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K2D - Knowledge and Data from the DeepSpace

D4.1 - Environmental and system scenario description

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Abstract	This document is expected to cover the requirements for deliverable D4.1 of project K2D, in what regards a proposed full description for the multiple scenarios for the acoustic propagation leading to ocean soundscaping using the cable environmental sensors.
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Executive Summary

Project Knowledge and Data from the Deep Space (K2D) aims at designing, developing and testing at sea a new concept for permanent ocean observation based on newly installed submarine telecommunications cables. This new concept builds on the SMART-cables idea of taking advantage of the cable junctions (repeaters) to install cable connected Environmental Observation Nodes (EONs). These EON have sensors for environmental sensing and for communication / interaction with nearby unmanned submarine platforms, such as as gliders, AUV's, drifters, and others. Since the EON are connected via the data cable, each module may be viewed as a node of a large cable connected distributed ocean observatory. K2D is specifically aimed at applying this new concept to the design of the telecommunications cable connecting continental Portugal-Azores-Madeira-ring (CAM-ring) that is up for replacement in the next few years.

Acoustic sensors will be used for transmitting and receiving information to/from the unmanned platforms, and also for passively listening to ocean ambient sound for characterization and soundscaping. Even if the final design of the new CAM-ring is not known at this stage, it is of paramount importance to determine which is its overall expected performance for acoustic monitoring.

The analysis of the geomorphology and historical oceanography of the CAM-ring area allowed to reduce the number of acoustic listening scenarios to four. These are: (1) shallow water, (2) deep water double minima, (3) deep water critical depth, and (4) deep to shallow transition wedge. It is suggested that wisely using these four scenarios would allow to predict CAM-ring passive acoustic theoretical performance. Performance prediction is just one step away from soundscape mosaicking, as well as to retrieving noise indicators and other relevant biological and environmental parameters.

This report will be the first in a series to be developed under the K2D program of work, work package 4, aiming at determining the listening capabilities of the CAM-ring for : (1) estimating baseline noise levels for the North Atlantic, (2) monitoring ocean excess noise level indicators, (3) monitoring ship traffic, and (4) trace biological cues of large whales.

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Abstract

It is of paramount importance to be able to predict acoustic observation performance in order to take maximum advantage of the monitoring capabilities of the future CAM-ring observatories. Ocean acoustics heavily relies on the environmental properties of the media through which the acoustic wave is propagating between any source - receiver pair. That dependency involves not only the water column but also, in some cases, the bottom and the sea surface. The CAM-ring area is extremely diverse, crossing long ocean stretches, across continental platforms and the abyssal plain. This study attempts to find common environmental properties along the supposed CAM-ring route, in order to reduce the problem complexity to a low number of repetitive propagation scenarios. Using bathymetric data, historical water column and bottom properties, the number of scenarios is reduced to four: (1) shallow water, (2) deep water double minima, (3) deep water critical depth and (4) deep-shallow transition zone wedge. Each scenario was fully characterized and the area of validity determined. The study is concluded by a few candid recommendations for the layout of the observation nodes.

Chapter 1

Introduction

The K2D initiative explores the possibilities of energy and data communication offered by submarine telecommunications cables to develop the concept of installation of technological modules for ocean observation and exploration. These modules will be strategically connected to the telecommunications cable at the cable junctions provided by the repeaters (every 60 km or so), so the concept is similar to that of SMART-cables [2]. However, it completely differs in the sense that the modules will not be integrated in the cable, and will therefore require a different deployment procedure than the standard cable layout. The various modules installed along the cable will be data connected forming a single distributed ocean cabled observatory composed of multiple environmental observation nodes (EON in the sequel). Among other sensors and actuators, each EON will entail acoustic capabilities for ocean acoustic sensing (passive) and acoustic communications (active).

The Continental-Azores-Madeira (CAM) telecommunications cable connection (hereafter CAM-ring), will cross the continental platform, the continental slope, the abyssal plain and will come to shore at each end point. In a so diverse environment, water depth is the main parameter that controls sound propagation, among others. In principle we may be facing multiple scenarios typically divided in three main groups: shallow water guided propagation in the continental platform, a deep water scenario in the abyssal plain and a sloping scenario that may take place at the border of the platform and at the islands shore point, depending on the case.

The separation between shallow and deep water is a classical paradigm of underwater acoustics, that often divides scientists. We must adopt the view that what separates one from the other is that in deep water the sound speed profile is generally, below a certain depth, upward refracting while in shallow water, it is either isovelocity or downward refracting. The former case normally occurs for water depths larger than 2000 m while the latter happens for water depths below 200 m. In between these two depths there is a mix situation that is characteristic of the continental slope. In shallow water the bottom is important and greatly contributes to the observed acoustic variability and attenuation, while in deep water bottom properties are mostly irrelevant since sound very seldom reflects in the bottom and, when it does, this takes place for long range propagation and therefore signal reception is very strongly attenuated.

For our acoustic scenario design purpose it is important to separate the active and the passive cases. The active case occurs when the emitting sound source is under our control. In that case the transmitted signal has a purpose that may be an impulse (ping) for localization or a coded message for underwater acoustic communications (UWAC). In both cases the frequency content and the energy will be designed to fit the transmission scenario. In active mode, if the message, or the ping, does not reaches the receiver, signal power may be increased, frequency changed or, in extreme cases, source - receiver geometry modified. In this report we will be mostly concerned with the passive listening only case, where there is no control on the source power or waveform characteristics. In passive mode, the acoustic signal will often be of stochastic nature. Some authors will tend to call this ambient noise, or simply noise. In our case we will reserve the "noise" terminology, for sound that is harmful for marine life, while in general we will use the term "ocean sound". Soundscaping is the characterization of the ocean scape through sound, or at least that part of the ocean marine environment that interacts with sound. This ocean - sound interaction is what we will try to determine through the analysis of the CAM-ring area environmental properties relevant to acoustics. The complex environment crossed by the CAM-ring will be reduced to a few typical scenarios.

This report is organized as follows: chapter 2 gives a generic account of the environment description for acoustic propagation to be found in the North Atlantic area crossed by the CAM-ring, detailing the most influential environmental characteristics of the bottom, water column and bathymetry; chapter 3 gives an account of the sound sources that will likely be received on the bottom nodes; chapter 4 describes the scenarios drawn from the previous chapters and chapter 5 draws some conclusions and makes some recommendations for forthcoming work.

Chapter 2

Environmental area description for passive acoustics

Sound propagation is governed by sound speed induced temperature variations in depth, since range and cross-range variations are seldom significant within the ranges of interest in most applications. Sound speed depth variations are primarily due to temperature and secondly due to static pressure, that linearly increases with depth. Since when depth becomes important, temperature is constant, sound-speed increases linearly, and the sound speed profile becomes upward refracting. That is the most distinctive characteristic of deep water propagation. In that case, sound seldom interacts with the bottom so the energy loss is limited and sound propagates far[3].

In the opposite, in shallow water sound strongly interacts with the bottom so it attenuates quite rapidly with distance. This attenuation is accompanied by a sort of chaotic behavior due to bottom roughness and properties variation along distance. Even attenuation (transmission loss) becomes difficult to predict in shallow water, because of its dependence on bottom properties. Figure 2.1 shows an artistic drawing of the CAM-ring over the bathymetry using the GEBCO database [1]. In practice deep water is nearly the whole area, except the dark brown borders of continental Portugal and in the approaches of the islands of Azores or Madeira. The cable drawing shows a length of over 3500 km, not including connections between islands in Azores, which may easily add another 500 km. The landing positions are not defined so the drawing is pure speculation.

Knowing the bathymetry is not sufficient because in most cases sound is generated at (or close to) the sea surface and then propagates away and down through the water column. That is true for ocean vessels and platforms, as well as waves, wind, ice and rain, but also for marine mammals that spend 90% of their time in the first 20 m from the surface (variable with specie). The water column sound velocity will have most influence on sound propagation, specially for receivers placed in, or close to, the bottom. In the sections below, the various possible scenarios are depicted, starting from the shallow water case, then the deep water scenario, and then the intermediate sloping bottom scenario occurring at the border of the platform or at the approach to the cable landing in the islands.

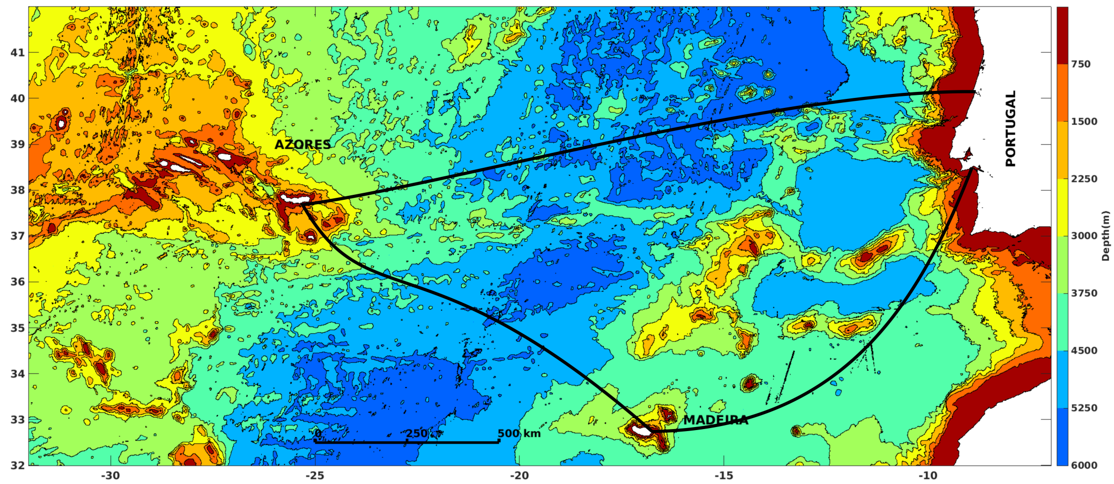

Figure 2.1: *Illustrative drawing of the CAM-ring over the bathymetry of the area (from the GEBCO database[1]).*

2.1 Shallow water

It is clear from picture of Fig. 2.1 that most of the area crossed by the submarine cable is considered, according to the definition above, as deep water. Since environmental observation nodes (EON) are expected to be separated by approximately 65 km, there is little chance to have those nodes in the shallow zone. However shallow areas are important because they are the ocean - land border, where most of our interaction takes place: exploration, transportation, fisheries, recreation, etc. Continental shelves are also among the fish catch richest. Depending on the final cable design, the continental shelf in the SW coast of continental Portugal will be the only shallow water area covered by observation nodes(s).

Shallow water acoustic propagation is characterized by a downward refracting profile, which pushes acoustic rays to interact with the ocean bottom. At distances above a few water depths we will have guided propagation with successive reflections on the surface and bottom. At those ranges, geometrical attenuation will be governed by cylindrical spreading and, compared to deep water, the influence of sound speed variations in the water column will be very reduced.

2.1.1 Bathymetry

Figure 2.2 shows an hypothetical landing of the cable trunk connecting Madeira Island to the town of Sesimbra after running South-North along the SW platform of continental Portugal (left) and the departure of cable from the town of Figueira da Foz to the Azores (right). In both cases the continental platform is relatively large within the 200 m isobath and parallel to the coast with the only exceptions of the Setúbal canyon near Sesimbra and the S.Vicente canyon (left) and of the canyon of Nazaré to the south of Figueira da Foz (right). This design would allow to have, say, two EON along the continental SW shelf, an important area for fisheries and ship traffic along the coast and those reaching

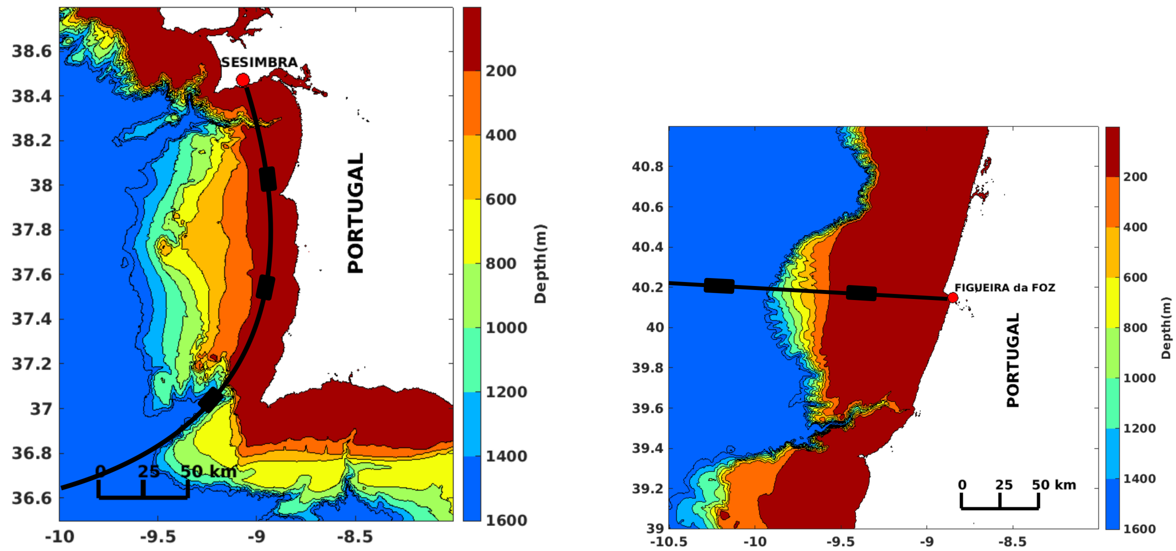

Figure 2.2: *Illustrative drawing of the continental approaches of the Madeira trunk with hypothetical landing in Sesimbra (left) and cable departure from Figueira da Foz (right). EON are designated by black boxes (not to scale).*

the ports of Sines and Setúbal. Another possibility for a shallow EON is that of the cable departure point from Figueira da Foz, where the continental platform exceptionally extends offshore, as shown in the right panel of Fig.2.2. At least one EON could be placed within the 200 m isobath giving access to the monitoring of that unique region in the proximity of the Nazaré canyon, known to be the generator of a number of oceanographic phenomena as for example large (nonlinear) internal tidal waves (solitons), with a well known impact on fisheries, as well as on the world famous big waves. The bathymetry in the surroundings of the hypothetical locations of the EON is nearly range independent in all directions with a slight down slope gradient in the first few km and then steeply across the shelf break towards the west.

Figure 2.3 (left) shows the observatory node in the continental shelf near Sines with a few dotted lines representing propagation lines from hypothetical sound sources to the receiver, as we move from a N-S line to a W-E line. The respective bathymetries are shown in the right hand plot, where the node is represented by the black box at the bathymetric intersection. Clearly the N-S line may be assumed range independent at approximately 120 m depth, while the other propagation lines rapidly become range-dependent from 500 m depth up to 0 at the coast. These may be easily represented by a wedge, that has been thoroughly studied in the literature (see *e.g.* [3]).

2.1.2 Water column

Let us consider the case of the first node near Sines, as shown in Fig. 2.3. The vertical and horizontal dotted lines represent possible propagation planes North - South along the platform and across the shelf break, for the West-East axis. The water column N-S variation as the typical mean sound speed in the months of January, April, July and October is shown in Fig. 2.4 from top left, top right, bottom left and bottom right, respectively. These sound velocity profiles were estimated using the Mackenzie approximation, on mean temperature and salinity profiles extracted from the European Copernicus Marine Ser-

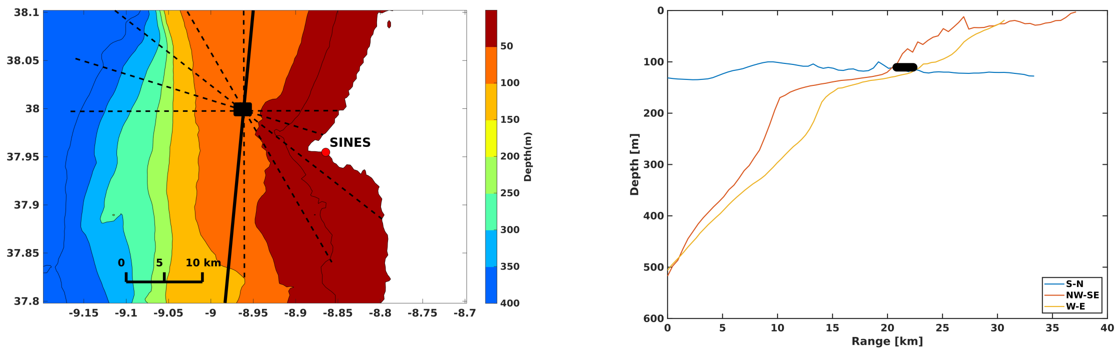

Figure 2.3: *Shallow water area near the Sines EON, as example: sound propagation dotted lines along the bathymetry (left) and extracted bathymetric profiles with observing node (right).*

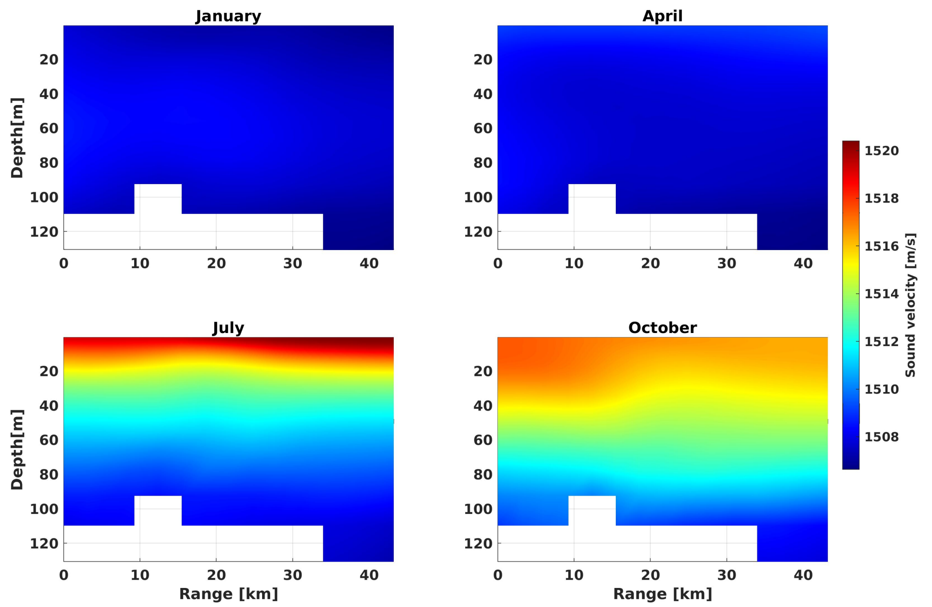

Figure 2.4: *Sound speed variation along a S-N line along 8.95 degrees longitude West, off the town of Sines, from mean CMEMS temperature and salinity data for the months of January, April, July and October, taking example the year of 2020.*

vice (CMEMS) database [1] for the respective months of 2020. Since the same color scale was used for all plots, it is clear that in the winter-spring months of January and April the water column is nearly isovelocity at approximately 1508 - 1510 m/s, while in the summer-autumn months a thermocline of variable thickness forms in the upper layer.

The same procedure was adopted for W-E line as shown for the same months of January, April, July and October in Fig. 2.5. The strong bathymetry variation makes the water column more stratified off-shore and then becoming more isovelocity as coming in-shore.

[1] CMEMS - https://marine.copernicus.eu/

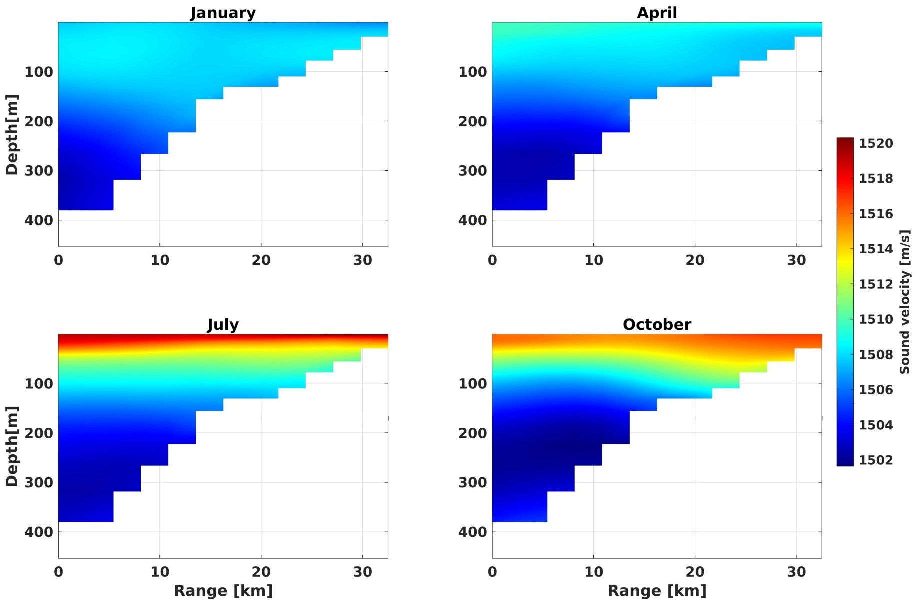

Figure 2.5: *Sound speed variation along a W-E line along 38 degrees latitude North off the town of Sines, from mean CMEMS temperature and salinity data for the months of January, April, July and October, taking example the year of 2020.*

2.1.3 Bottom properties

As mentioned above shallow water attenuation and signal scattering is governed by bottom interaction, therefore the acoustic properties of the ocean bottom become relevant. Sub-bottom layering and properties are much more complicated to obtain than water column sound velocity. As an example slightly to the north of the area of interest but which geology might not be very different from that of the whole continental shelf, was the object of a detailed study [4]. This study aimed at determining the geological and physical constitution of the bottom layers. The study referred to above offers a geological description as follows: the sub-surface geological structure of this area may be sub-divided in five formations US1 to US5 as we go deeper into the bottom and also in age so, and therefore also, in increasing compactness and density. In general unit US1 is a thin layer with an approximate geological age of 7500 - 5000 years. It covers most of the shallowest platform down to 65 m water depth. Unit US2 has an age of 18000 years and is an intermediate layer in many points indistinguishable from US1. US2 is also thin between 65 and 85 m water depth where surfacing of harder rocks of layers US3, US4 or even US5 (hard magma rock) may occur. US2 has a maximum thickness of 9 m and all together US1+US2 reach 10 to 12 m at the base of the coastal slope.

In terms of materials there are formations of sand and gravel cords between 35 and 45m depth, varying from bio mud to heavy sand mud just before the slope and then at a lower degree in the slope. Bottom coverage changes to muddy sand either fine, medium or large grain either mixed or not with biological remains, shells, etc, near the coast. Finally, there were a number of acoustic propagation and environmental inversion sea trials that were carried further offshore in the continental platform between Sesimbra and the Setúbal Canyon. This area is off to the north of the area of interest but is the closest we can get to the characterization of the acoustic properties of upper sediments of the area that tend to extrapolate at least up to the base of coastal slope of the area. The bottom model of table 2.1 is reported to correspond to this area [5, 6].

Layer	Thick (m)	C_p (m/s)	C_s (m/s)	α_p (dB/λ)	α_s (dB/λ)	ρ (Kg/cm^3)
sed 1	2-4	1600	0	0.8	0	1.9
bottom	-	1800	0	0.8	0	1.9

Table 2.1: Setúbal platform bottom inversion results obtained during the Infante sea trial [5, 6].

To the northern area near Figueira da Foz, as shown in the right panel of Fig. 2.2, the bottom properties may be seen as slightly different from those of the SW coast. In fact, acoustic experiments carried out during the INTIMATE'96 sea trial in that area showed that a model composed of a sandy covered bottom characterized by an acoustic half space with a compressional speed of 1750 m/s, an attenuation of 0.9 db/λ and a density of 1.9 g/cm^3, would give the best matching with the real data [7, 8]. This was shown either using a ray tracing model (Bellhop) or a normal mode (Kraken).

2.2 Deep water

As mentioned above, the principal characteristic of deep water propagation is the existence of an upward refracting sound velocity profile below a certain depth. This allows for the acoustic energy to be refracted into the sound channel without no or little bottom interaction. In most case there is a temperature increase towards the surface and therefore the formation of a sound channel, through which the transmission loss will be small.

In this situation there are two phenomena that are relevant: one is the existence of a critical depth and the other is the formation of convergence zones. The critical depth is the depth at which the sound speed is equal to that of the surface. The critical depth is therefore variable, depends on the surface sound speed, and may not exist when the ocean is not deep enough or if the sound speed at the surface is too large. Convergence zones are zones of high sound intensity that repeat themselves at a given distance that depend on various factors such as the source depth and the regime of deep water refracted paths associated to a given source launch angle. The convergence distance largely depends on the critical depth and is generally of tens of kms. Jensen *et al.*[3] refers to convergence zones 55 km apart for the Mediterranean and 65 km apart for the Atlantic, for respective minimum water depths of 2000 and 3500 m.

2.2.1 Bathymetry

Since bottom interaction is mostly nonexistent in the deep water case, bathymetry along cable layout is irrelevant, apart from the landings in the islands. The case of S. Miguel is an example which is shown in Fig. 2.6. This is clearly a cable landing without continental platform and therefore essentially different from what is happening in the main land. The hypothetical locations of the first nodes for the incoming or departing cables are already situated at depths of 2000 m or more.

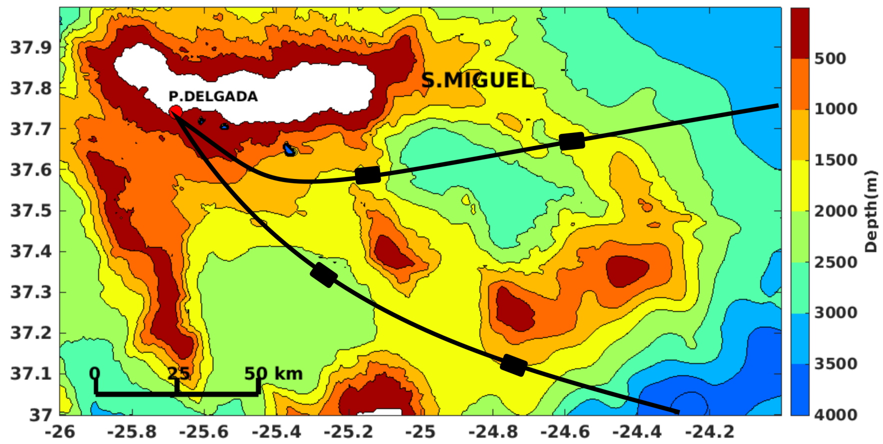

Figure 2.6: *Bathymetric detail of the hypothetical cable landing near Ponta Delgada, in S.Miguel island.*

2.2.2 Water column

Figure 2.7 shows a range-depth South-North cut of sound velocity along a longitude of 10 degrees West for the mean CMEMS temperature and salinity of months of January, April, July and October 2020. Clearly, the critical depth is more often attained in the

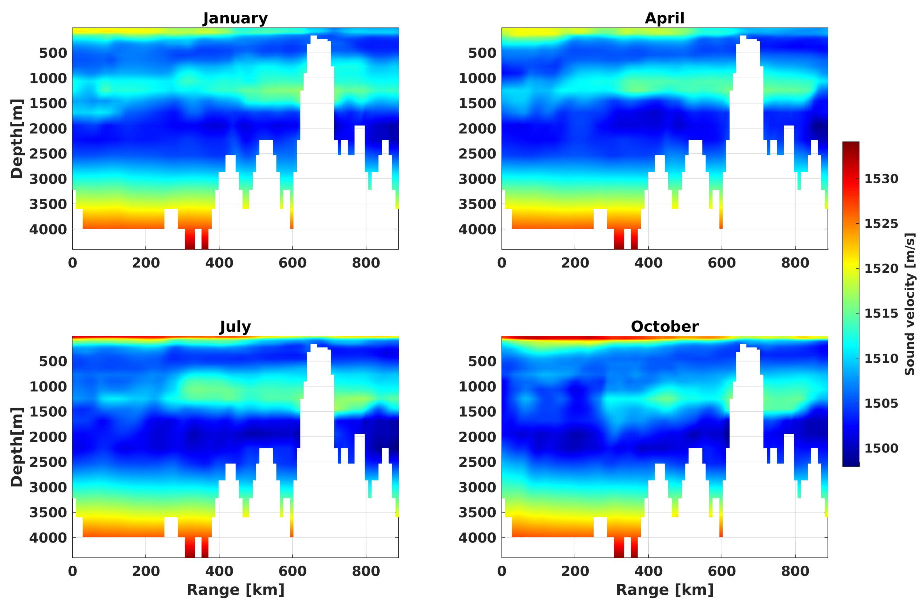

Figure 2.7: *Sound speed variation along a S-N line along 10 degrees longitude West, from mean CMEMS temperature and salinity data for the months of January, April, July and October, taking example the year of 2020.*

winter months of January and April and is more difficult in the summer when surface sound speed is higher. The typical double minimum often observed in the Atlantic is clearly seen with minima at approximately 800 and 2200 m depth.

Figure 2.8 shows a range-depth West-East cut of sound velocity along a latitude of 38 degrees North for the mean CMEMS temperature and salinity of months of January, April, July and October 2020. In this case, since water depths are higher, the critical

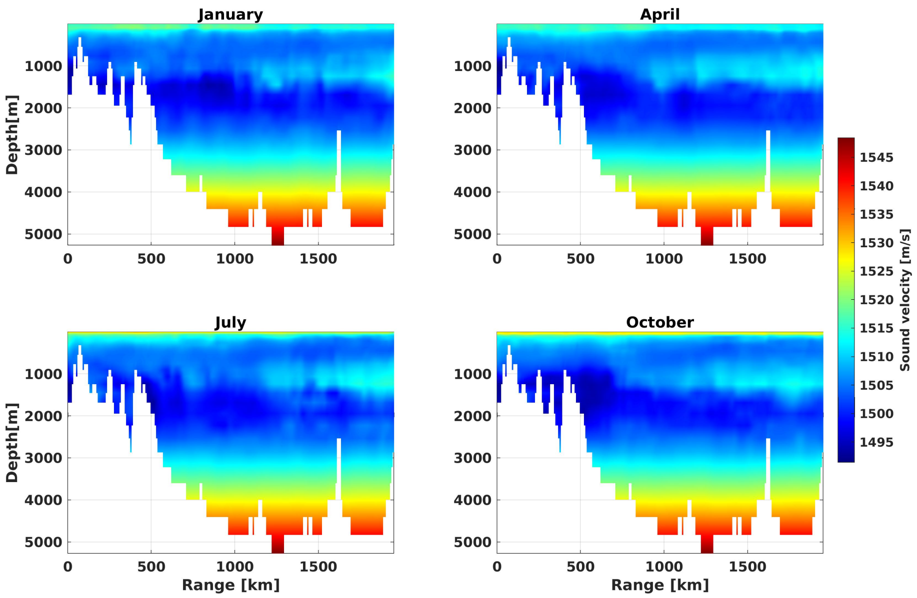

Figure 2.8: *Sound speed variation along a W-E line along 38 degrees latitude North, from mean CMEMS temperature and salinity data for the months of January, April, July and October, taking example the year of 2020.*

depth is easily attained in all months. The typical double minimum is also observed but more pronounced near the Iberian shelf, which is consistent with Fig. 2.7 and probably due to intruding Mediterranean warm water circulating northwards from the bay of Cadiz out of the strait of Gibraltar.

The landing in Ponta Delgada is an atypically abrupt transition from deep water to land. Water column variations for the usual months of January, April, July and October are shown in Fig. 2.9 along a S-N line at 25.3 longitude West and in Fig. 2.10 along a W-E line at 37.35 latitude N. In both cases there is no double minima or pronounced propagation channel (SOFAR). Sound velocity is continuously downward refracting to the strongly variable bottom depth and the overall variation is huge, specially in the summer period, where difference between bottom and surface is larger than 35 m/s. In the approach to the island the bathymetry variation is abrupt so, there is no platform and no shallow water propagation.

2.2.3 Bottom properties

As already referred to above, bottom properties are mostly irrelevant for sound propagation in deep water. One might think that the regions of cable landing in the Azores (or in Madeira) might have some bottom interaction for the landing closest observation nodes. However, inspection of Fig. 2.9 shows that the bathymetry is so abrupt at the approach of the island (S. Miguel in this case) as a variation from 1500 m to 0 within 8 km, that bottom interaction is minimal and in any case, extremely difficult to model. We will dismiss that case, and consider solely a deep water case (with no bottom interaction).

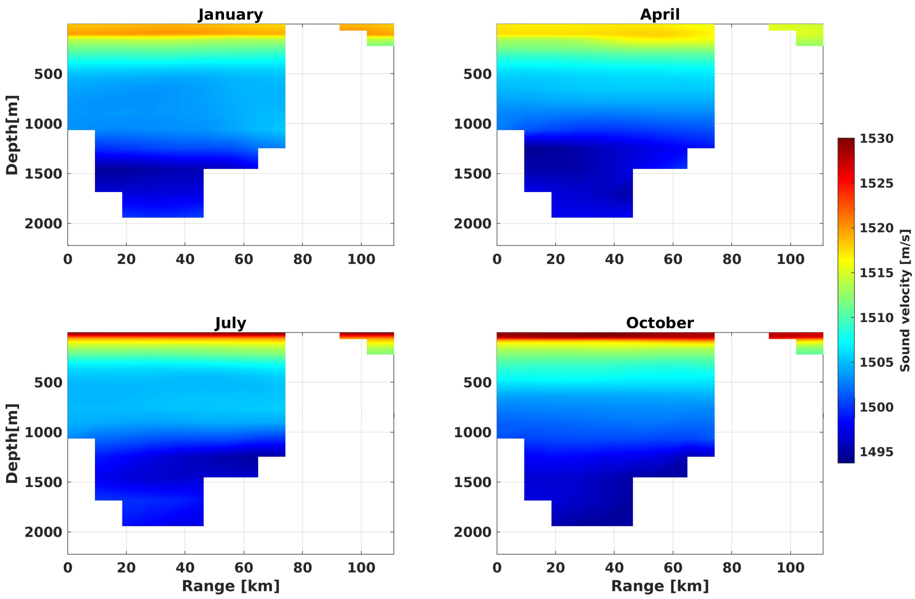

Figure 2.9: *Sound speed variation along a S-N line along 25.3 degrees longitude West, from mean CMEMS temperature and salinity data for the months of January, April, July and October, taking example the year of 2020.*

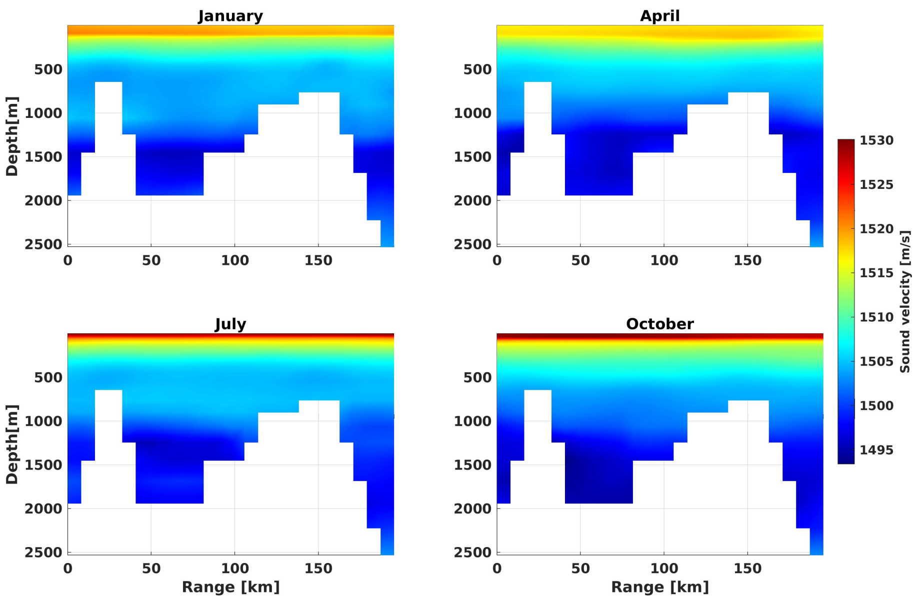

Figure 2.10: *Sound speed variation along a W-E line along 37.35 degrees latitude North, from mean CMEMS temperature and salinity data for the months of January, April, July and October, taking example the year of 2020.*

Chapter 3

Sound sources

In all the above typical sound channels for each receiver positions are described, but the expected scenarios would not be complete if the sound sources are not defined. In the ocean in general, sound is generated at the ocean surface. Man manned submarines and diving marine mammals are the exceptions, even though the latter spend most of their time close to the surface (the most studied case is that of sperm whales that only performs quick dives for feeding).

In the deep water region, which comprises 95% of the EON, the most prevalent environmental sound is that generated at the sea surface by wind and occasionally by passing ships. According to Gaul *et al.* [9] sound recording below the critical depth offers exceptional recordings of long distance surface generated sound through bottom bounces, that can be associated with wind noise. Long time series of such recordings would help to establish a much needed baseline reference for estimating excess noise level, and thus a basis for a continuous noise MSFD indicator. Occasional ships with high intensity will be relatively easy to spot and then separate from the remaining data. Biological noise can also be separated due to its waveform or spectral content, either in frequency bands below surface environmental sound (for large odontocetes) or well above the shipping noise band (mysticetes). Earthquake sound is comprised in the frequency band below or slightly overlapped with large whales, say from a few Hz up to 20 or 30 Hz.

Chapter 4

Typical scenarios

Based on the hypothetical telecommunications cable layout, including the suggested emplacement of the Environmental Observation Nodes (EON) and historical environmental data of the region gathered in the previous sections, this chapter draws a number of possible scenarios for acoustic propagation prediction and ocean noise estimation.

The most determinant feature is the bathymetry variation across the region, which encompasses shallow water near the coasts, continental shelf, transition from deep to shallow, and the deep ocean. The second most determinant feature is the water column properties variation both in time and space. Temperature is the most characteristic property, but salinity has also a role, and of course static pressure for determining sound velocity distribution.

In order to fix ideas we have extracted typical sound velocity profiles from the data sets shown in the previous section, in the various environmental conditions and periods of the year. These are shown in Fig. 4.1 for six cases and four periods of the year. Generic observation of this figure shows that Sines-shallow, Continental-deep and Offshore-deep are three well differentiated groups of profiles with proper and individual characteristics. These form three scenarios. The other three (Sines-deep, Azores-west and Azores-north) may be seen as a variation of a unique representation: that of variable bathymetry while approaching the coast, either the continental shelf for Sines or the island of S. Miguel, for the Azores (with obvious differences in water depth).

After careful analysis it was decided to represent this complex and diverse CAM-ring area in four scenarios: (1) shallow water range independent, (2) deep water with double minimum sound velocity range independent, (3) deep water with critical depth range independent, and (4) wedge shaped transition zone range dependent. For each of these scenarios several sound speed profiles were selected depending on the period of the year. Bottom properties only really matter for scenario (1) and will assume generic properties in all other scenarios. These four scenarios are described in the following sections.

4.1 Scenario 1: shallow water range independent

Figure 4.2 shows the admitted shallow water scenario for representing coastal waters in the SW continental shelf in winter (a) and in summer or late summer (b). In the continental shelf at north of Nazaré, the sediment layer would be suppressed and the compressional

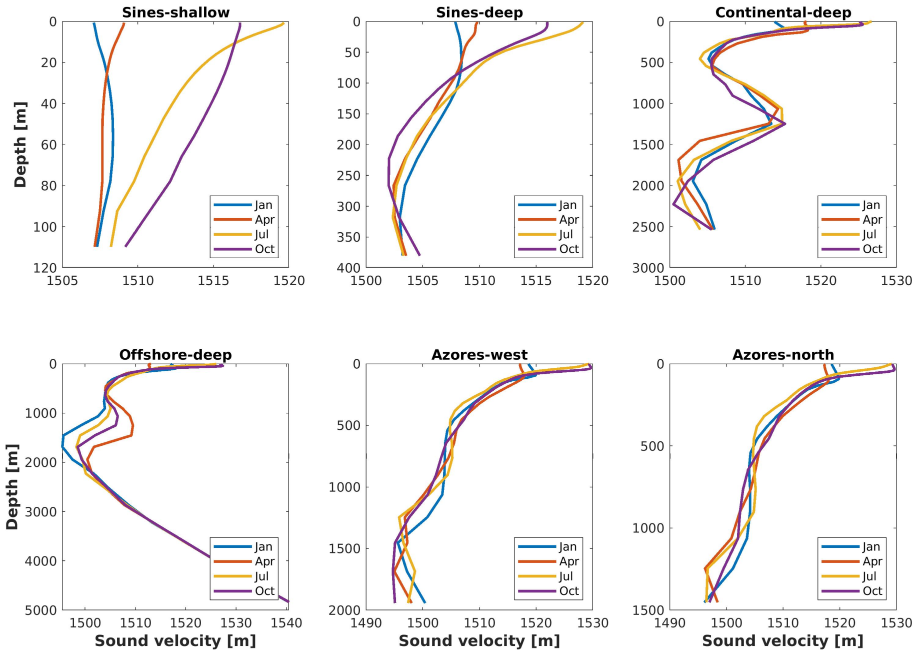

Figure 4.1: *Typical sound velocity profiles in various environmental conditions and periods of the year.*

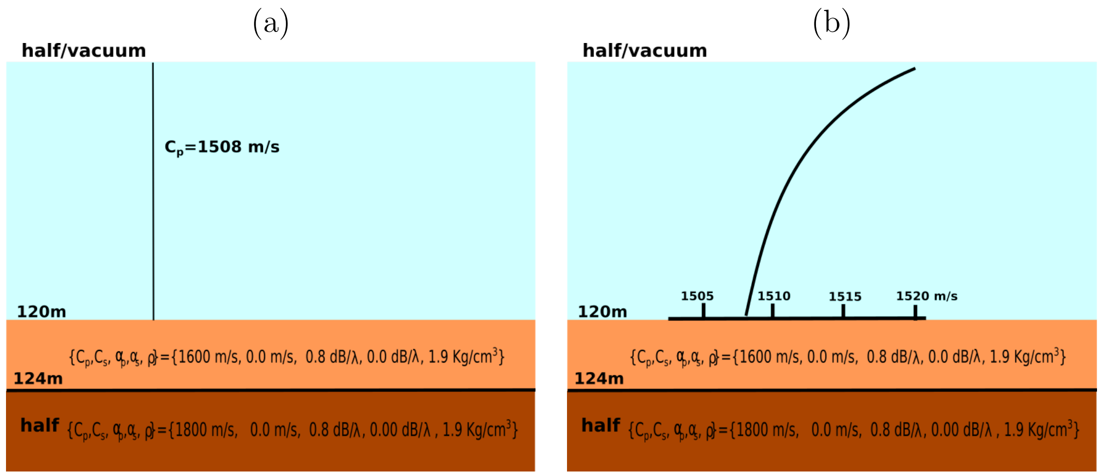

Figure 4.2: *Range independent scenarios for the SW Portugal continental shelf.*

speed and attenuation of the half space slightly changed to 1750 m/s and 0.9 db/λ.

4.2 Scenario 2: deep water double minima profile range independent

The scenario of Fig. 4.3 is representative of the deep water area off the continental platform to the west of the Iberian peninsula within, say, 1500 and 3000 m water depth. This scenario is characterized by a range independent double minima sound velocity profile without critical depth. In some cases there might be a very thin surface duct of a few tens of meters in the winter - spring period.

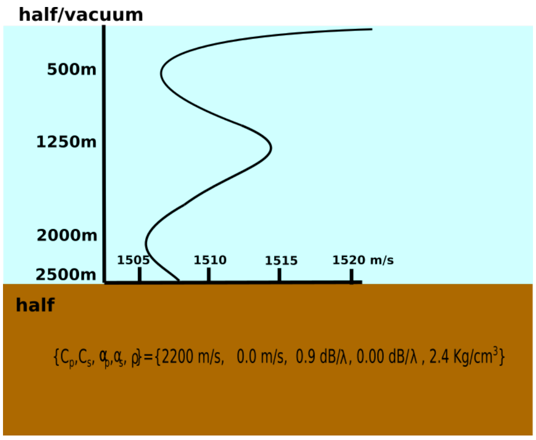

Figure 4.3: *Range independent deep water scenario West of continental Portugal.*

4.3 Scenario 3: deep water double critical depth range independent

The scenario of Fig. 4.4 is meant to represent the deep water abyssal plain between Iberia and the Azores archipelago, where water depth is larger than, say, 3500 m and where the critical depth is permanently attained.

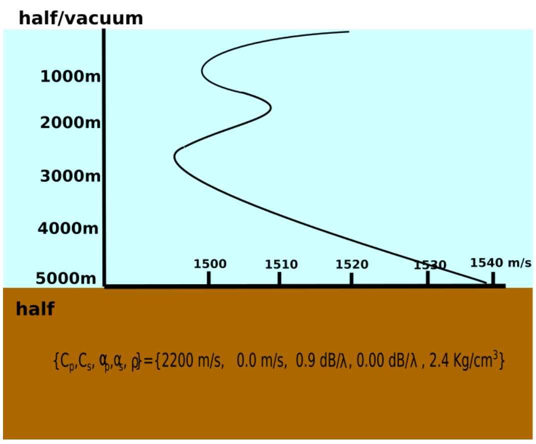

Figure 4.4: *Range independent scenario for the abyssal plain between Portugal and Azores.*

4.4 Scenario 4: wedge transition deep-shallow range dependent

This scenario (Fig. 4.5) is meant to represent the range dependent transition zones between deep and shallow water or coast. There might be sub-cases, depending on the degree of bathymetric variation or period of the year. The sound velocity profile is only for illustration since it will be adapted along range in order to obtain a fully range dependent environment. Bathymetric variation and slope will depend on the case: it will be relatively

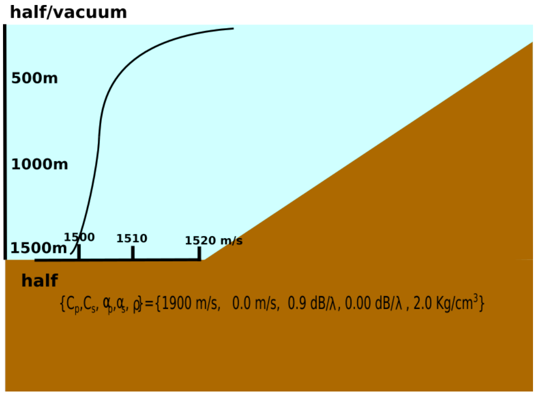

Figure 4.5: *Range dependent scenario for representing the transition zone between deep and shallow water.*

smooth near the continental shelf from, say 1500 and 200 m along a distance of 20 or 30 km, or very steep passing from 2000 to 0 m in only 5 km, as it happens near the islands of Azores or Madeira. Bottom properties become important but its variation along range is unknown. It is possible that hard rock may be surfacing in those steep slopes and sediments accumulated in the deeper area.

Chapter 5

Conclusions

This report presents a compilation of environmental information for the area supposed to be crossed by the future submarine telecommunications cable between continental Portugal - Azores and Madeira (CAM-ring). The departure and landing stations are assumed to be located in Figueira da Foz, Ponta Delgada (S. Miguel), north of Madeira and Sesimbra. A generic description is adopted throughout so that if these do not correspond to the actual locations, the environmental description and therefore the subsequent simulations, will still be valid, within appropriate confidence bounds.

The resulting scenarios converge to four environmental sets of descriptors that may be directly used for acoustic propagation prediction, in order to be able to estimate the acoustic range coverage of the whole CAM-ring. This coverage will be modulated by several variables, such as, environmental observation nodes (EON) number and spacing, frequency and period of the year.

Although this work is still at very early stages, a number of candid recommendations may be drawn :

- the positioning of at least two EON on the SW continental shelf seem important to be able to monitor, study and understand the processes taking place in that important area;
- placing one EON in the north of Nazaré canyon, seems an important asset to gather permanent monitoring of that important oceanographic feature of the coast of Portugal;
- as areas of strong exchange, the border of the platform are also regions very interesting for permanent monitoring;
- in anticipation of the acoustic simulation, it is possible that deep water EON will have a relatively long range capability (at least at low frequency) so the spacing between EON could be larger (not installed on every repeater) than in shallow water or close to the continental slope. Therefore in case of need of resource saving, we may prioritize shallow water or close to platform EONs as more relevant for ocean soundscaping.

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