

# Mission Shyrna Odyssey

*CNRS LIS univ. Toulon & Seaproven*

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*F. de Varenne, Sea-Proven SAS*

# Introduction : high risk, high gain...

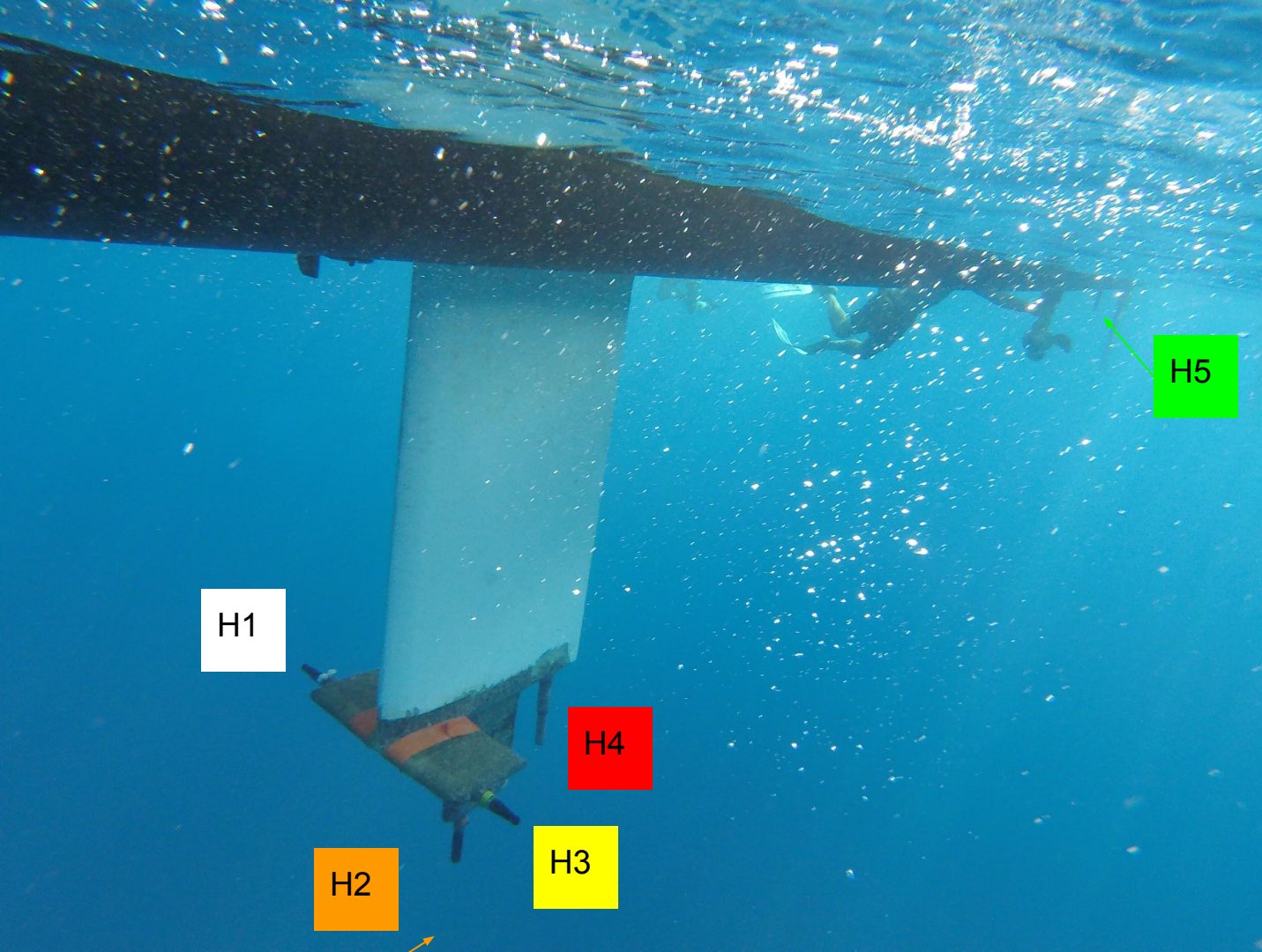
ALV Sphyrna are Polynesian Design  
= Stable, perfect hydrodynamic,  
**Low acoustic print**

=> H. Glotin proposed end of 2017  
to observe in 3D cetaceans dives  
with hydrophones array fixed  
on the keel + Embedded Artificial Intellig



Context : Dyni LIS team is expert in AI and machine listening

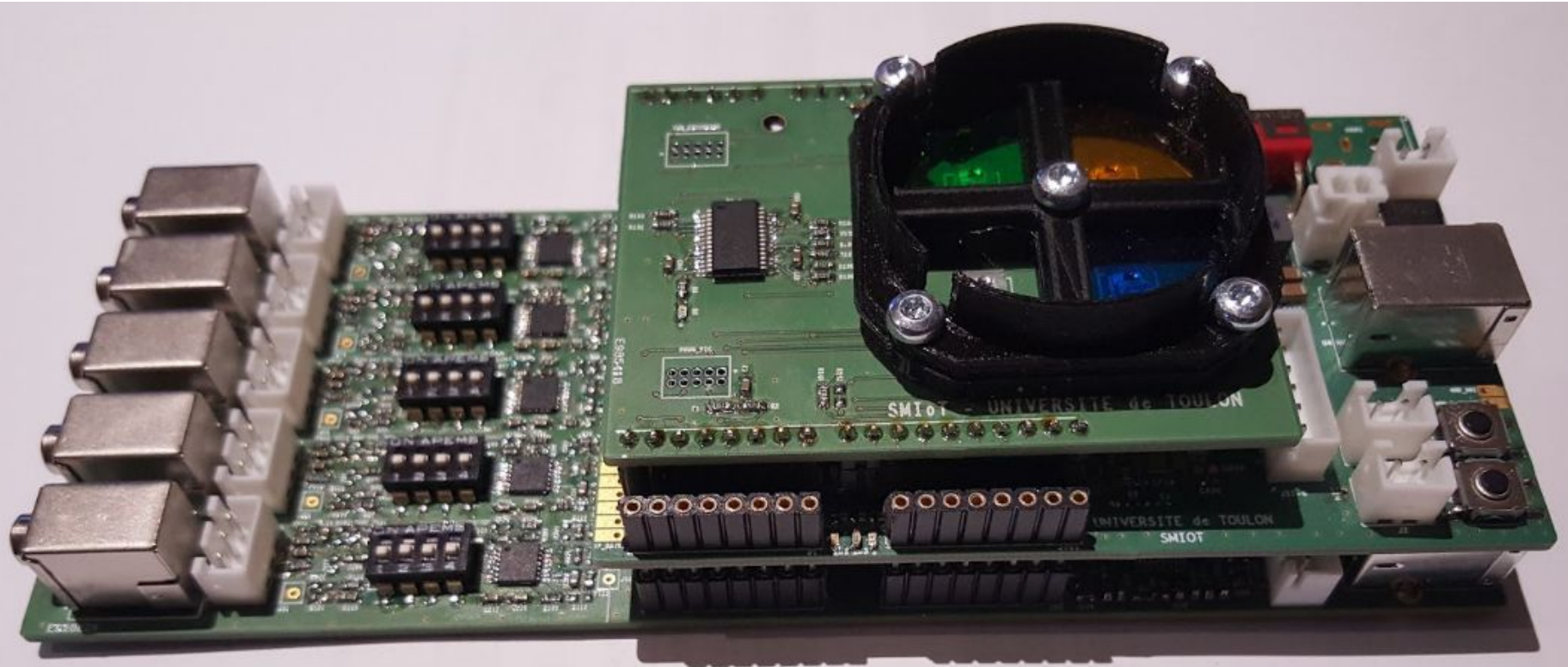
<http://bioacoustics.lis-lab.fr>



The 5 hydros fixed under the keel of the Sphyrna



The JASON sound card innovated by univ. Toulon, SMIoT, designed for innovant bioacoustic research  
5 x 1 mHz sampling rate



# Effect of the Lockdown

## Sphyrna Odyssey :

From October 2019 to March 2020 (before lock down) + April to May 2020 (lock down)

Map of the dB level for 20 Hz octave before lock down

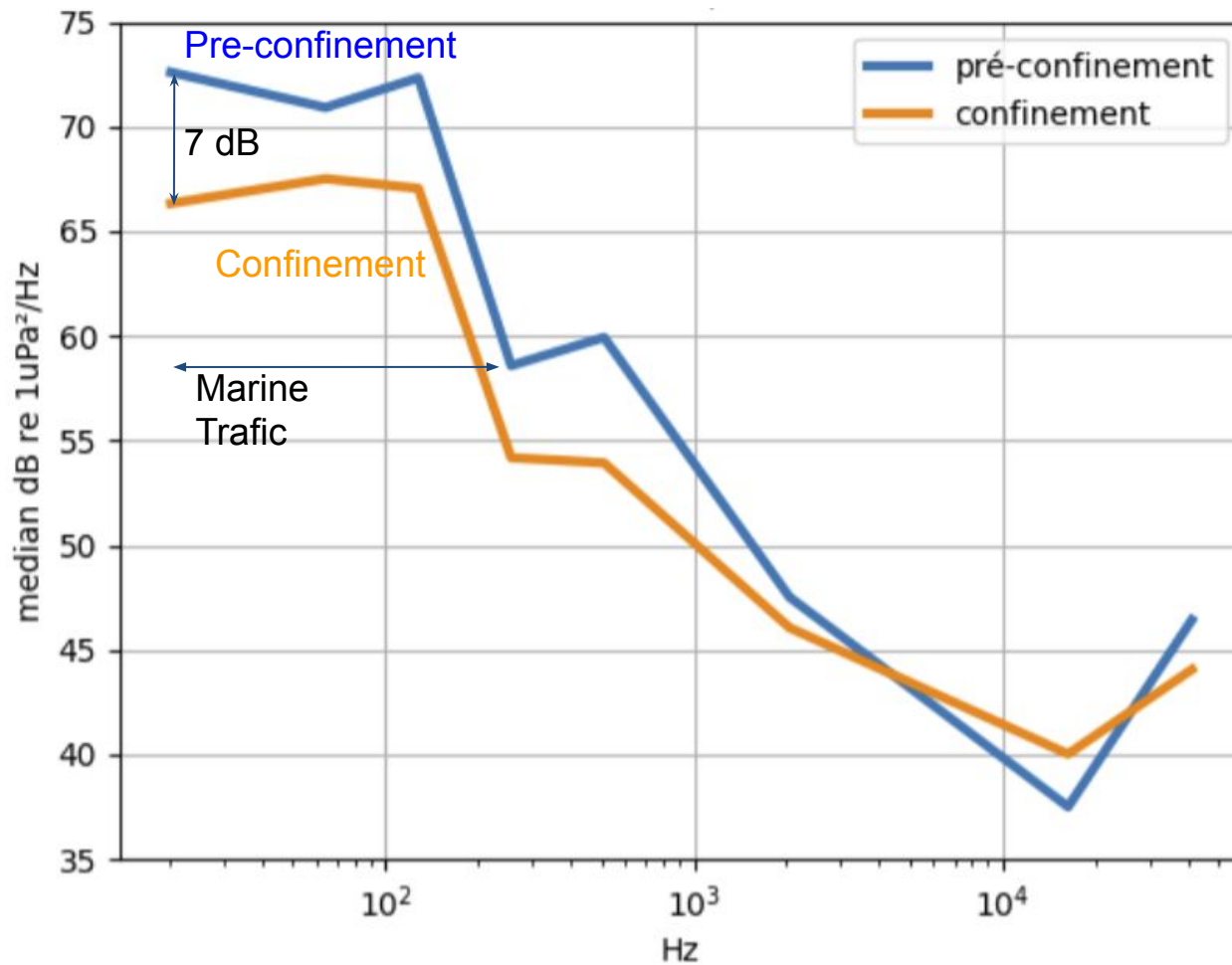


octave 20Hz



Rencontre d'une quinzaine de Tursiops t. dans la baie de Hyères le 23 Avril (Film complet disponible à <https://www.youtube.com/watch?v=Amn20xFMpTo>).

Covid Lockdown effect

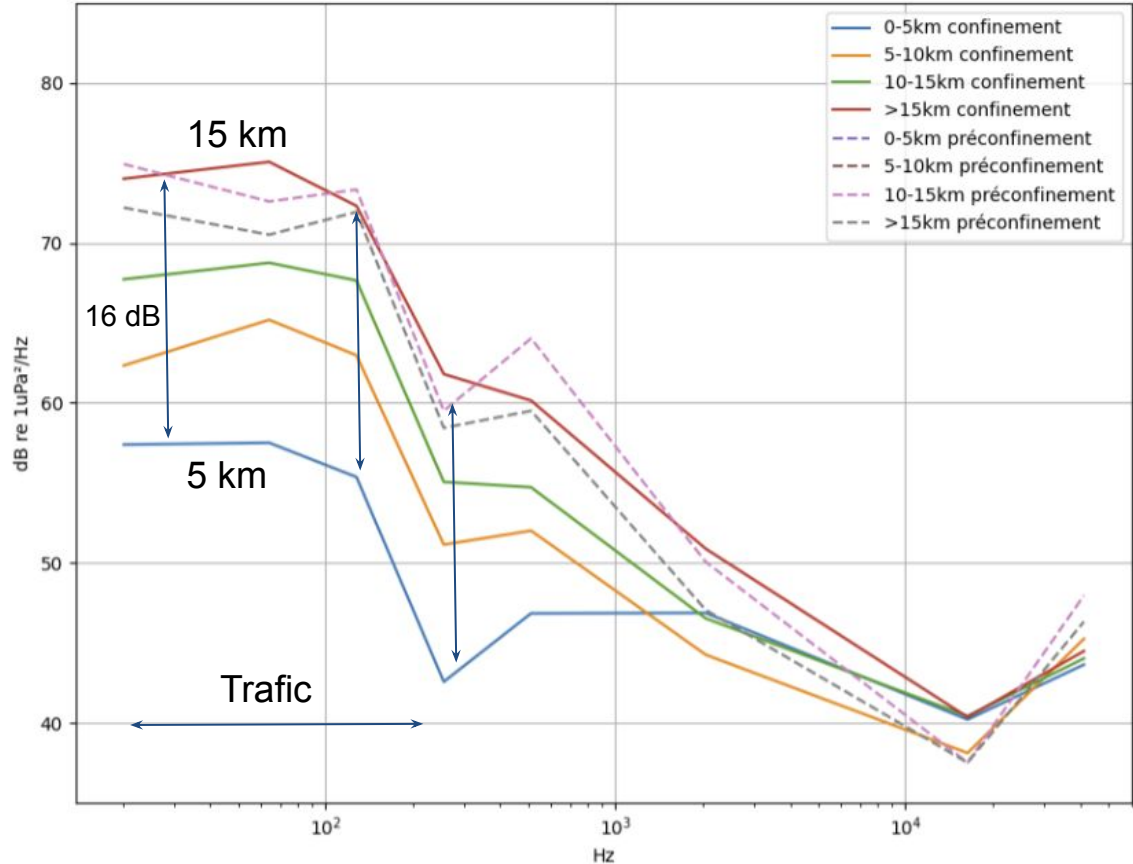


Medium of minimum dB levels, hourly, for each octave during (blue) vs out (orange) lock down



Effect of the lockdown according to the distance to the coast  
 => Human activity mostly changed along the coast  
 big tankers were still there...

Solved hydrocarbure reduced by 50% during the lockdown !



Medium of minimum dB levels for each octave during vs out lock down according to distance to the coast

Observe Abyss by Listening

Clear dolphin clicks, TDOA measures, recorded on 5 channels, Chan 1, 4, 5 = gain x 4, Chan 2, 3 = gain 1/2



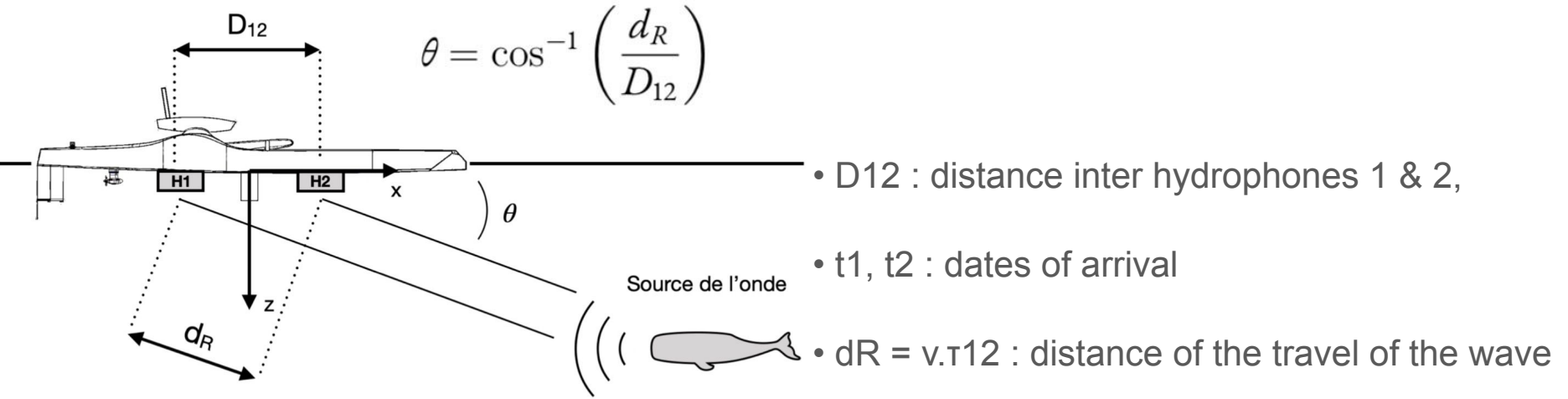
Direct

Echo surface

# Tracking in 3D : TDOA

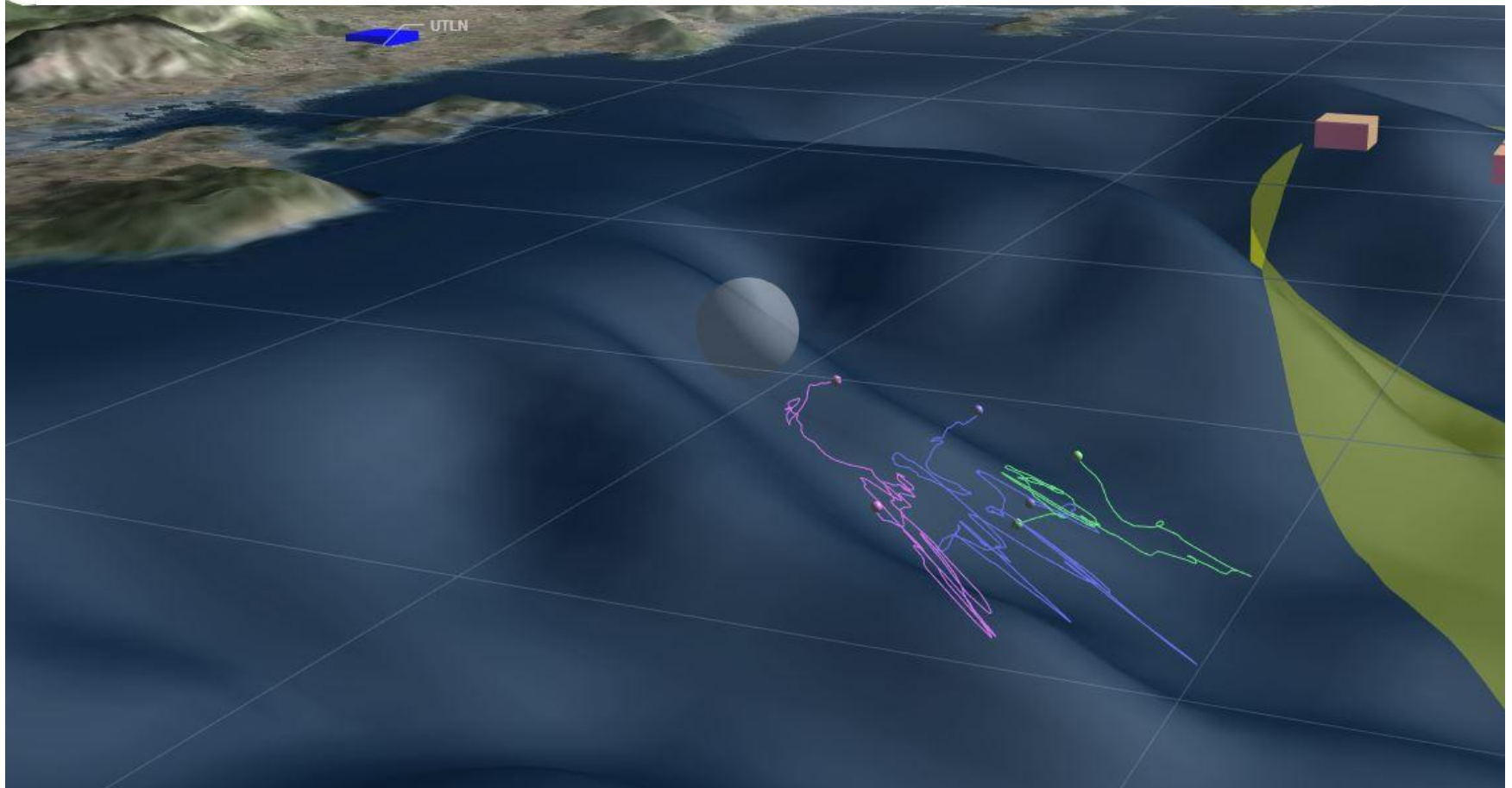
“Time Difference Of Arrival”

$$\text{TDOA}_{21} = \tau_{21} = t_1 - t_2$$



August 2018, Proof of concept

Physeter observation by first version of the system, with 3 tracks, 50 minutes each, down to -1000 m  
[ Poupard et al IEEE ICASSP 2019 ]

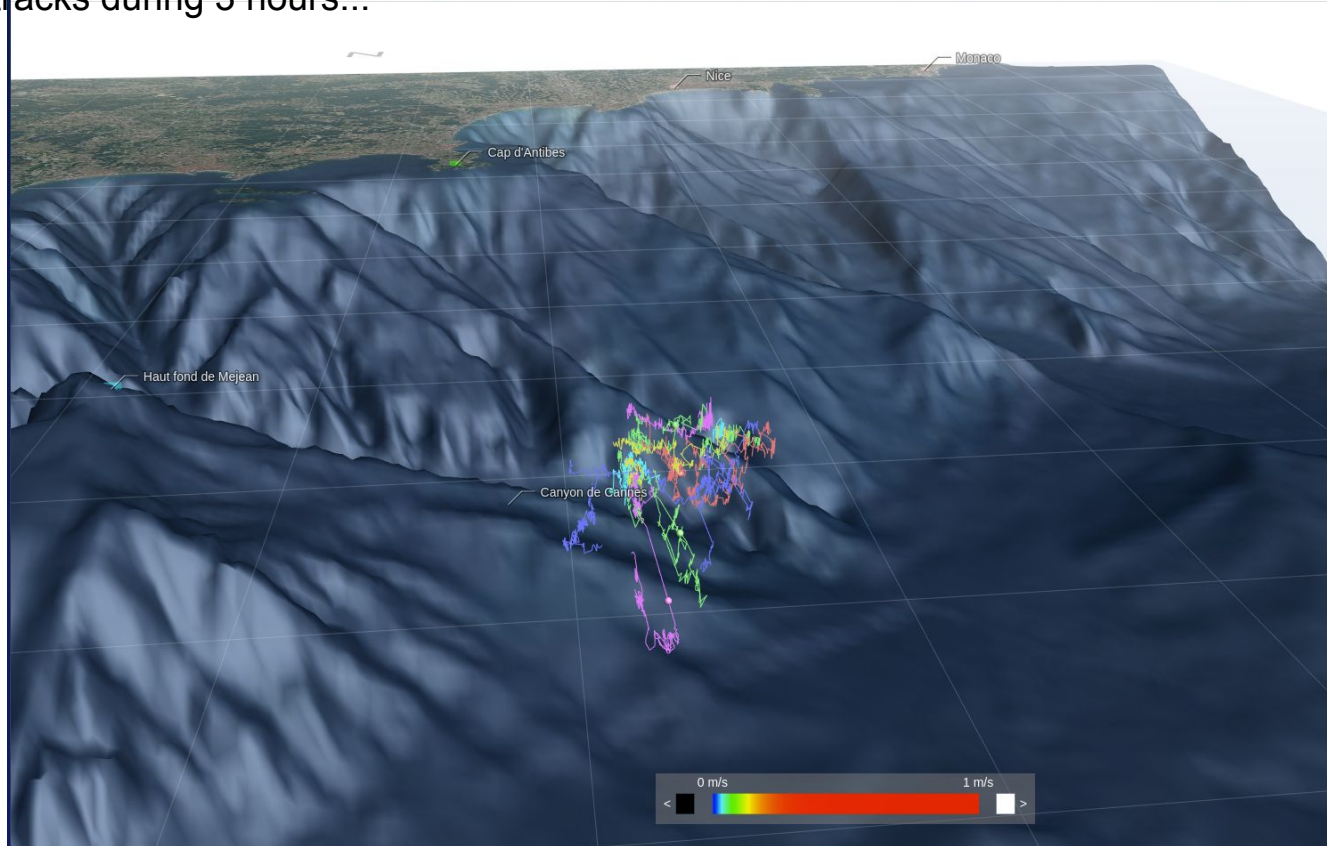




2020 01 11 ... and next :



A great meet, among others, during Sphyrna Odyssey  
14th january 2020, South Monaco  
The 15 tracks during 3 hours...



## Bioacoustic monitoring of *Physeter macrocephalus*

Vamos Sphyrna Odyssey TOULON & SABIOD



Settings Tracks Speed

Latitude : off

Longitude : 6.847

Depth : off

Min norm : 0 m/s

Max norm : 1 m/s

Enhance Low Norm :

Choose the graphics slices by cursors.  
Change orientation & zoom using your mouse.  
2 clicks: center & get details on an object.

(c) SPHYRNA ODYSSEY project. Concept and 3D tracks :  
Glotin et al. CNRS LIS U Toulon & SEAPROVEN SA.  
Currents : Y. Ourmieres CNRS MIO U. Toulon. Web : P.  
Cosentino.  
gloito. (a) univ-tln.fr



[https://sabiody.lis-lab.fr/pub/SPHYRNA/3D/current\\_norm/](https://sabiody.lis-lab.fr/pub/SPHYRNA/3D/current_norm/)

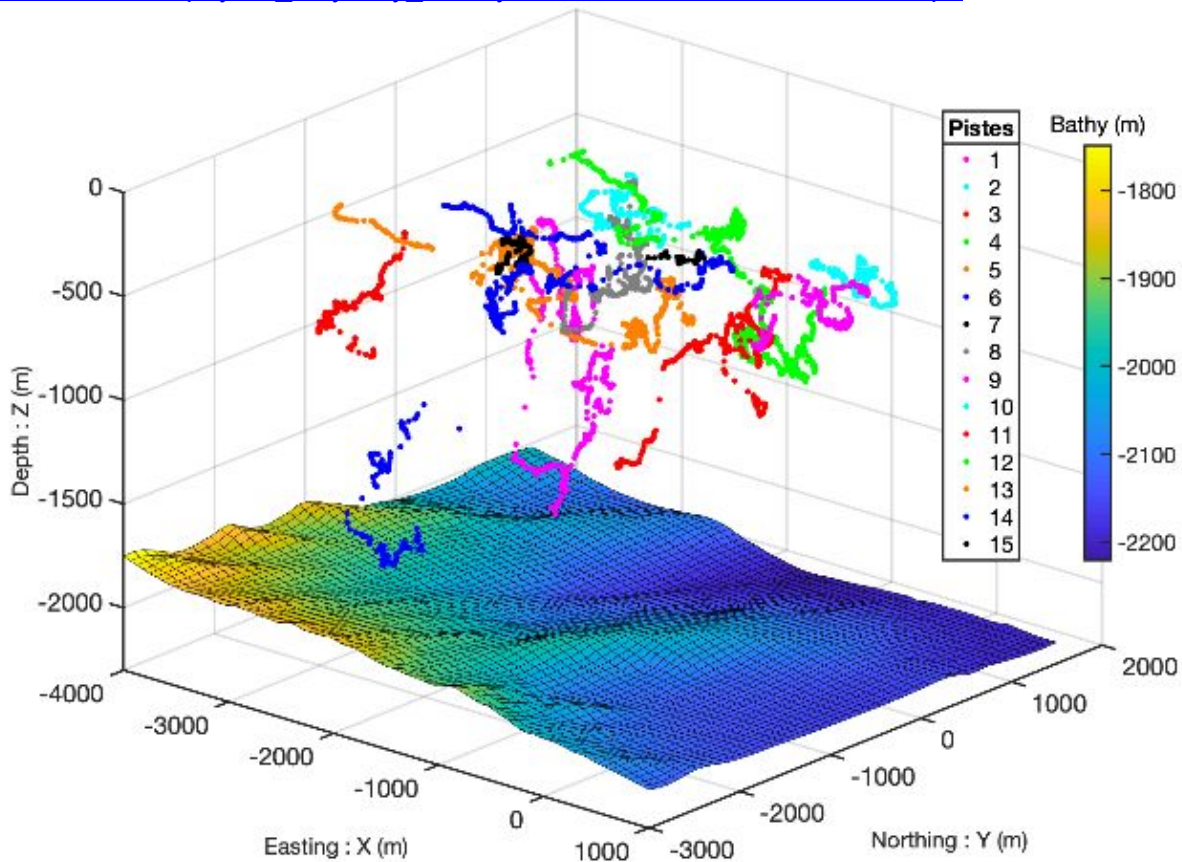
14 January 2020, 5 to 7 Physeters : Alliance = coordination up to 500m

[http://sabiod.univ-tln.fr/pub/SPHYRNA/Sphyrna\\_Odyssey\\_3DAbyssalAlliance20200114Monaco.mp4](http://sabiod.univ-tln.fr/pub/SPHYRNA/Sphyrna_Odyssey_3DAbyssalAlliance20200114Monaco.mp4)

Correlation  
between  
the tracks : Alliance

Coincidences of the  
beams of the  
biosonars

They Collaborate  
May need Silence  
to do so.



# Dynamic visualisation of the tracks :

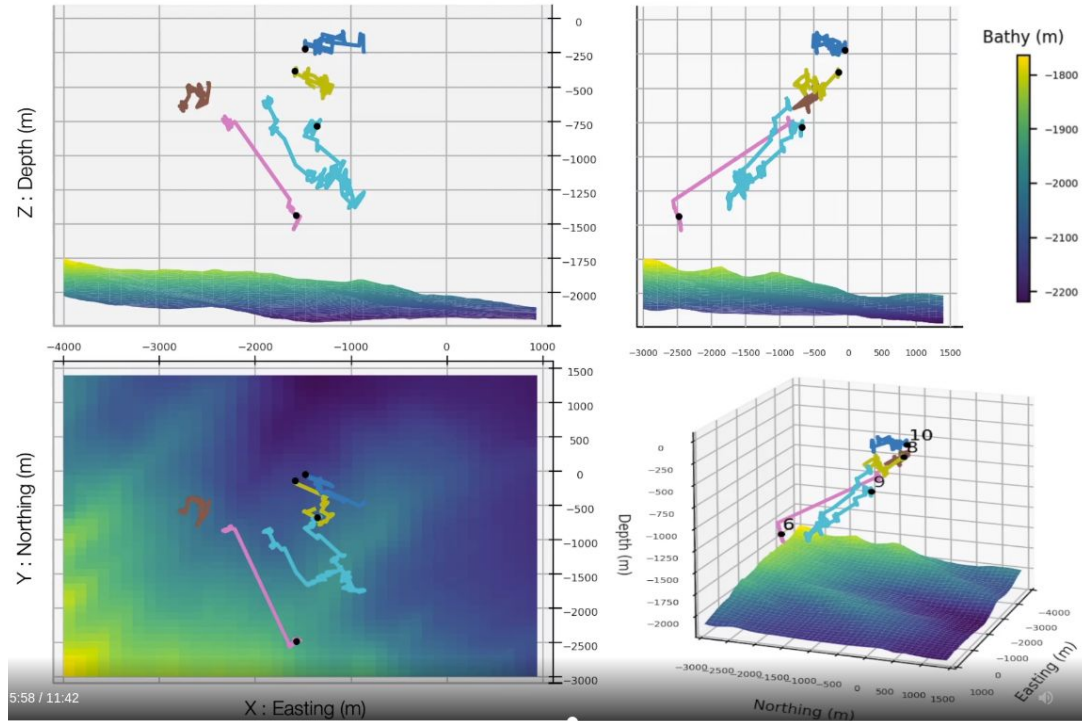
[https://sabiody.lis-lab.fr/pub/SPHYRNA/3D/SO\\_Glotin\\_Thellier\\_etal\\_PhyseterAlliance\\_Monaco\\_20200114\\_3DtracksX\\_Y\\_Z.mp4](https://sabiody.lis-lab.fr/pub/SPHYRNA/3D/SO_Glotin_Thellier_etal_PhyseterAlliance_Monaco_20200114_3DtracksX_Y_Z.mp4)

## Sphyrna Odyssey

Surface Passive Acoustics and Artificial Intelligence

First Demonstration of Sperm Whales Collaborative Hunting in the Abyss  
(South of Monaco, 2020.01.14, -500 to -1500 m deep, time accel. x10)

Glotin H., Thellier N. et al.





# Ethoacoustics, Alliance & multistatic observations

Illustration with biosonar conic emissions

( 500m, 35° aperture )

We reveal frequent colinear tracks

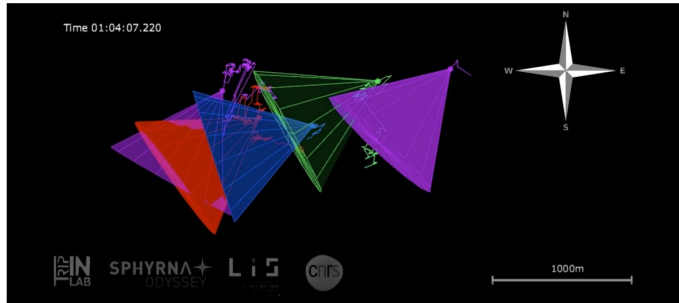
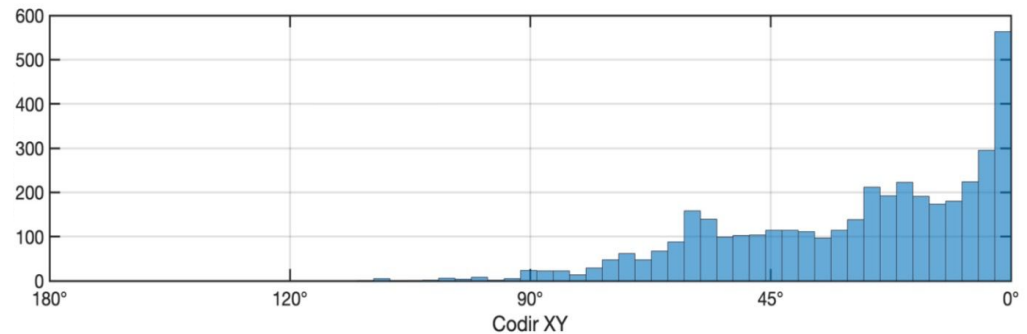
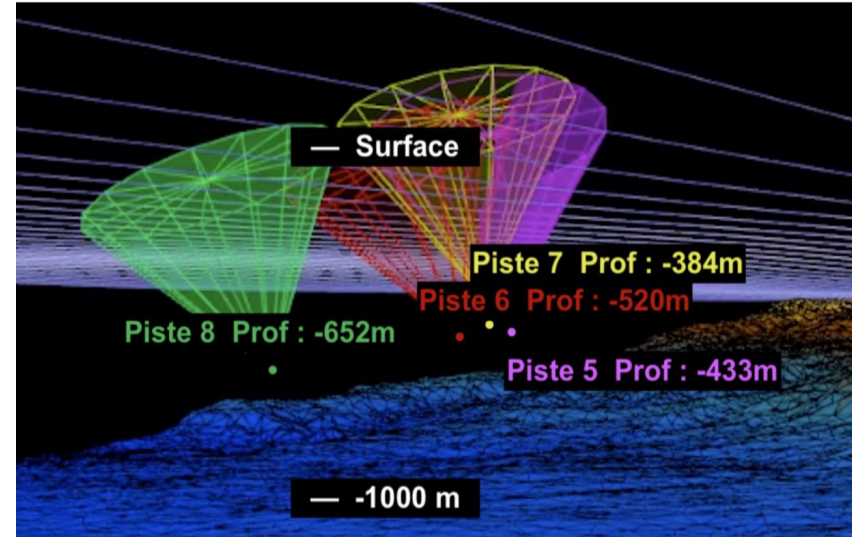


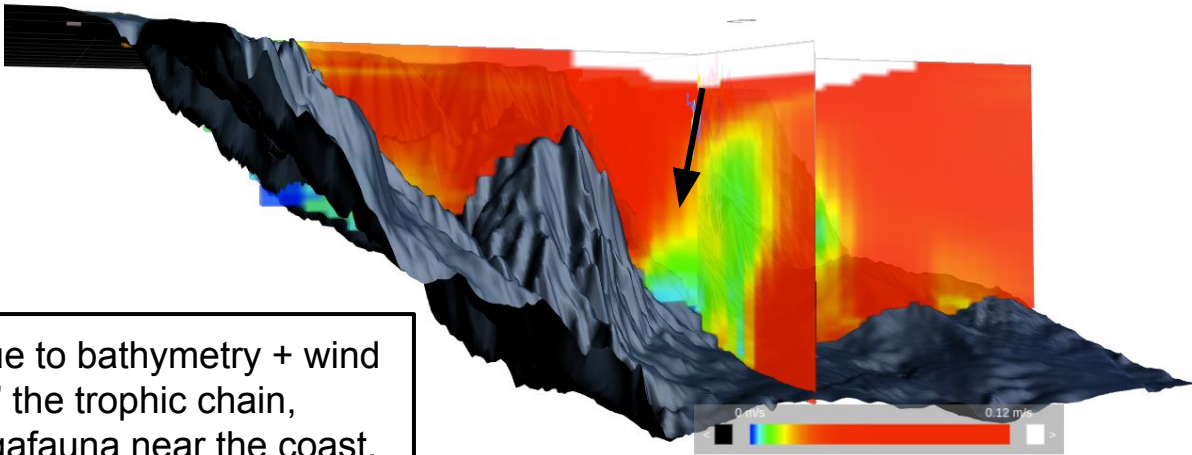
Figure 10.15: Cinq chachalots émettant dans la même direction. Chaque cône d'émission est placé suivant la tangente à la trajectoire calculée. Démonstration en vidéo disponible sur [http://sabiiod.univ-tln.fr/pub/SPHYRNA/3D/SO\\_Glotin\\_Theillier\\_et\\_al\\_Mercier\\_PhyseterAlliance\\_Monaco\\_20200114\\_accelx2\\_skyview.mp4](http://sabiiod.univ-tln.fr/pub/SPHYRNA/3D/SO_Glotin_Theillier_et_al_Mercier_PhyseterAlliance_Monaco_20200114_accelx2_skyview.mp4)

Fig : Histogram of the angles between each pair of tracks



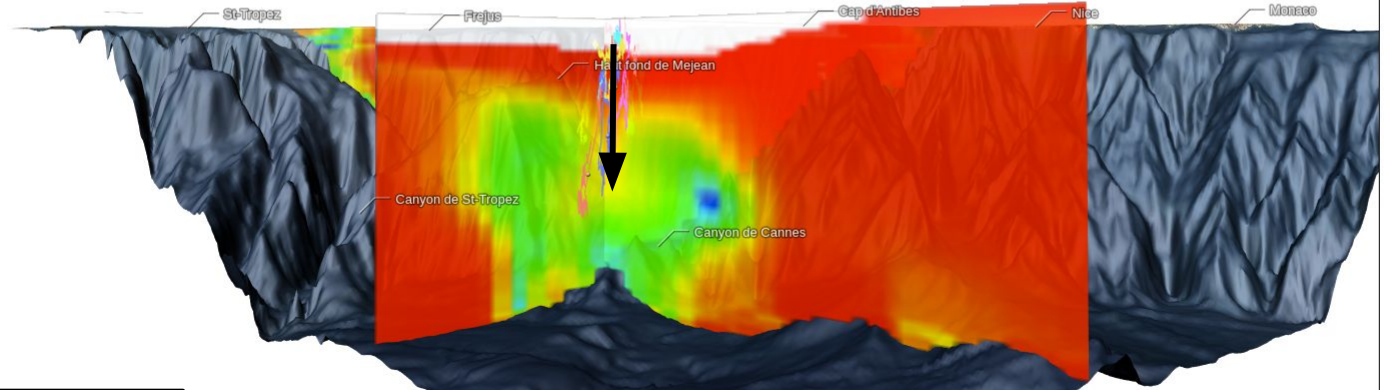


# Hunting together during hours into the heart of a Vortex



Upwelling due to bathymetry + wind are “feeding” the trophic chain, thus the Megafauna near the coast.

Current speed



In coll. Y. Ourmières

Current speed

## Bioacoustic monitoring of *Physeter macrocephalus*

Vamos Sphyrna Odyssey TOULON & SABIOD



Settings Tracks Speed

Latitude : 43.336

Longitude : 7.183

Depth : off

Min norm : 0 m/s

Max norm : 0.12 m/s

Enhance Low Norm :

Choose the graphics slices by cursors.  
Change orientation & zoom using your mouse.  
2 clicks: center & get details on an object.

(c) SPHYRNA ODYSSEY project. Concept and 3D tracks : Glotin et al. CNRS LIS U Toulon & SEAPROVENV SA. Currents : Y. Ourmières CNRS MIO U. Toulon. Web : P. Cosentino, glotin (at) univ-tln.fr



# More results in 3D visualisations with currents

Trajectories :

[http://sabiiod.lis-lab.fr/pub/SPHYRNA/3D/SO\\_Glotin\\_Thellier\\_etal\\_PhyseterAlliance\\_Monaco\\_20200114\\_3DtracksX\\_Y\\_Z.mp4](http://sabiiod.lis-lab.fr/pub/SPHYRNA/3D/SO_Glotin_Thellier_etal_PhyseterAlliance_Monaco_20200114_3DtracksX_Y_Z.mp4)

Trajectories and norm of the current :

[https://sabiiod.lis-lab.fr/pub/SPHYRNA/3D/current\\_norm](https://sabiiod.lis-lab.fr/pub/SPHYRNA/3D/current_norm)

Trajectories and thermocline :

<https://sabiiod.lis-lab.fr/pub/SPHYRNA/3D/temp>

Trajectories and halocline :

<https://sabiiod.lis-lab.fr/pub/SPHYRNA/3D/salt>

Demo of the map : [https://sabiiod.lis-lab.fr/pub/SPHYRNA/radio/20201029\\_FranceInter\\_TerreauCarre\\_Glotin\\_1h/Sphyrna\\_Odyssey\\_courant\\_halocline\\_3D\\_aveclectrajectoires\\_20200114.mp4](https://sabiiod.lis-lab.fr/pub/SPHYRNA/radio/20201029_FranceInter_TerreauCarre_Glotin_1h/Sphyrna_Odyssey_courant_halocline_3D_aveclectrajectoires_20200114.mp4)

# Conclusion

- Evidences of soundscape variation during Covid19
  - World first precise 3D tracking of Alliance of Physeters in Abyssa
  - First evidence of hunting strategies of Megafauna : **collaborative super sonar**
  - New cues for more precise estimation of anthropophonic impact / new regulations ?
  - New cues for whale-ship anti-collision systems : whale diving behavior is link to vortex, visible from space...
- 
- Perspectives : new Era of Ethoacoustics into the Abyssa, correlations between Oceanic fronts, Anthropophony and “Whale CULTURE”



SMIoT UTLN JASON sound card : 100 dB of Dynamics : recording of a chirp 0.1 to 500 kHz

