Good practice guide for C calculation

Albert Garcia-Benadí, Javier Cadena-Muñoz, David Sarrià- Gandul, Rafael Sitjar Cañellas, Joaquín del-Río-Fernández

Universitat Politécnica de Catalunya, Grupo de investigación SARTI

Rambla Exposició,24. 08800 Vilanova i la Geltrú (Barcelona)

Abstract- *The aim of this paper is to detail the procedure to calculate the C parameter in the spreading factor. This factor is the most important because is the main reason of the pressure level fall. Calculating the C parameter with more accuracy it provides better information of the environment.*

Keywords- *spreading, acoustic, pressure, seawater*

INTRODUCTION

Nowadays numerous studies and activities are realized in marine environment. Many of these in the communication field through the acoustics modems, and in the study of the life in ocean ecosystems.

The aim of the paper is to detail the spreading calculation process in seawater in function of the generator that it's used.

The basic equation is (1): Where: SL is the source level, RL is the receipt level and TL is the transmission loss.

$$RL = SL - TL \quad (1)$$

In transmission loss component (2) different factors are taken. A factor is the energy loss owing to the propagation of the wave in the fluid, in this case in seawater. Other contributions are the absorption of the environment and the echo factor. The echo factor is produced by reflection in the sea surface and the seabed.

$$TL = C \cdot \log(r \cdot 1000) + \alpha \cdot r - T_{echo} \qquad (2)$$

In (2) r represents the distance between the source and receiver, expressed in km. The attenuation index is α [1] and T_{echo} is the echo contribution. The alpha parameter is function of the temperature, salinity, pH and depth. The paper objective is the quantification of the C parameter expressed in (2). In an ideal case the parameter C has two possible values. The C value is 20 for the spherical propagation, and the C value is 10 for the cylindrical propagation. However, in the reality the C value is between 10 and 20.

EQUIPMENT

The equipment that was used is the follow:

- Source sound pressure generator, LL9642T, Fig. 1

Figure 1. Sound pressure generator LL9642T

- The receiver used is the hydrophone Brüel, type 8103, Fig 2, for test to real value of the source sound generator.

Figure 2. Hydrophone B&K, type 8103

- The receiver used is the Bjørge Naxyx Ethernet Hydrophone, type 02345, Fig. 3.

Figure 3. Hydrophone (Bjørge Naxyx Ethernet Hydrophone 02345)

DEVELOPMENT

The development includes three tests. The first and second tests are for characterize the source and the third test is for C calculation.

The signal generator process sequence is as follows: first the signal is generated with the function waveform generator HP33120A. This signal is amplified by the transducer’s amplifier, and then the transducer generates the signal. The first test is to find the amplified factor. For this test the waveform generator gives a signal and with a multimeter is measured the output signal. Using this value and the manufacturer specifications, the TVR table for various frequencies, the output pressure is calculated. This value is theoretical value, and for this reason is necessary to find the real value with the second test. In this test is used a nylon semicircle with a radius of 1 meter as shown in Fig 4. This item is located in the metallic structure of the transducer. The B&K hydrophone is collocated on semicircle in different positions and for different angles. Therefore, the real value of pressure generated, and his direction is obtained with this test.

Figure 4. Assembly of source generator and nylon semicircle

The process to calculate the C parameter is done by generating sound in various positions. The positions are around the OBSEA [2], at the minimum distance of 800 m. These positions are over the sea, and for this reason it uses the reception of GNSS. Giving the coast proximity of OBSEA, the RTK [3] system is used to get the source coordinates with high accuracy.

C parameter is calculated through the fit where the coordinate axis is log(r·1000) and the ordinate axis is (3).

$$Y = C \cdot \log(r \cdot 1000) = SL - RL - \alpha \cdot r \quad (3)$$

RESULTS

The source characterization has been made with 2V_{pp} of the HP33120A to amplificatory, with a frequency at 10 kHz.

In the first test, the source generate the signal and the signal read the values with a B&K hydrophone located in different positions on the semicircle. The voltage values found are presented in Table 1. In Table 2 are shows the same values but converted to dB. This conversion is possible because the sensibility of B&K is known, -211 dB in V/µPa.:

Table 1. Values received from 1 meter to source

mV (pp)	Semicircle angle		
Angle over semicircle	-45	0	45
-90	**117**	**115**	**115**
-45	**115**	**90**	**80**
0	**87**	**268**	**160**
45	**61**	**85**	**84**
90	**115**	**126**	**110**

Table 2. Value of the Table 1 converts to dB

dB	Semicircle angle		
Angle over semicircle	-45	0	45
-90	**186,34**	**186,19**	**186,19**
-45	**186,19**	**184,06**	**183,04**
0	**183,77**	**193,54**	**189,06**
45	**180,69**	**183,57**	**183,46**
90	**186,19**	**186,99**	**185,81**

The results of this test are used to know the emissivity of our source. The distance of emission is obtained with the GNSS data, but these data must be correct with an RTKlib application and the fixed station file offer by ICC (Institut Cartogràfic de Catalunya). In this case the fixed station is Garraf.

The data corrected indicate the position through the latitude and longitude over the revolution ellipsoid in WGS84. Table 3 shows an example of the data corrected.

% GPST	latitude(deg)	longitude(deg)
2013/09/19 10:19:44.000	41,17596962	1,765765888
2013/09/19 10:19:45.000	41,17599033	1,76579163
2013/09/19 10:19:46.000	41,17594371	1,765860997
2013/09/19 10:19:47.000	41,17596045	1,765847909
2013/09/19 10:19:48.000	41,17596953	1,765766216
2013/09/19 10:19:49.000	41,17600257	1,765703582
2013/09/19 10:19:50.000	41,17601676	1,765699566
2013/09/19 10:19:51.000	41,17601913	1,765706548
2013/09/19 10:19:52.000	41,17601482	1,765757202
2013/09/19 10:19:53.000	41,17601363	1,765757745
2013/09/19 10:19:54.000	41,17601166	1,76575859
2013/09/19 10:19:55.000	41,17600471	1,765757978
2013/09/19 10:19:56.000	41,17601735	1,765763599
2013/09/19 10:19:57.000	41,17601363	1,765765296
2013/09/19 10:19:58.000	41,17601387	1,765767891

Table 3. Example of position file

The receipt position is known (latitude, longitude) and the depth is 20 meters. The distance between source and receipt is calculated with the Vicenty conversion. Fig. 5 shows the time emission and the distance calculated.

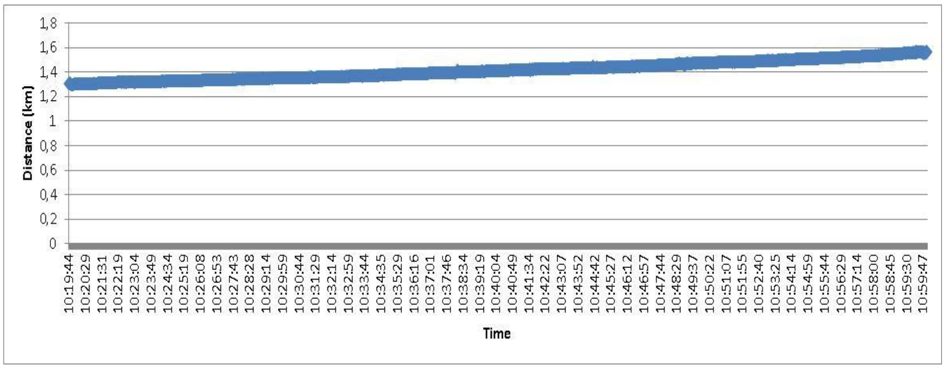

Fig. 5 Distance between receipt and generator

The absorption environment index [1] is calculated with the CTD parameters (Temperature of 24,04 Celsius degree, salinity of 8,06 $^{0}/_{00}$ and pH de 8,3). The CTD is located in OBSEA. The absorption index is 0,85 dB/km.

The generator system and reception system are not synchronized and for this reason the reception file is independent of the generation. The reception file is bigger because the frequency sample is 9600 Sa/s and the duration of recorded is 1.5 hour. This factor elicit that the processed signal is a critical factor.

The signal processing has been made with Matlab® application. The sequence of this application is: analyze every frame that arrived at hydrophone (512 values in int16). The maximum value is located and creates a sub-frame with the 15 index values before of maximum and the 16 index value after the maximum. The sub-frame, with 32 values, is processed with a FFT in order to determinate if the maximum value is centered in 10 kHz. The Fig 6 shows temporal frame (512 values) and the FFT of the sub-frame (32 values) for the acceptation case, and the Fig. 7 is for the decline case.

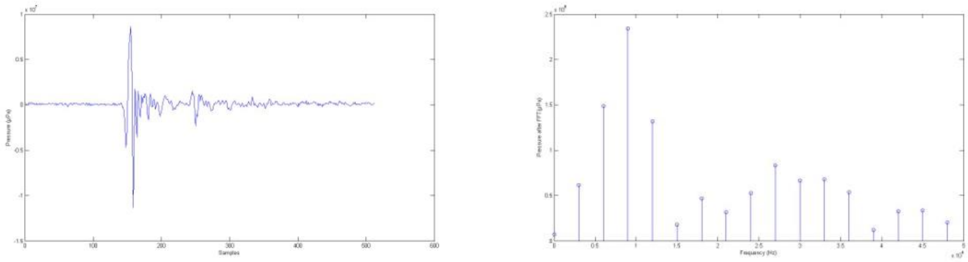

Figure 6. Temporal Frame and frequency sub-frame for the acceptation case

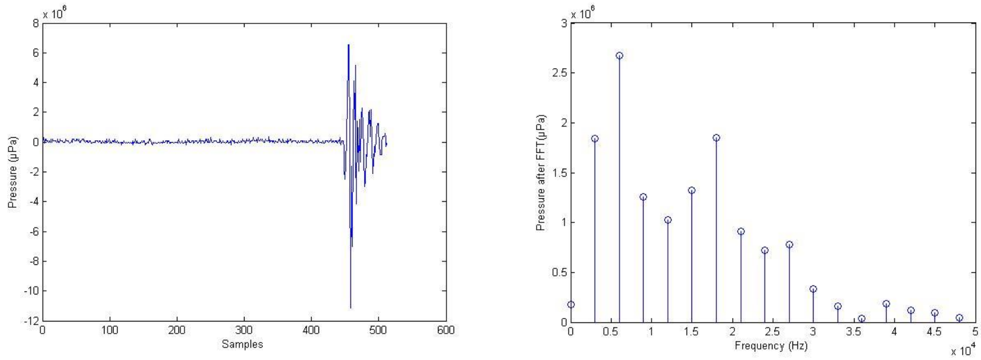

Figure 7. Temporal Frame and frequency sub-frame for the decline case

Once the maximum value for the acceptation case, and his time are found, other Matlab® application is used to overlap the times values.

The result, Eq. 3, for spreading factor (C) is 16,04±0,67. In Fig 8 shows the graphical fit.

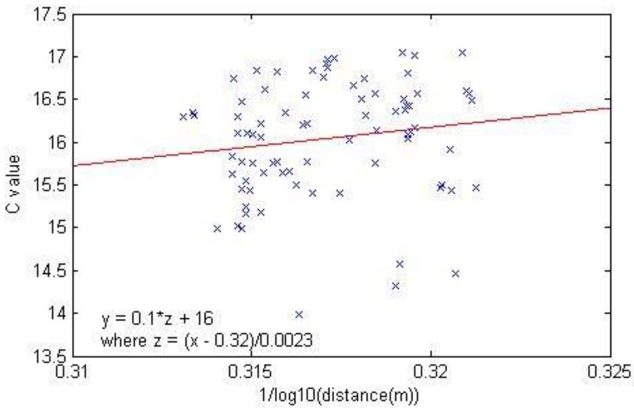

Figure 8. Graphical fit of the spreading factor

CONCLUSION

The first goal of the paper is to present the systematics to calculate the emissivity of a directional source in the sea environment. The result of this first test is the variety of the source in function of the angle, and for this reason the final result have a big dispersion. In the future test will be necessary to include an electronic compass synchronized with the GNSS, in the PVC triangle to know the direction of emission, and to correct the SL value in function of this angle. This correction will decrease the dispersion of the values of spreading in Fig 8.

Also the same test will be realized with different positions in order to decrease the distance between the source and the receipt to determinate the independency of the spreading factor of the environment parameters and of distance.

ACKNOWLEDGEMENTS

This work has been carried out in part thanks to the projects "Sistemas Inalámbricos para la Extension de Observatories Submarinos" (CTM2010-15459), and "Analisis de datos basados en aprendizaje automatico y sistemas inteligentes de adquisicion de datos" (ENE2012-38970-C04-02)

REFERENCES

[1] R.E. Francois and G. R. Garrison “Sound absorption based on ocean measurements. Part II: Boric acid contribution and equation for total absorption” J. Acoust. Soc. Am. Vol. 72, N.6, December 1982.

[2] Aguzzi, J.; Mànuel, A.; Condal, F.; Guillén, J.; Nogueras, M.; Del Rio, J.; Costa, C.; Menesatti, P.; Puig, P.; Sardà, F.; Toma, D.; Palanques, A. “The New Seafloor Observatory (OBSEA) for Remote and Long-Term Coastal Ecosystem Monitoring”. Sensors 2011, 11, 5850-5872.

[3] Parareda, C.; Soro, M.; Bosch, E.; Términs, A. “Un año de experiencias con el servicio RTKAT”, Revista Catalana de Geografia IV època / volum XII / núm. 32 / novembre 2007.