_FILE70.000_18hrs01min.png	Suporte acústica
20-nov-10	6:50:10 PM	23o01.673'S	042o05.101'S	FILE71.000	OAEX_2010_FILE71.000_18hrs52min.png	Suporte acústica
20-nov-10	8:04:24 PM	22o59.233'S	042o04.382'S	FILE73.000	OAEX_2010_FILE73.000_20hrs05min.png	Suporte acústica
20-nov-10	9:57:53 PM	22o57.971'S	042o10.927'S	FILE75.000	OAEX_2010_FILE75.000_21hrs58min.png	Grade Oc. Dia 3
20-nov-10	10:19:52 PM	22o59.851'S	042o11.251'S	FILE76.000	OAEX_2010_FILE76.000_22hrs20min.png	Grade Oc. Dia 3
20-nov-10	10:51:13 PM	23o01.901'S	042o11.247'S	FILE78.000	OAEX_2010_FILE78.000_22hrs52min.png	Grade Oc. Dia 3
20-nov-10	11:19:47 PM	23o03.992'S	042o11.255'S	FILE79.000	OAEX_2010_FILE79.000_23hrs22min.png	Grade Oc. Dia 3
21-nov-10	11:43:51 PM	23o05.980'S	042o11.105'S	FILE81.000	OAEX_2010_FILE81.000_23hrs46min.png	Grade Oc. Dia 3
21-nov-10	12:11:01 AM	23o08.110'S	042o11.087'S	FILE82.000	OAEX_2010_FILE82.000_00hrs14min.png	Grade Oc. Dia 3
21-nov-10	12:54:45 AM	23o08.001'S	042o07.110'S	FILE83.000	OAEX_2010_FILE83.000_00hrs57min.png	Grade Oc. Dia 3
21-nov-10	1:22:13 AM	23o05.900'S	042o07.126'S	FILE86.000	OAEX_2010_FILE86.000_01hrs25min.png	Grade Oc. Dia 3
21-nov-10	1:49:24 AM	23o03.972'S	042o07.154'S	FILE88.000	OAEX_2010_FILE88.000_01hrs52min.png	Grade Oc. Dia 3
21-nov-10	2:15:19 AM	23o02.075'S	042o07.163'S	FILE90.000	OAEX_2010_FILE90.000_02hrs17min.png	Grade Oc. Dia 3
21-nov-10	2:36:56 AM	23o00.104'S	042o07.160'S	FILE91.000	OAEX_2010_FILE91.000_02hrs38min.png	Grade Oc. Dia 3
21-nov-10	3:00:41 AM	22o57.973'S	042o07.071'S	FILE93.000	OAEX_2010_FILE93.000_03hrs01min.png	Grade Oc. Dia 3
21-nov-10	7:02:20 AM	22o58.093'S	042o02.972'S	FILE95.000	OAEX_2010_FILE95.000_07hrs02min.png	Grade Oc. Dia 3
21-nov-10	7:28:53 AM	22o59.797'S	042o03.002'S	FILE97.000	OAEX_2010_FILE97.000_07hrs30min.png	Grade Oc. Dia 3
21-nov-10	7:51:42 AM	23o01.789'S	042o03.146'S	FILE99.000	OAEX_2010_FILE99.000_07hrs53min.png	Grade Oc. Dia 3
21-nov-10	8:15:59 AM	23o03.855'S	042o03.182'S	FILE100.000	OAEX_2010_FILE100.000_08hrs18min.png	Grade Oc. Dia 3
21-nov-10	8:38:20 AM	23o05.996'S	042o03.108'S	FILE101.000	OAEX_2010_FILE101.000_08hrs41min.png	Grade Oc. Dia 3
21-nov-10	9:13:47 AM	23o06.074'S	041o59.151'S	FILE103.000	OAEX_2010_FILE103.000_09hrs16min.png	Grade Oc. Dia 3
21-nov-10	9:50:14 AM	23o02.264'S	041o58.953'S	FILE104.000	OAEX_2010_FILE104.000_09hrs53min.png	Grade Oc. Dia 3
21-nov-10	2:40:52 PM	23o00.049'S	042o01.673'S	FILE105.000	OAEX_2010_FILE105.000_14hrs42min.png	Suporte acústica
21-nov-10	4:04:13 PM	23o00.921'S	042o02.752'S	FILE107.000	OAEX_2010_FILE107.000_16hrs06min.png	Suporte acústica
21-nov-10	4:51:52 PM	23o01.302'S	042o03.839'S	FILE109.000	OAEX_2010_FILE109.000_16hrs53min.png	Suporte acústica
21-nov-10	5:59:11 PM	23o01.395'S	042o05.134'S	FILE111.000	OAEX_2010_FILE111.000_18hrs01min.png	Suporte acústica
21-nov-10	6:32:57 PM	23o00.930'S	042o04.417'S	FILE112.000	OAEX_2010_FILE112.000_18hrs34min.png	Suporte acústica
21-nov-10	7:53:01 PM	23o00.668'S	042o03.236'S	FILE113.000	OAEX_2010_FILE113.000_19hrs54min.png	Suporte acústica
21-nov-10	8:33:59 PM	23o00.518'S	042o02.006'S	FILE115.000	OAEX_2010_FILE115.000_20hrs35min.png	Suporte acústica
22-nov-10	1:24:40 PM	23o00.000'S	042o07.890'S	FILE118.000	OAEX_2010_FILE118.000_13hrs26min.png	Suporte acústica
22-nov-10	2:28:03 PM	22o59.878'S	042o08.229'S	FILE121.000	OAEX_2010_FILE121.000_14hrs29min.png	Suporte acústica
22-nov-10	4:47:31 PM	23o01.994'S	042o03.971'S	FILE124.000	OAEX_2010_FILE124.000_16hrs49min.png	Suporte acústica

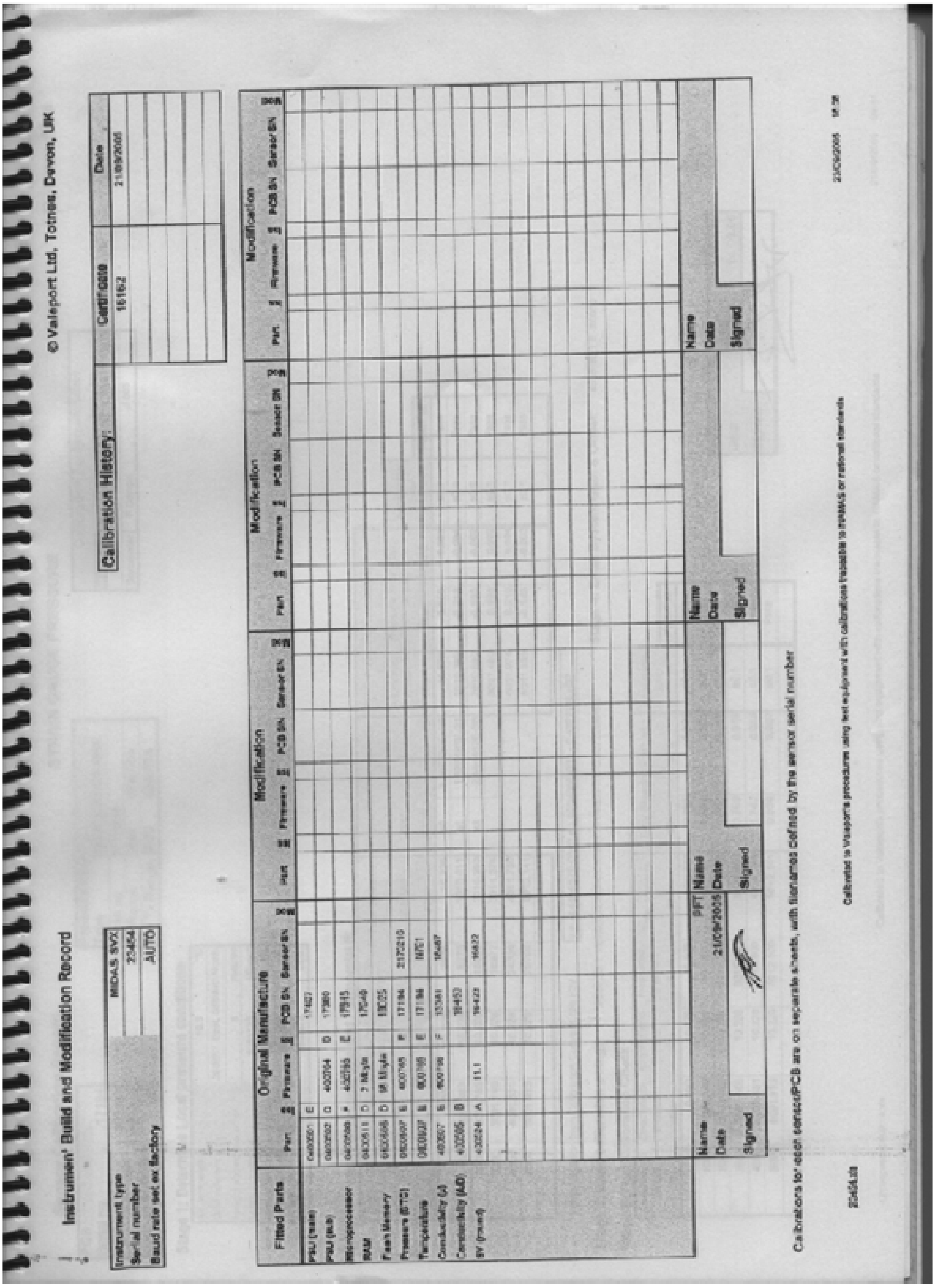
Appendix G

Guide to XBT Data Files (more information in Appendix I)

Data	Hora (UTC)	Latitude	Longitude	Arquivo	Figura
19-nov-10	2:21	23o09.932'S	042o01.096'S	T0_00003.edf	OAEx_2010_T0_00003_02:21.png
19-nov-10	3:57	23o03.967'S	042o03.271'S	T0_00005.edf	OAEx_2010_T0_00005_03:57.png
19-nov-10	4:08	23o02.158'S	042o03.231'S	T0_00006.edf	OAEx_2010_T0_00006_04:08.png
19-nov-10	5:47	23o00.079'S	042o07.208'S	T0_00007.edf	OAEx_2010_T0_00007_05:47.png
19-nov-10	6:30	23o03.909'S	042o07.100'S	T0_00008.edf	OAEx_2010_T0_00008_06:30.png
19-nov-10	7:12	23o07.848'S	042o07.145'S	T0_00009.edf	OAEx_2010_T0_00009_07:12.png
19-nov-10	8:15	23o09.939'S	042o10.803'S	T0_00011.edf	OAEx_2010_T0_00011_08:15.png
19-nov-10	8:58	23o06.228'S	042o10.995'S	T0_00013.edf	OAEx_2010_T0_00013_08:58.png

Appendix H

Valeport CTD calibration sheet



Instrument Build and Modification Record

© Valeport Ltd, Totnes, Devon, UK

Instrument type	MIDAS SVX
Serial number	23454
Baud rate set ex factory	AUTO

Calibration History:	Certificate	Date
	16162	21/09/2005

Fitted Parts	Original Manufacture: Part	Iss	Firmware	Iss	PCB SN	Sensor SN	Mod
PSU (main)	0400501	E			17427		
PSU (sub)	0400502	D	400764	D	17380		
Microprocessor	0400500	F	400765	E	17845		
RAM	0400518	D	2 Mbyte		17040		
Flash Memory	0400508	D	16 Mbyte		18005		
Pressure (STG)	0400507	E	400765	F	17194	2172210	
Temperature	0400507	E	400765	E	17194	NT61	
Conductivity (J)	400507	E	400798	F	13381	18487	
Conductivity (A/D)	400505	B			18453		
SV (round)	400524	A	11.1		16422	16822	

Modification: Part | Iss | Firmware | Iss | PCB SN | Sensor SN | Mod

Name PFT
Date 21/09/2005
Signed

Calibrations for each sensor/PCB are on separate sheets, with filenames defined by the sensor serial number

23454.xls

Calibrated to Valeport's procedures using test equipment with calibrations traceable to NAMAS or national standards

21/09/2005 16:38

Sensor Calibration Record | **STRAIN GAUGE PRESSURE** | © Valeport Ltd

PCB	
Serial no.	17194
Part no.	400507
Firmware	0400765e
Module	20

Pressure sensor		
Type	DRUCK PDCR4000	
Serial no.	2173215	
Tx Range	5000	dBarAbs
Set Tx Range	5000	dBarAbs

Calibration Equipment used		
Instrument	Type	Serial No
DWT	Budenburg	480L/24175/317E/3285
Barometer	F Darton	J 665

Stage 1: Determine Local pressure conditions

Air temperature	16.8	°C
Grid reference	280557 East, 050840 North	
Height above sea level	5	metres
Local Gravity	9.81125	M/sec²
Gravity std for barometer	9.80665	M/sec²
Atmospheric pressure	768.900	mmHg
	10.2278	dBar

Stage 2: Obtain Calibration data and Polynomial fit

Deadweight weight	Deadweight pressure	Atmospheric Pressure	Counts (nnnn)	Total pressure absolute	Polynomial fit for raw data		Polynomial calculations			Acceptable Error	Pass/Fail
					Order	2	Polynomial Result	Pressure Error (Calc - Actual)			
dBar	dBar	dBar	nnnn	dBarA	Parameter	Value	dBarA	dBar	%FS		
0	0.000	10.228	2936	10.228	a0	-5.407220E+02	10.378	0.150	0.003	±0.1	Pass
1000	1000.383	10.228	8276	1010.611	a1	1.876485E-01	1010.395	-0.216	-0.004	±0.1	Pass
2000	2000.765	10.228	13622	2010.993	a2	2.444482E-08	2010.890	-0.103	-0.002	±0.1	Pass
3000	3001.148	10.228	18977	3011.376			3011.480	0.105	0.002	±0.1	Pass
4000	4001.531	10.228	24339	4011.758			4011.974	0.216	0.004	±0.1	Pass
5000	5001.913	10.228	29706	5012.141			5011.993	-0.148	-0.003	±0.1	Pass

Paste Equation from Calibration Curve in cell F29: y = -2.444482E-08x2 + 1.876485E-01x - 5.407220E+02

Stage 3: Enter calibration string: #024;20;1;15;0;0;0;-2.444482e-08;1.876485e-01;-5.407220e+02

Stage 4: Enter System Gain & Offset: #035;20;1;8;-23000

Stage 5: Post Calibration Check

Deadweight weight dBar	Deadweight pressure dBar	Atmospheric Pressure dBar	Measured pressure dBarA	Total pressure dBarA	Error (Reading - Actual) dBar	%FS	Acceptable Error	Pass/Fail
0	0.000	10.228	10.625	10.228	0.397	0.008	±0.1	Pass
1000	1000.383	10.228	1011.000	1010.611	0.389	0.008	±0.1	Pass
2000	2000.765	10.228	2011.750	2010.993	0.757	0.015	±0.1	Pass
3000	3001.148	10.228	3012.125	3011.376	0.749	0.015	±0.1	Pass
4000	4001.531	10.228	4013.500	4011.758	1.742	0.035	±0.1	Pass
5000	5001.913	10.228	5012.500	5012.141	0.359	0.007	±0.1	Pass

Name	J.Harper
Date	14.09.05
Signed	

Sensor Calibration Record | **TEMPERATURE** | **Valeport Ltd**

PCB		
	Serial no.	17194
	Part no.	400507
	Firmware	0400765e
	Thermistor Type	DS18B20
	Module	20

Temperature sensor	
Type	100r
Serial no.	N701

Calibration Equipment used		
Instrument	Type	Serial No
Temp Bridge	ASL - F28	14-005
PRT	S17918/A T35/02	X1984A/TE MA/93

PCB internal temperature calibration

Stage 1: Obtain PCB temperature calibration data

PCB therm reading				Correction formula	
°C (internal)	Output counts				
3	41360	Best fit slope	-0.031	Gain =	3.125
19	41359	Best fit intercept	41359.92708	Offset =	-46.875
35	41359				

Normalised counts [20]	Reading	Temperature
counts	counts	°C
41359.302	41359.000	19

Stage 2: Enter calibration string: #086;20;3;-47

PCB/Sensor calibration

Stage 1: Obtain Calibration data and Polynomial fit

Counts	Bath temp	Polynomial fit for raw data		Polynomial calculations		Acceptable Error	Pass/Fail
		Order >>>>	2	Calc Temp	Error (Calc - Actual)		
nnnn	°C [90]	Parameter	Value	°C [90]	°C [90]		
24384	2.043	a0	-2.215946E+01	2.043	0.000	±0.005	Pass
40346	17.927	a1	9.910822E-04	17.926	0.000	±0.005	Pass
57519	35.045	a2	6.0059910E-11	35.045	0.000	±0.005	Pass

Enter polynomial in cell E26 y = 6.005910E-11x2 + 9.910822E-04x - 2.215946E+01

Stage 2: Enter calibration string: #024;20;2;15;1;0;0;6.005910e-11;9.910822e-04;-2.215946e+01

Stage 3: Enter System Gain & Offset #035;20;2;1000;-20000

Stage 4: Post Calibration Check

Reading	Bath temp	Error (Reading-Actual)	Acceptable Error	Pass/Fail
°C [90]	°C [90]	°C [90]		
35.044	35.044	0.000	±0.005	Pass

Name	J.harper
Date	14.09.05
Signed	

Calibrated to Valeport's procedures using test equipment with calibrations traceable to NAMAS or national standards

No. of Conductivity PCBs	2

Conductivity µ board	
Serial no.	13381
Part no.	400507E
Firmware	400796F
Module	49

Conductivity A/D	
Serial no.	18450
Part no.	400505B

Conductivity Sensor	
Serial No.	18423
Part No.	400524

Calibration Equipment used		
Instrument	Type	Serial No
Multimeter	HP34401	US36049071
Decade Box	Hatfield 2001	51262
Temp Bridge	ASL - F26	14-003
PRT	5179/15/A T25/62	X1964/MTE MA/03
Autosal	84005	65741

Stage 1: Circuit Calibration with Resistance Loop

Decade box setting	Measured Resistance	Counts	1/R	Polynomial fit for 1/R		Polynomial calculations				Acceptable Error	Pass/Fail
Ohms	Ohms	nnnn	1/Ohms	Order	3	Calc 1/R	1/R Error	Calc Cond.	Cond. Error		
65	65.273	35365	0.0153203	Parameter	Value	0.0153202	-0.0000001	71.9153342	0.000	±0.01	Pass
75	75.278	30816	0.0132841	a0	-4.468814E-04	0.0132842	0.0000001	62.3580792	0.001	±0.01	Pass
95	95.270	24560	0.0104965	a1	4.456095E-07	0.0104966	0.0000001	49.2726366	0.001	±0.01	Pass
115	115.293	20468	0.0086736	a2	-2.318859E-15	0.0086733	-0.0000002	40.7137969	-0.001	±0.01	Pass
155	155.288	15455	0.0064396	a3	4.679080E-20	0.0064397	0.0000000	30.2287062	0.000	±0.01	Pass
255	255.258	9795	0.0039176			0.0039177	0.0000001	18.3902996	0.000	±0.01	Pass
455	455.290	5932	0.0021964			0.0021964	0.0000000	10.3103381	0.000	±0.01	Pass
40455	40465.000	1058	0.0000247			0.0000246	-0.0000001	0.1154334	-0.001	±0.01	Pass
AIR		1003	0.0000000			0.0000001	0.0000001	0.0003679	0.000	±0.01	Pass

Enter polynomial fit from graph in cell D24 | y = 4.679080E-20x3 - 2.318859E-15x2 + 4.456095E-07x - 4.468814E-04

Stage 2: Cell Gain determination and Conductivity polynomial fit

Autosal temp	°C [IPTS 68]	21
Double from Autosal		2.24397
Autosal Salinity	PSU	39.84574
Bath temp	°C [IPTS 90]	19.0205
Conductivity from Salinity	mS/cm	52.65689
Bath Salinity (Check)	PSU	39.84574
Counts from instrument		26178
Calc.1/R from Counts & Poly f	1/Ohms	0.01121755
Cell Gain [Conductivity per 1/R]		4694.15101

Polynomial fit for Conductivity	
Order	3
a0	-2.097635E+00
a1	2.091758E-03
a2	-1.068507E-11
a3	2.156431E-16

Stage 5: Check readings after calibration entered

		In bath	In air
Autosal temp	°C [IPTS 68]	21	
Double from Autosal		2.24397	
Salinity	PSU	39.84574	
Bath temp	°C [IPTS 90]	19.0200	
Cond. from Sal.	mS/cm	52.65633	0.000
Bath Salinity	PSU	39.84574	
Rdg from Instr.	mS/cm	52.656	0.000
Error [Rdg - Act]	mS/cm	0.000	0.000
Acceptable Error	±0.01	Pass	Pass

Stage 3: Enter calibration string #024;49;1;15;0.000000e+00;0.000000e+00;2.156431e-16;-1.068507e-11;2.091758e-03;-2.097635e+00

Stage 4: Enter Gain and Offset: #035;49;1;500;-20000

Name	J.Harper
Date	22.09.05
Signed	

Sensor Calibration Record **Sound Velocity** © Valeport Ltd

Instrument Serial Number	23454
Transducer Type, mm	100
Transducer Ser No	16822
PCB Part No	400524
PCB Ser No	16423
SV Firmware Version	11.10
Module Number	12

Calibration Equipment used		
Instrument	Type	Serial No
Temp Bridge	ASL - F26	14-335
PRT	917915/A T25/62	X1684A/TE MA/83

Stage 1: First order fit

Temp	SoS from Bilaniuk & Wong	Measured ToF	Coefficients	Calc SoS from coefficients	Error (Calc - True)	Acceptable Error	Pass/Fail
°C90	m/s	nsec*100		m/s	m/s	m/s	
2.0611	1412.480	14227090	7.193600E+04	1412.480	0.000	±0.001	Pass
15.9426	1469.204	13680680	5.001532E+06	1469.204	0.000	±0.001	Pass

Stage 2: Enter calibration string

#024;12;1;15;0;0;0;0;5.001532e+06;7.193600e+04

Stage 3: Check point

Temp	Actual SoS	Measured SoS	Error SoS Reading-Actual	Acceptable Error	Pass/Fail
°C90	m/s	m/s	m/s	m/s	
15.9429	1469.205	1469.205	0.000	±0.005	Pass

Name:	CPQ
Date:	01/09/05
Signature:	

Instrument Test Certificate

VALEPORT

Valeport Contract Number:	15290.

System Description:	MIDAS SVX. System

Main Serial Number:	23454.

Item	Serial Number	Assembly Completed		Service Completed		Calibration Completed		Functionality Test Completed		Pressure Test Completed (1000 Bar)		Immersion Test Completed		Post Immersion Functionality Test Completed	
MIDAS SVX.	23454	Inits: [illegible]	Date:	Inits:	Date:	Inits: [illegible] Certificate number C-14412	Date: 24/9/05	Inits: [illegible]	Date: 23/9/05	Inits: [illegible]	Date: 24/9/05	Inits:	Date:	Inits: [illegible]	Date: 24/9/05
		Inits:	Date:	Inits:	Date:	Inits: Certificate number	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:
		Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:
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		Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:	Inits:	Date:

This document certifies that, where indicated above, the specified instrument and accessory items have undergone assembly, service, calibration and test procedures according to Valeport Limited's standard procedural documentation, and are declared ready for shipment.

Signed: [illegible] Contract Controller

Date: 26th September 2005

Appendix I

This report is intended to be distributed with a group of files in order to the have all information collected during the OAEx'10 sea trial, in this way we have above a description of this files and the directory structure. Notice that in both the Acoustic Data Folder and in the Oceanographic Data Folder there are files (named in red in the following folder structure) to ease the data files access, providing the information and links to the desired files.

Files and folders from the root directory:

- The present report file: 'OAEx10 Report_Version_1_1.doc';
- OAEx'10 Test Plan file: 'Test Plan for OAEx10 CRUISER_Final.doc';
- Acoustic Data Folder: 'OAEx_Acoustic_Data';
    - File: '**Signals Control Table.xls**';
    - Folder: 'OAEx Reception Data';
        - Folder: 'Day 1 – wav';
        - Folder: 'Day 2 – wav';
        - Folder: 'Day 3 – wav';
        - Folder: 'Day 4 – wav';
        - Folder: 'GPS Data Day 1';
        - Folder: 'GPS Data Day 2';
        - Folder: 'GPS Data Day 3';
        - Folder: 'GPS Data Day 4';
    - Folder: 'OAEx Transmission Data';
        - Folder: 'Day 1';
        - Folder: 'Day 2';
        - Folder: 'Day 3';
        - Folder: 'Day 4';
        - Folder: 'Signals';
- Oceanographic Data Folder: 'OAEx_Ocean_Data';
    - Folder: 'figuras';
    - Folder: 'originais';
    - Folder: 'processados';
    - Folder: 'XBT';
    - File (Portuguese version): '**LEIAME.txt**';
    - File: 'Oc_Fisica_OAEx_2010.xls';
    - File (English version): '**README.txt**';