MSFD: status and perspectives for D11 in Portugal

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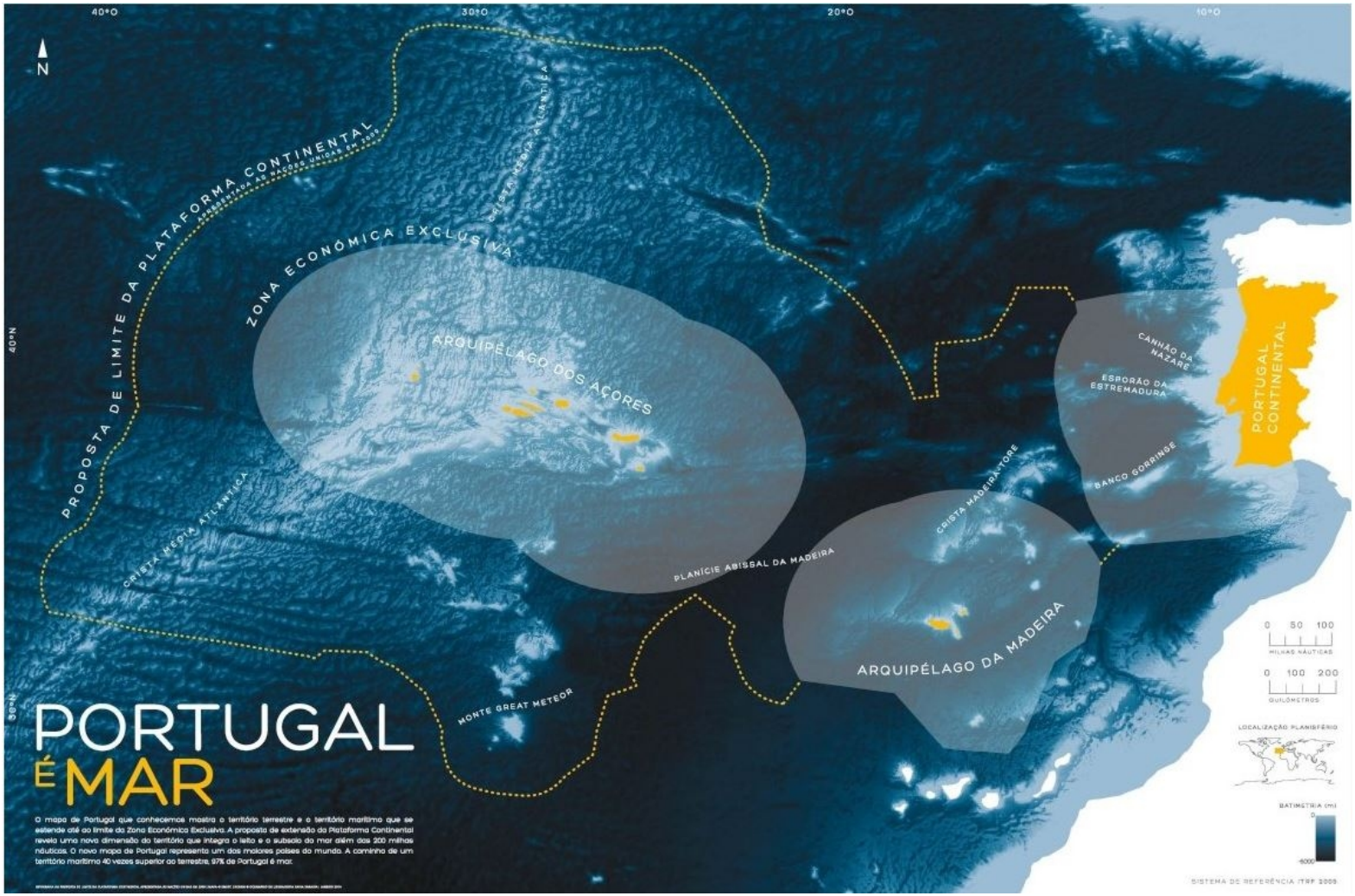
Serenade 2016, Brest - October 13, 2016

Portugal: 90.000 Km^2, EEZ: 1.7→3.8M Km^2



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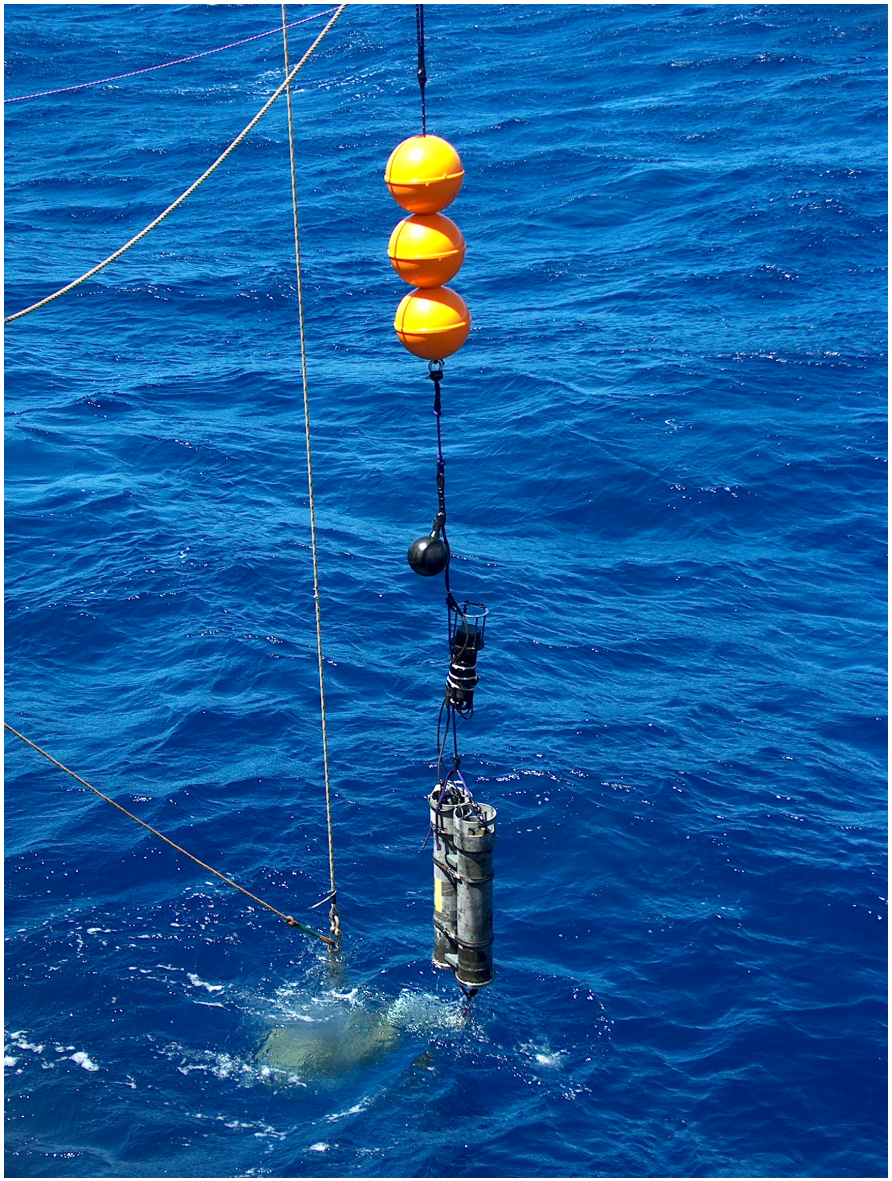
Outline



1. MSFD background
2. Portuguese timeline for D11
3. the SUBECO project
4. the source inverse problem
5. conclusions

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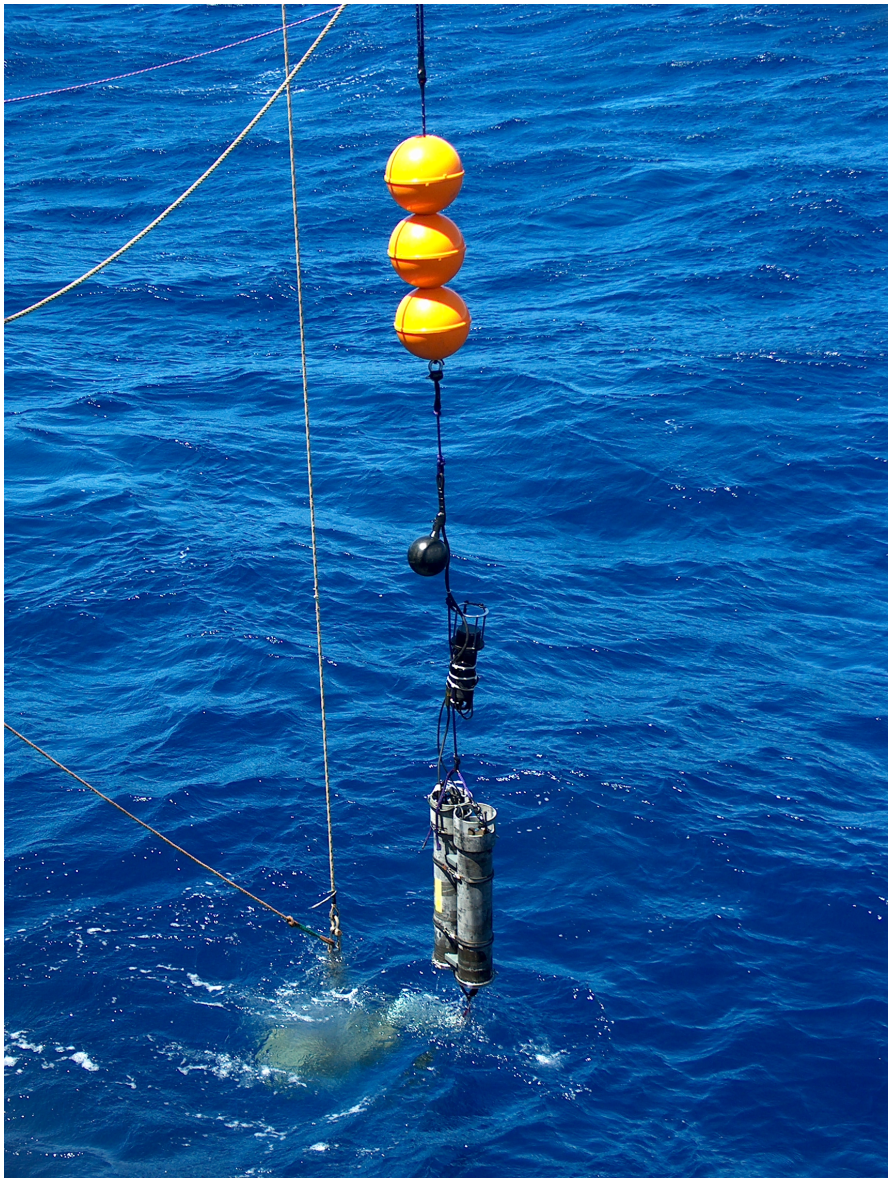

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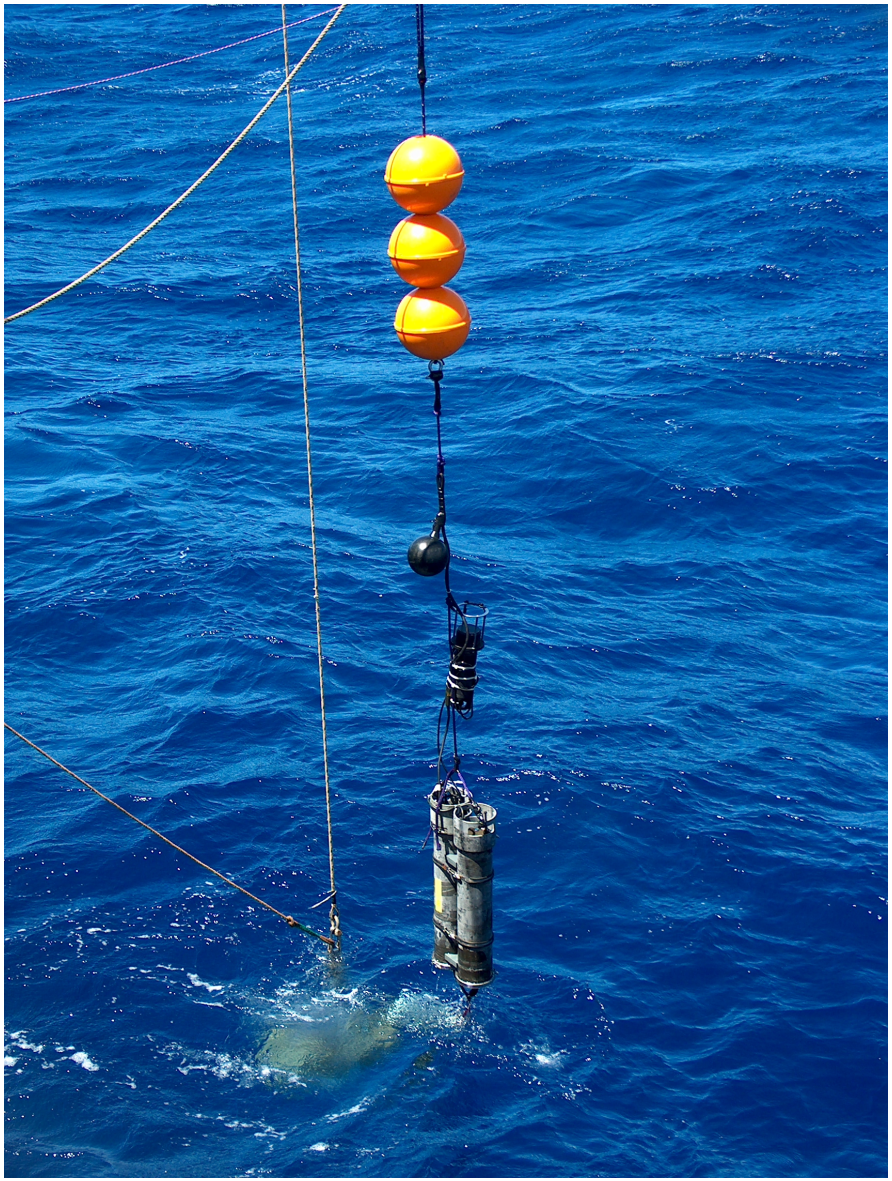

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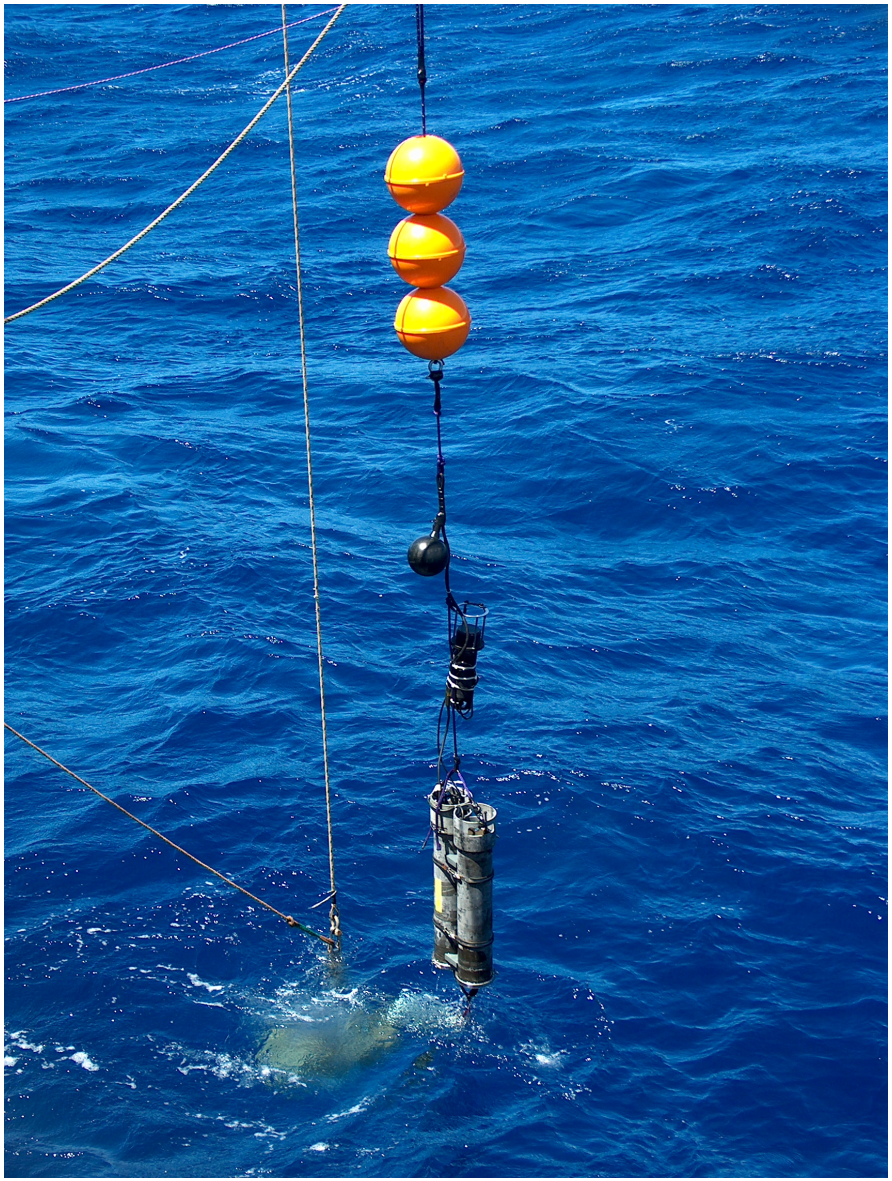

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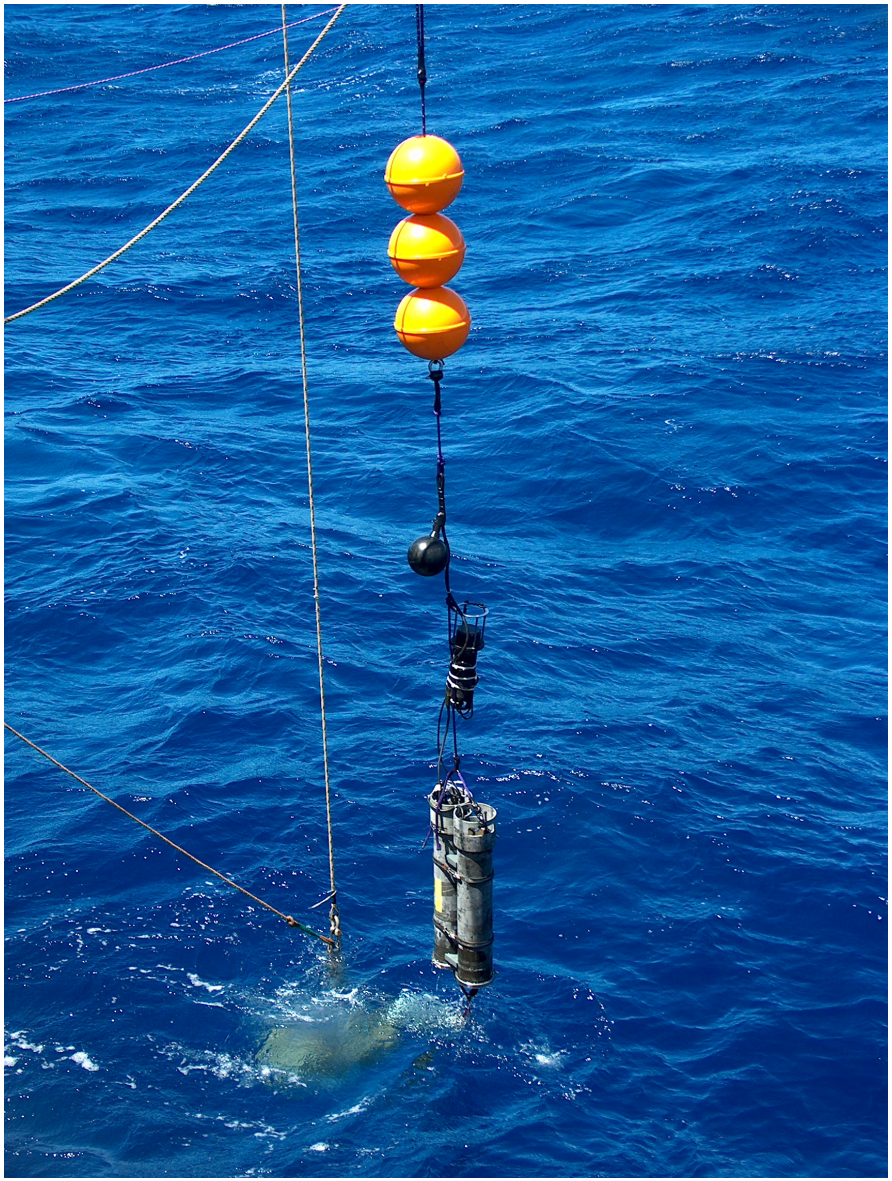

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MSFD background

What

...achieving or maintaining **good environmental status**... means *...Anthropogenic inputs of substances and energy, including noise, into the marine environment* (art.3 5.(b)) (...) **pollution** means *...the direct or indirect introduction into the marine environment, as a result of human activity, of substances or energy, including human-induced marine underwater noise,...* (art.3 8.)

Whom

member states (MS) with marine waters jurisdiction

When

(17/June/2008) MSFD...by 2020
(01/Sep/2010) criteria and methodology for GES $\rightarrow$ D11
(15/July/2012) initial assessment
(15/July/2014) monitoring program, art.11
(2015) program of measures, art.13
(2016 at the latest) implementation of program of measures.

Portuguese timeline for D11

May 2012	first contact, request for assessment report
July 2012	input and submission (total 2 report 900 pages+)
June 2013	request for monitoring program (3 meetings)
July 2014	monitoring plan (CASPER)
March 2015	establishing a commission for revision of MSFD descriptors
October 2015	SUBECO project (2015-2018) started

SUBECO: objectives & partnership

Objectives

- aims at reinforcing the capabilities of national underwater surveillance using passive detection of illicit activities of both surface and submerged ships off the coast of Portugal
- shipping noise monitoring to comply with Portuguese contribution to MSFD
- support to security and defense mission under its military component and for the protection of the marine environment

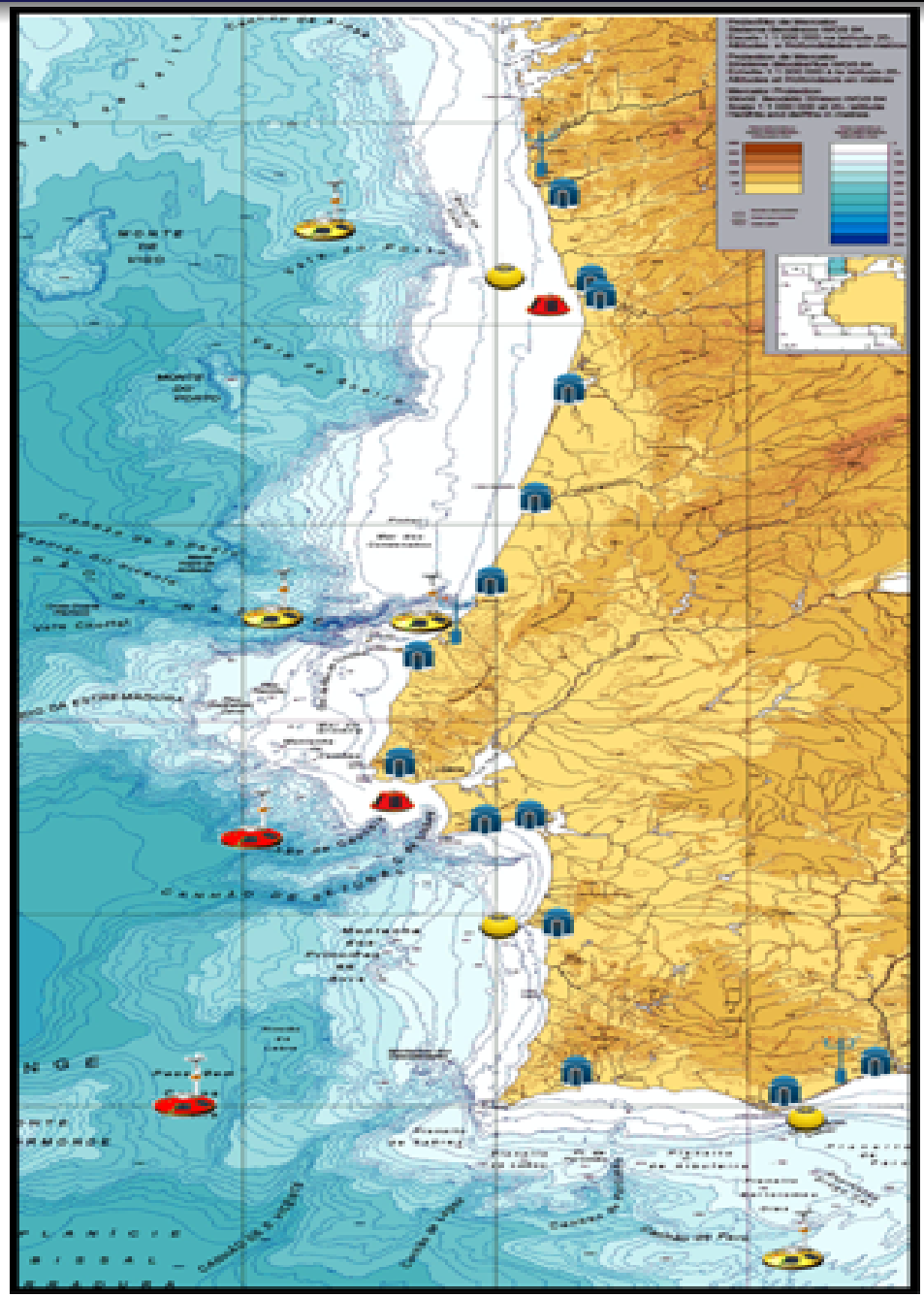
Partnership

Instituto Hidrográfico (PT Navy, coordinator), Esquadron 601 (PT Air Force), CISMIL (PT Army), Marsensing and CINTAL

Start date: October 1, 2015, duration 36 months.

SUBECO: buoy network

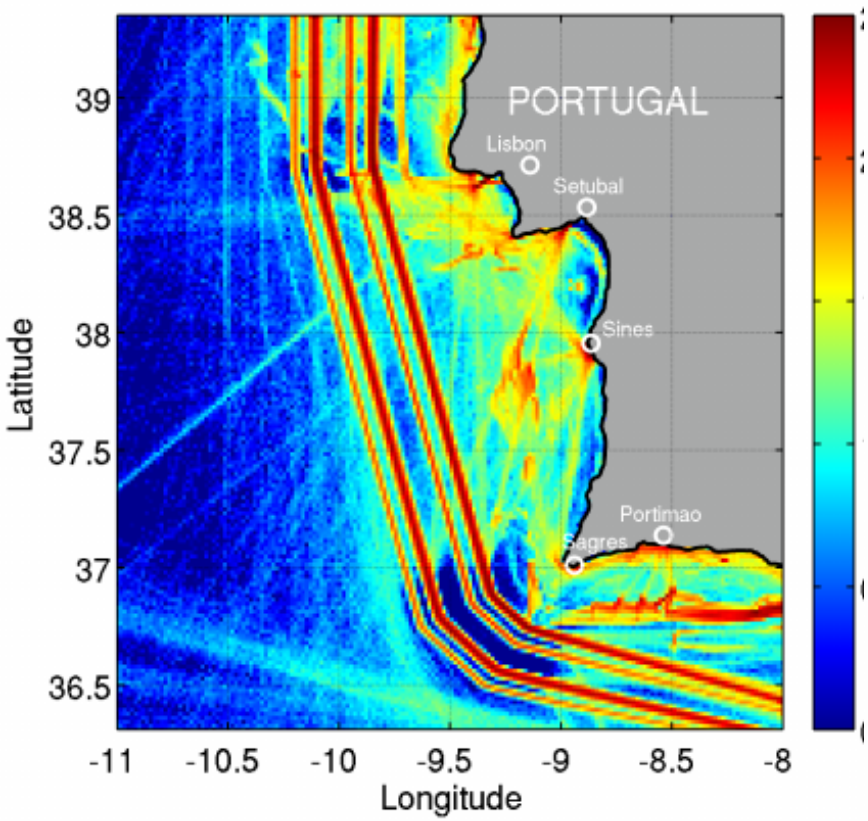
- 4 existing + 2 new offshore bouys (Wavescan Oceanor)
- $\approx$ 2000 m bathymetric
- environmental, meteo,...
- 5 hydrophones tetrahedral configuration @ 80m depth
- pre-processing and online transmission of events
- test: March 2017; deployment Aug - Sep 2017;



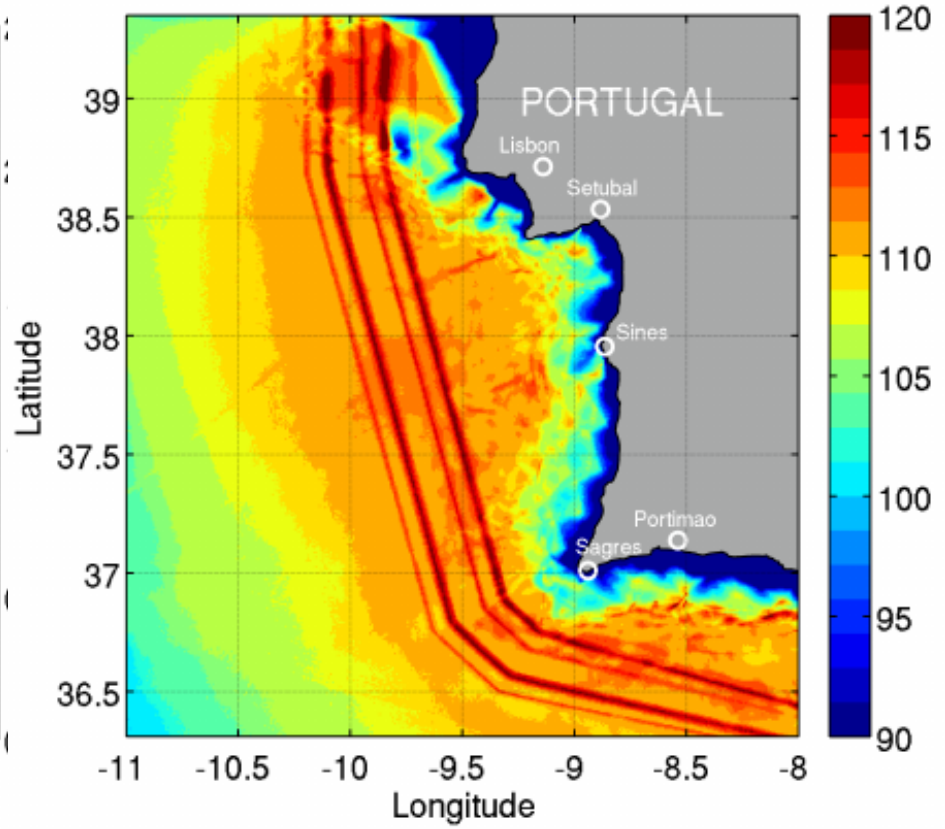
Southwest Portugal, ship trafic and prediction

AIS data March 19 - December 31st, 2014*

Ship density (ship x hour)



SPL [dBre1μPa@1m]@80m,32-1008Hz



*C. Soares et. al., "A Shipping noise prediction tool", IEEE/OES Oceans'15, Genova (Italy), 2015.

Sound sources in the ocean (1)

Spectral density of ocean sources (breaking waves, etc...)[1][2]

$$P(\omega;\mathbf{r}) = \sum_{\text{classes}} \int_V \lambda(\mathbf{r}) |G(\omega;\mathbf{r}_0,\mathbf{r}) S(\omega;\mathbf{r}_0)|^2 dv$$

- classes: environmental, man made, biological, etc
- $\lambda(\mathbf{r})$ source spatial extension/distribution
- $G(\omega;\mathbf{r})$ Green's function
- $S(\omega;\mathbf{r})$ source power

$$P(\omega;\mathbf{r}) = \sum_{\text{point sources}} |G(\omega;\mathbf{r_i},\mathbf{r}) S(\omega;\mathbf{r_i})|^2 + \sum_{\text{ext. sources}} n_j(\omega)$$

[1] G.B. Deane, "Sound generation and air entrainment by breaking waves in the surf zone", JASA, **102**, 1997.

[2] G.B. Deane and J.C. Preisig "Very High Frequency Noise Sources in the Littoral Zone", UCOMMS'16, 2016

Sound sources in the ocean (2)

Sources are considered random or random propagation media, but statistically independent

$$P(\omega;\mathbf{r}) = \sum_{i}^{I} E[|G(\omega;\mathbf{r_i},\mathbf{r})|^2]E[|S(\omega;\mathbf{r_i})|^2] + N(\omega)$$

K sensors	$\mathbf{p} = \mathbf{Gs} + \mathbf{n}$	$K \times I$
L source ranges	$\mathbf{p} = \mathbf{Gs} + \mathbf{n}$	$L \times I$

LMS solution (or ML under Gaussian noise assumption)

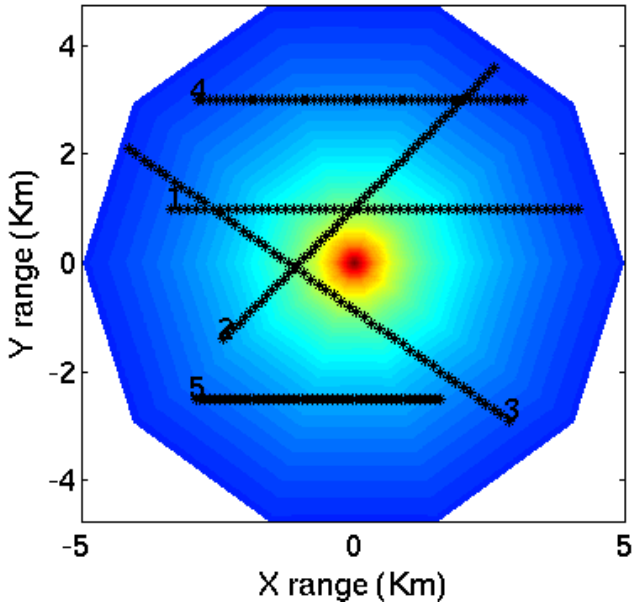
$$\hat{\mathbf{s}} = [\mathbf{G}^H \mathbf{R}_n^{-1} \mathbf{G}]^{-1} \mathbf{G}^H \mathbf{R}_n^{-1} \mathbf{p}$$

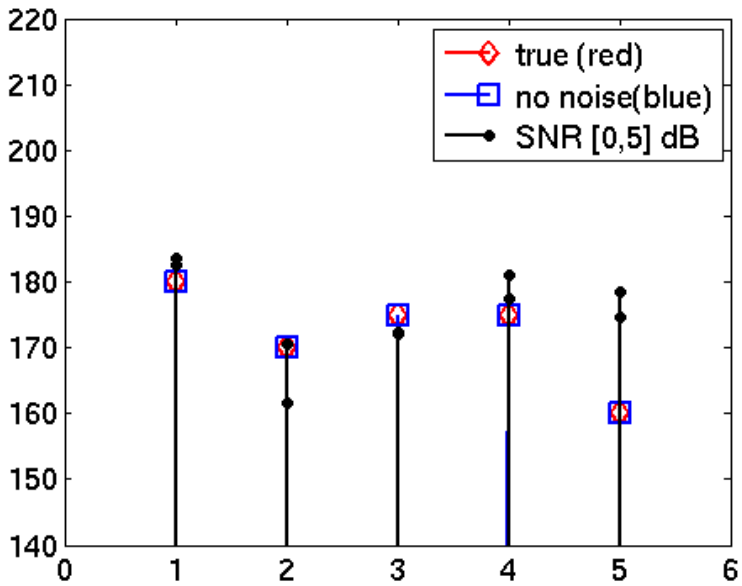
if $\mathbf{R}_n$ is known or an estimate exists.

Ship SPL estimation (1)

Naive simulation test:

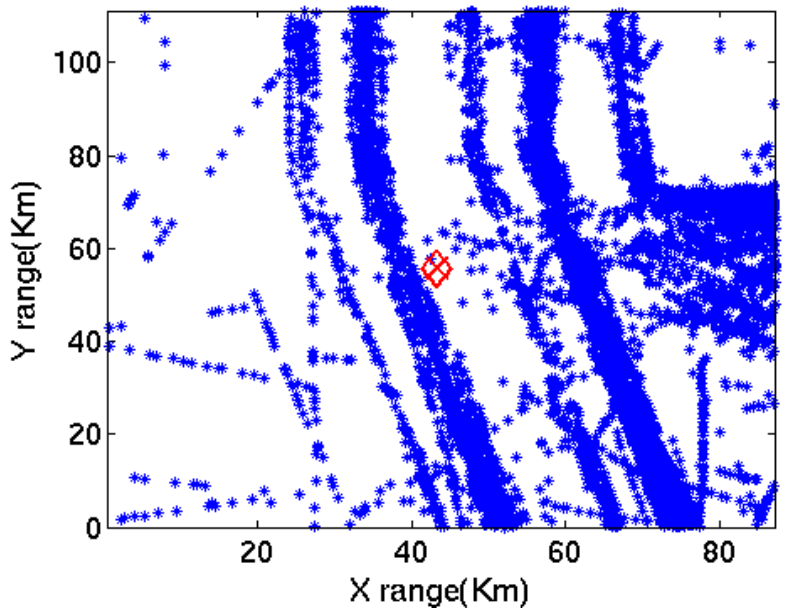
- cylindrical spreading only
- 5 targets within 5km
- single hydrophone
- variable SNR



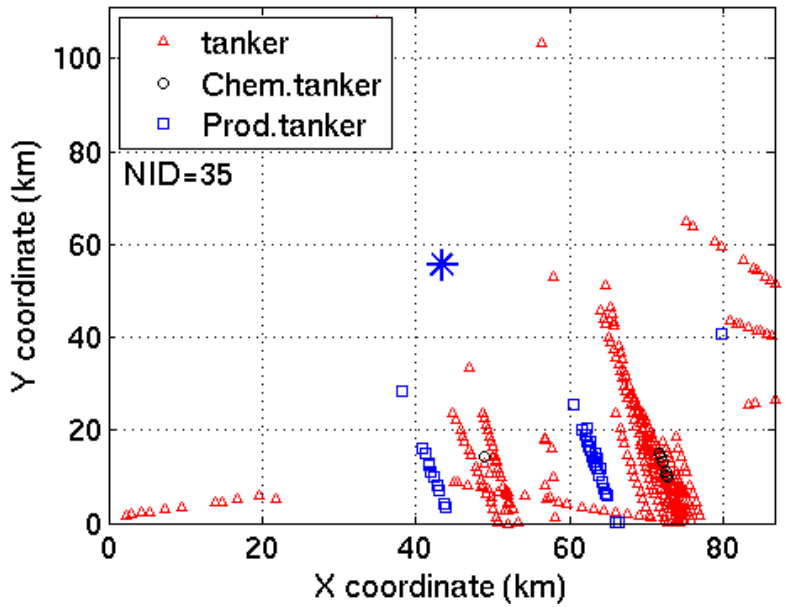


Ship SPL estimation (2)

AIS data near 38.5 N 10.0W
1 - 31 Aug 2014



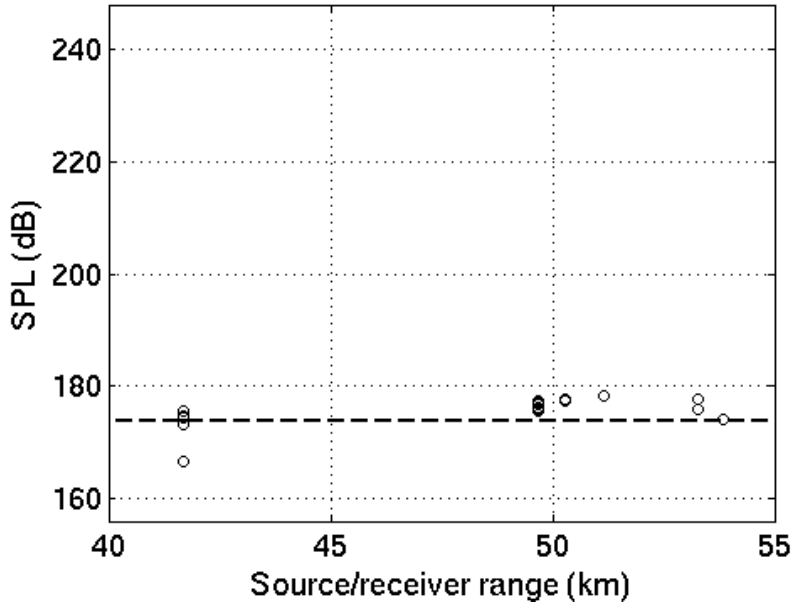
Selected:
2 Aug 2014 03:33 to 15:54 GMT

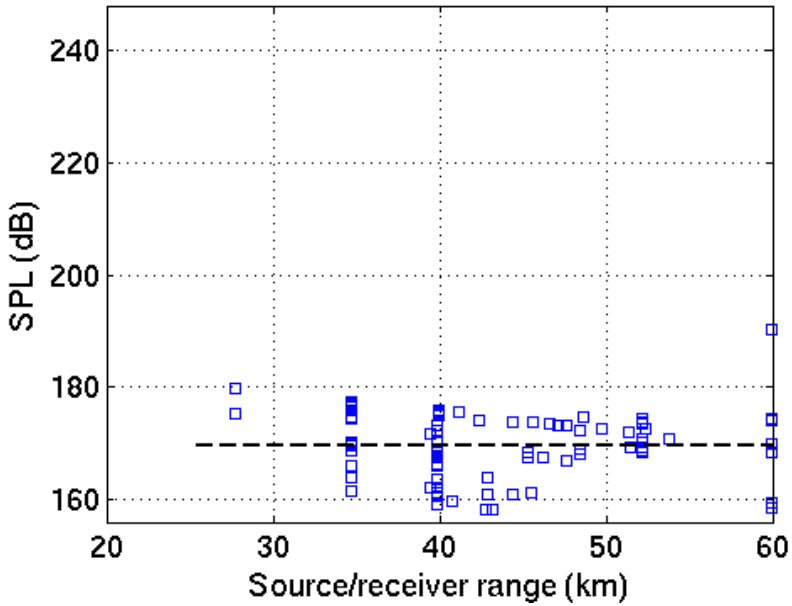


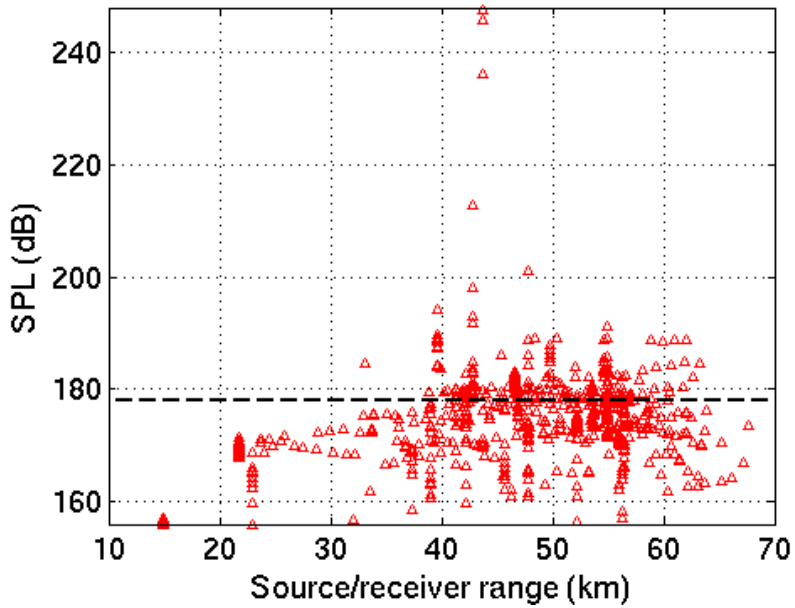
Ship SPL estimation (3)

AIS data near 38.5 N 10.0W
2 Aug 2014 03:33 to 15:54 GMT

- Kraken @ 504 Hz
- 1h sliding window
- 3 min sampling
- max # ships=20







Conclusions and perspectives

Current/future plans:

- monitoring strategy with some delay but underway
- acoustic SUBECO equipment deployed in 2017
- plans for forecast calibration under SUBECO 2017-2018
- continue/couple/extend to other regions with JONAS (?)

Next (possible) steps

- if more sensors: retrieve field structure by adjusting the environment (knowing the position)
- assume a sparse distributed field, randomize in range or sensor (or both) for a low coherence observation matrix

Mercis

!! Merci de votre attention !!

Merci à Serenade