

Propagation model for range estimation, perspective on megafauna localisation with in situ experiments :

Whale Way 6 & SeGaMas

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³ Parc National de Port-Cros

⁴ Longitude 181

⁵ Chaire IA AID ANR-20-CHIA-0014, ULPCochlea ANR-21-CE04-0020, Europam Biodiversa 2021-488

WhaleWay6, a Longitude 181 mission

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⁴ *Longitude 181*

⁵ *Europam Biodiversa 2021-488*

⁶ *Chaire IA AID DGA ADSIL ANR-20-CHIA-0014*



▲ WhaleWay6, a 6th mission for “*La voix des cachalots*”



Studying the Mediterranean sperm whale population to better protect them

In two weeks :

- ★ 19 sperm whales never encountered before
- ★ 1 large male “*The-one*”
- ★ Groups of 7 and 8 individuals socializing and hunting



Aerial photo of a group of 4 sperm whales, taken by drone on September 30 (© Ody D).

▲ WhaleWay6, data collected

Photos-identification

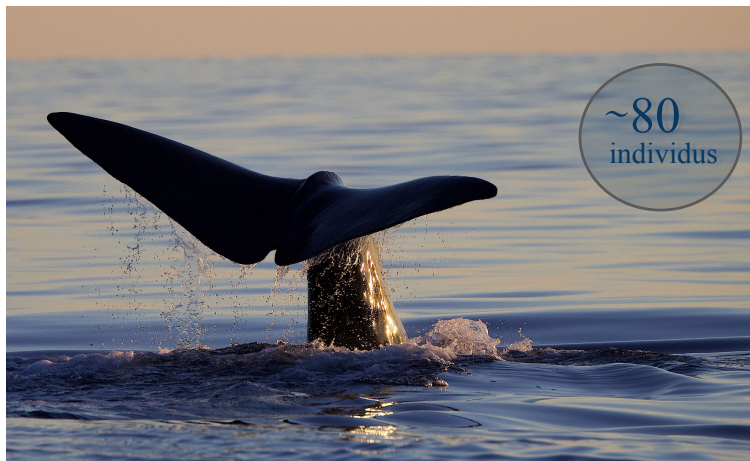


Photo-identification of the caudal fin of the named sperm whale “*Aigle-noir*” (© Sarano F).

- ✓ 16 complete ID cards
- ✓ 3 partial ID cards
- ✓ 6 recaptures during the mission

Aerial photos taken by drone

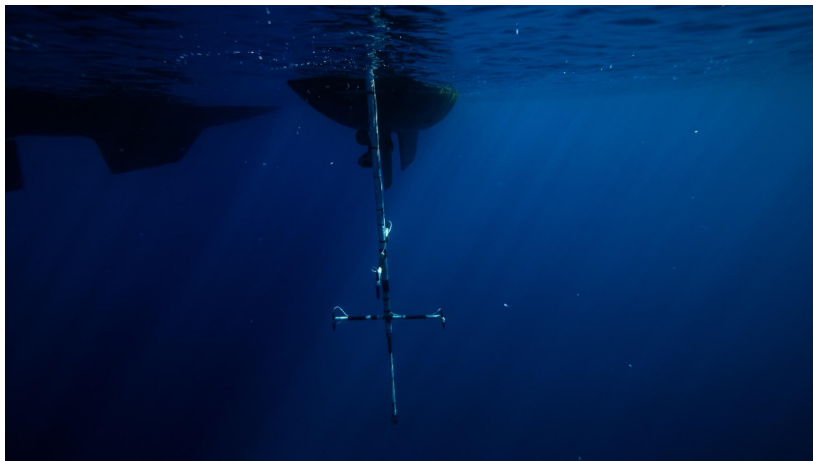


Aerial photo of a group of seven sperm whales, taken by drone on September 28 (© Ody D).

- ✓ Assist with identification
- ✓ Observe affinities
- ✓ Calculation of individual size

▲ WhaleWay6, data collected

Acoustic recordings



“Bagheera” acoustic sensor
with 5 hydrophones (© Chavin S).

- ✓ Recordings after each dive
- ✓ Recordings of codas, including one of a large male

CTD measures

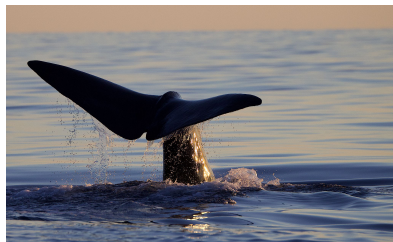


Instrument de mesure CTD *CastAway*,
prêté par Arnaud La Ridant MIO

- ✓ Measures every day
- ✓ Measures after each promising recordings

■ WhaleWay6, expected analysis

Photos-identification

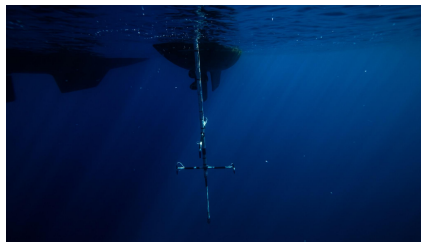


Associating IPI
with individuals

Estimating the residence of
sperm whales in areas at risk of
collision with ships

AIS

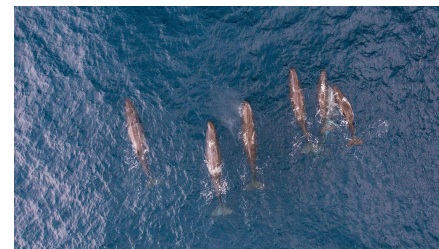
Acoustic recordings



Associate IPI and size of each individual
Establish a function specific
to the Mediterranean IPI/size

Analyzing acoustic scenes with echo

Aerial photos taken by drone



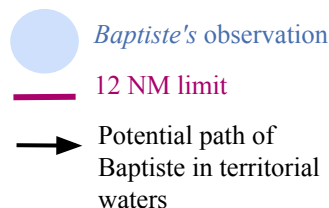
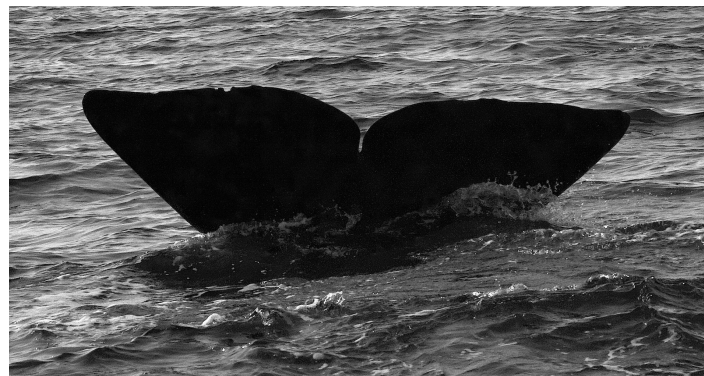
CTD measures



▲ **WhaleWay6**, the retaking of “*Baptiste*” and his movement

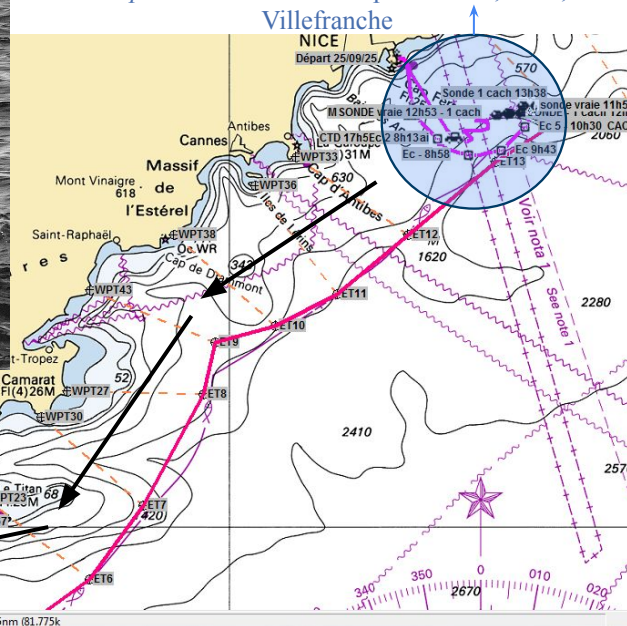
From September 25 to October 1, 2025:

- + 100 NM traveled in 6 days
- 12 NM from the coast



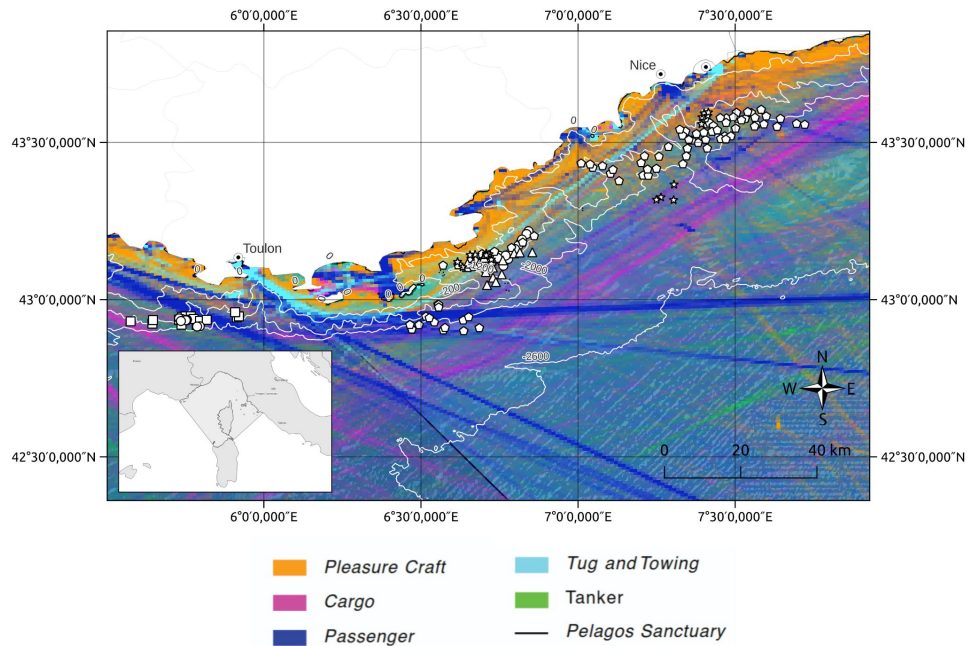
“*Baptiste*” observed on October 1, 2025, in Toulon

“*Baptiste*” observed on September 25, 2025,

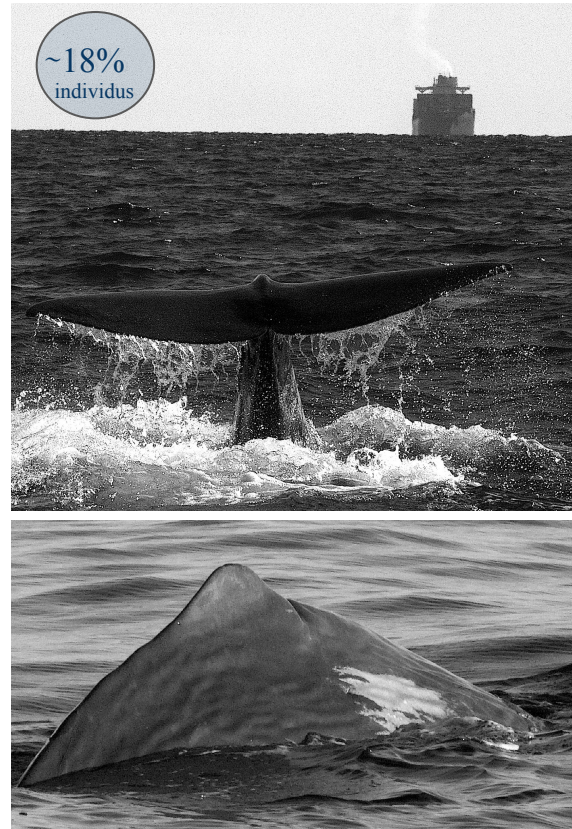


(Left) New sperm whale identified, named “*Baptiste*”
 (Right) Observations of “*Baptiste*” during *WhaleWay6*, covering an average of 16 NM per day over 6 days. (© Sarano F. et V.)

WhaleWay6, refine collision risk



Positions of sperm whales observed during Longitude 181 missions in 2023 and 2024 with vessel density in September 2022 (© Chavin S.)



(Top) Dive of the sperm whale named “*Saladin*” on a marine rail.
 (Bottom) New sperm whale named “*Rescapé*”
 injured by a propeller before its dorsal fin (© Sarano F.)

SeGaMas

Serious Game for Marine Mammal Survey

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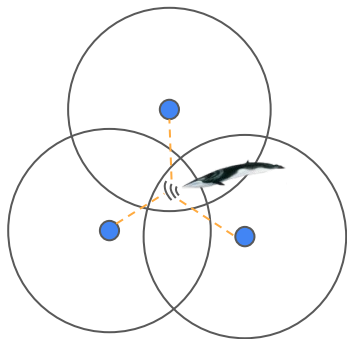
³ *Parc National de Port-Cros*

⁴ *Chaire IA ADSIL DGA AID ANR-20-CHIA-0014*



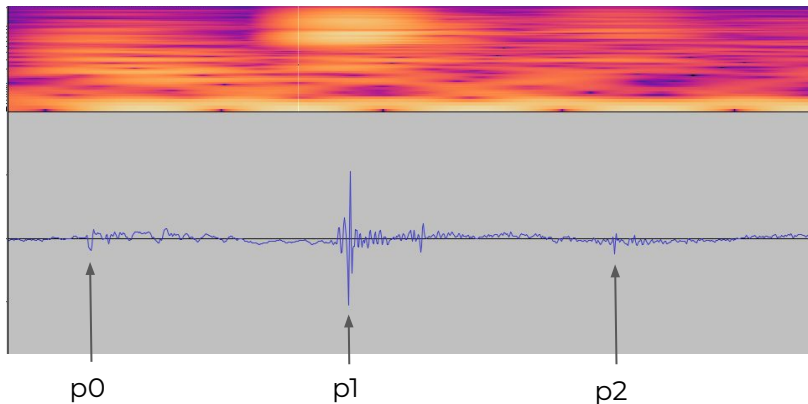
▲ TDoA to locate cetaceans

Time-Difference-of-Arrival



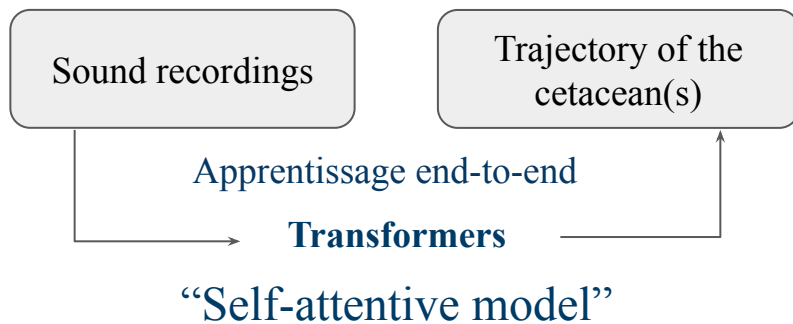
- **Ultra-synchronized** hydrophones
- **Simple** environment
(**no echo**, causing false positioning)
- **Simple** sounds (only one speaker at a time) and good quality
- Network fairly **distant**

Spectrogram and waveform of a sperm whale click



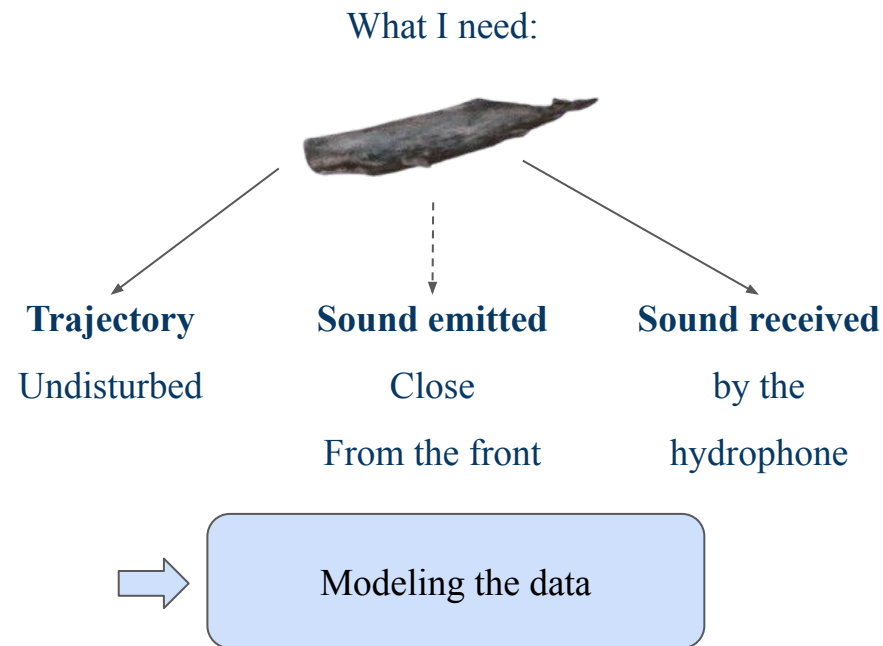
- 2 hydrophones : azimut
- 3 hydrophones : elevation
- 4 hydrophones : distance (?)

SeGaMas, complete the traditional method with AI

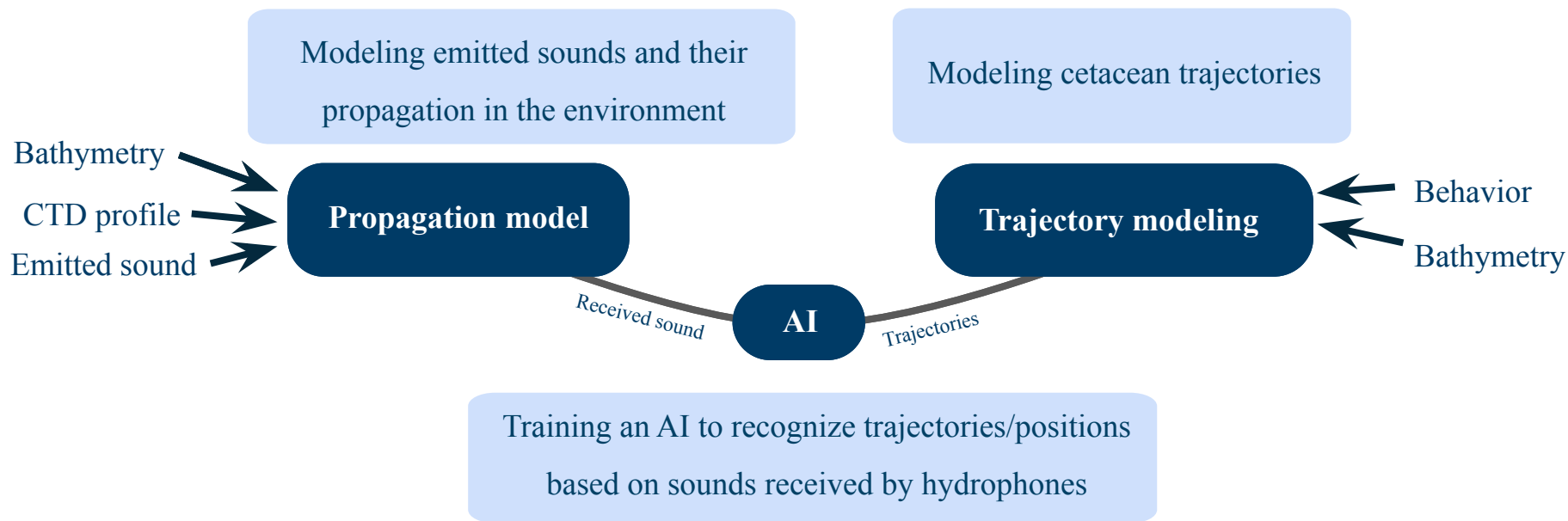


Distant temporal relationships

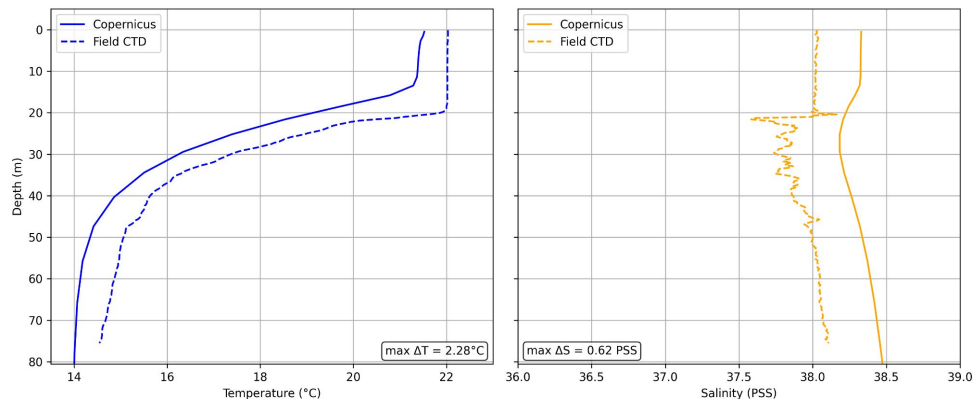
Taking into account the entire click sequence to determine the trajectory



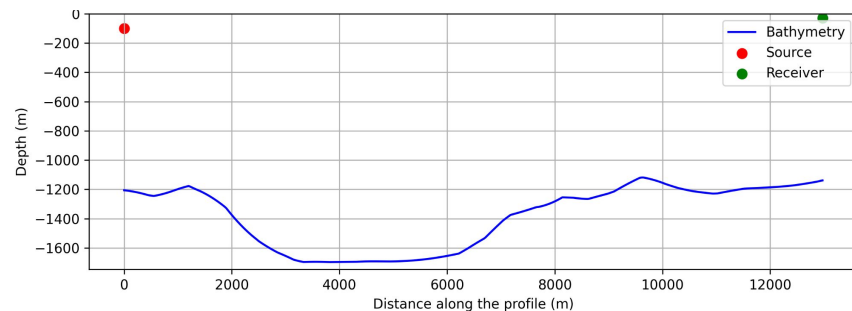
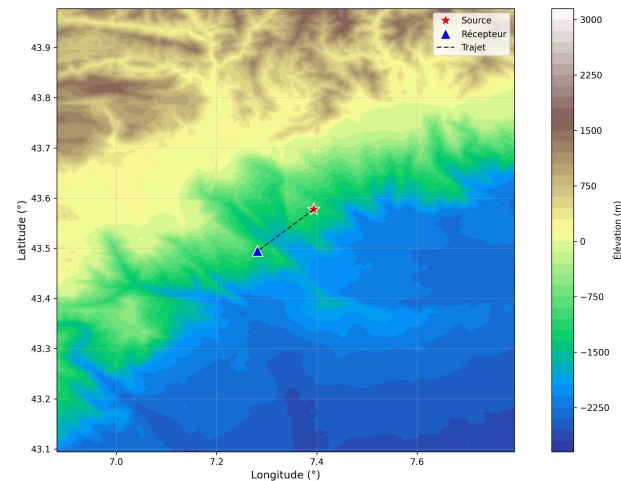
SeGaMas : Serious Game for Marine mammals Survey



BELLHOP, the propagation model



Comparison of temperature and salinity recorded
on September 29, 2025, at 8:24 a.m. at 42.96°N 6.57°E during mission *WW6*
and extracted from the *Copernicus* daily average at 43°N 7°E



GEBCO bathymetry extracted off the coast of Antibes,
for a cross-section between a source and a receiver
(a) Plan view (b) Vertical cross-section

▲ BELLHOP, validation of the model with *Téthys II*

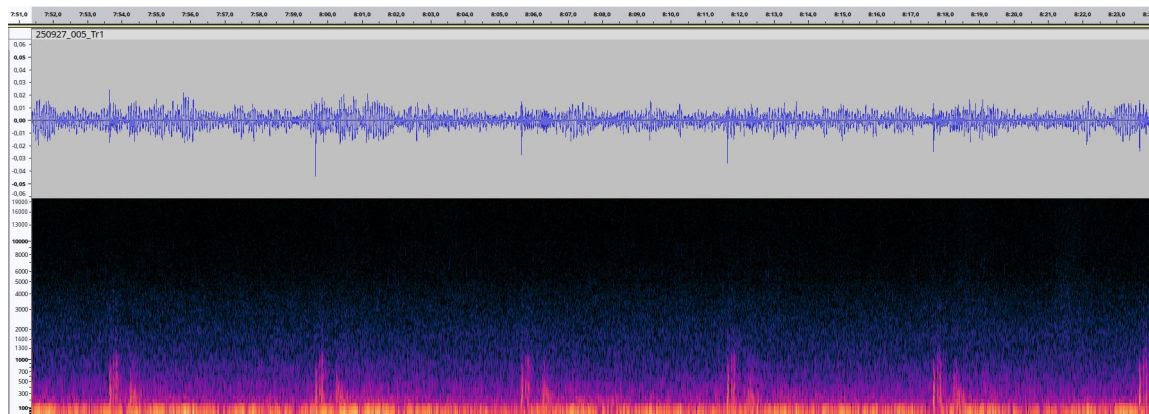
Seismic prospecting of *Téthys II*

Recording from *White Pearl* on *Whale Way 6*

Air gun pulse every 6 seconds



Téthys II (© Ifremer)

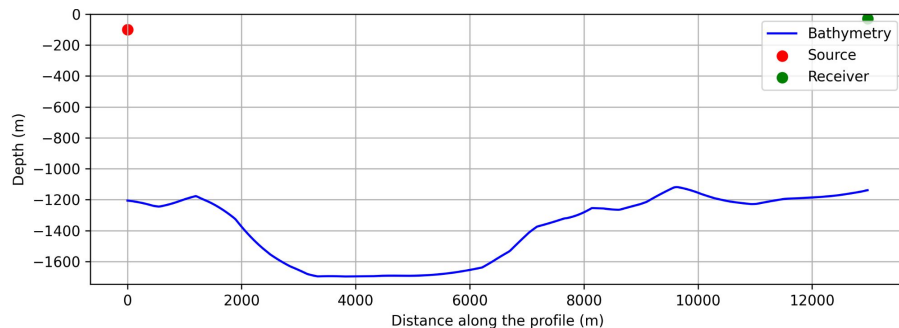


Acoustic recording of sound emissions from *Téthys II*

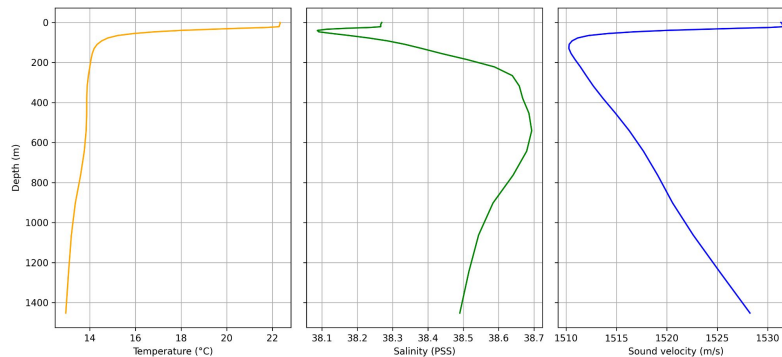
BELLHOP, validation of the model with *Téthys II*



Position of *Téthys II* and *White Pearl* on September 27, 2025, at 1:57 p.m.



Bathymetric profile between *Téthys II* and *White Pearl*

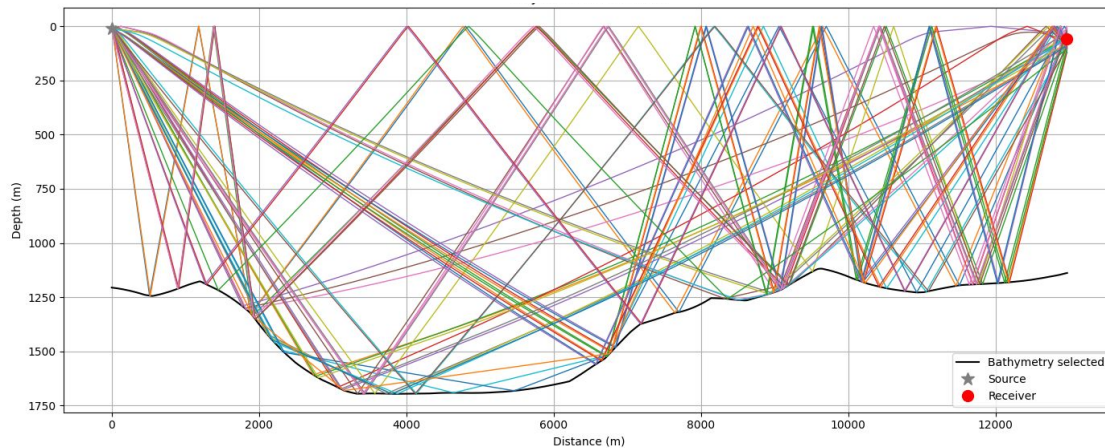


CTD profile between *TéthysII* and *White Pearl* : 43,53° N, 7,33° E

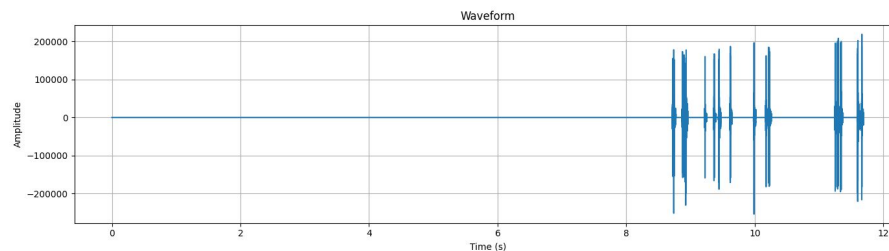
BELLHOP, validation of the model with *Téthys II*



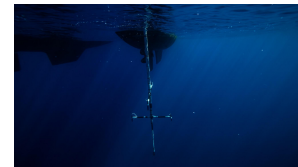
Téthys II (© Ifremer)



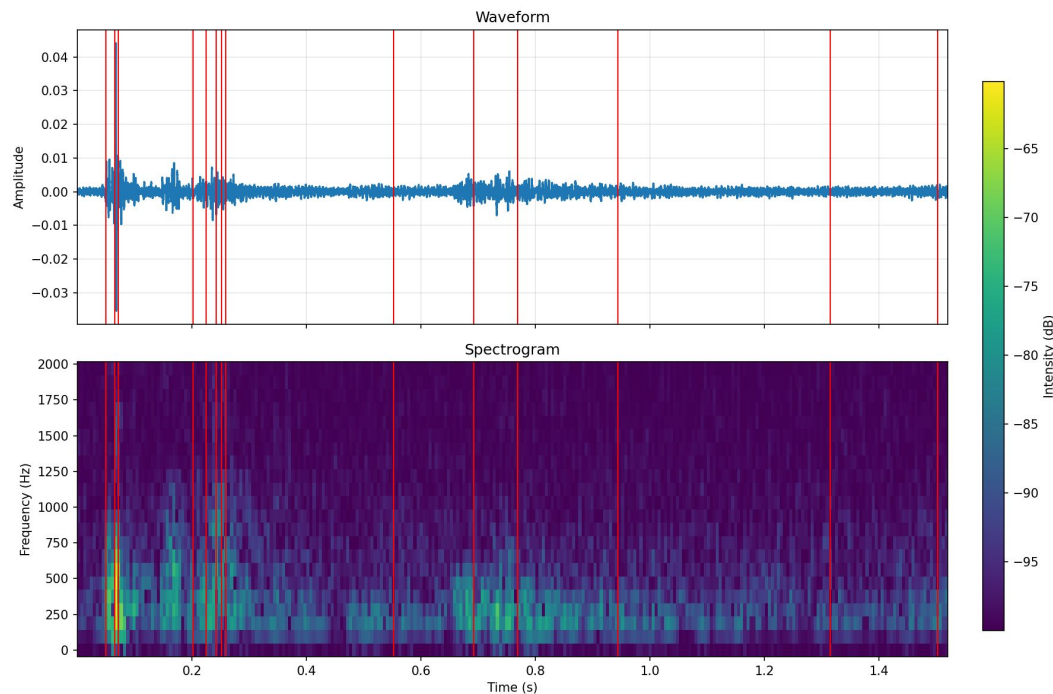
Ray tracing from *Téthys II* and received by *White Pearl*



Waveform of the signal reconstruction



▲ BELLHOP, validation of the model with *Téthys II*



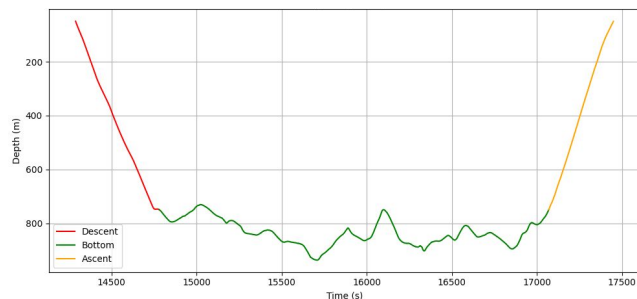
Overlay of the *in situ* acoustic recording from the acoustic survey of *Téthys II*
and the arrival times simulated by *Bellhop*

▲ Trajectoires, modeling the dive of sperm whales

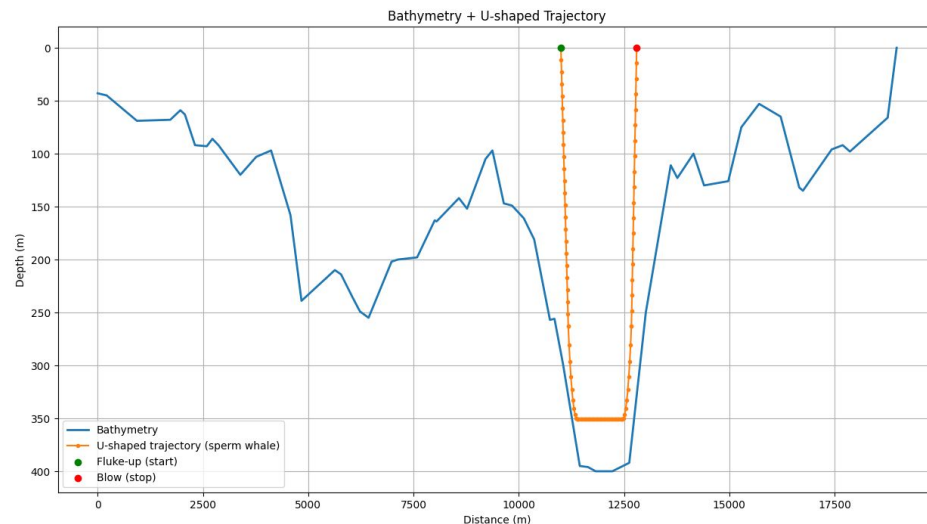
Weakly parametric 2D U-shaped trajectory

Statistics on the seven sperm whales of the Azores, tracked by DTAG by Claudia Oliveira

- 75 U-shaped dive profiles
- averages of descent and ascent rates



Dive profile #5 of the sperm whale “211bprh”



Example of the simulated trajectory of a sperm whale in a 2D cross-section of the Norwegian fjord Seglvik

Dataset, simulate click emissions along trajectories

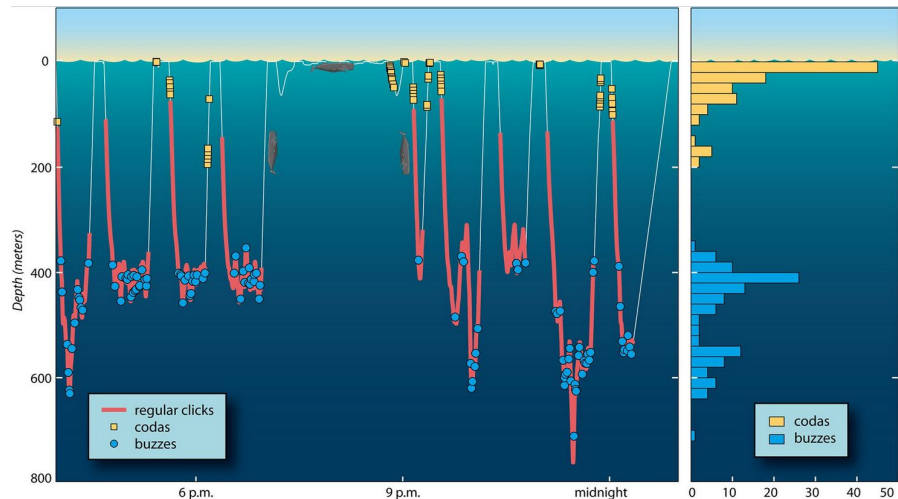
Creating a dataset:

Simulation of trajectories in the
Mediterranean

Emission of clicks and buzzes
along trajectories

Acoustic reconstruction

Training a self-attentive learning
model



Jack Cook, WHOI Graphic Services
data from Stephanie Watwood, WHOI

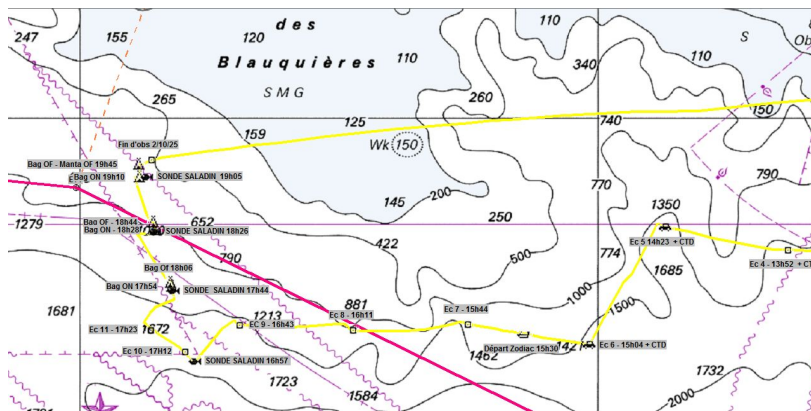
SeGaMas, concrete exemple with *Whale Way 6* data

“*Saladin*”

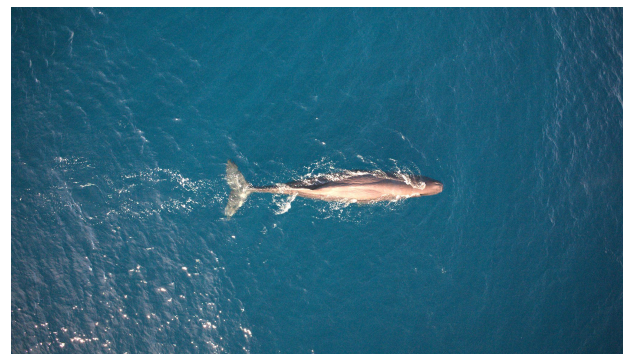
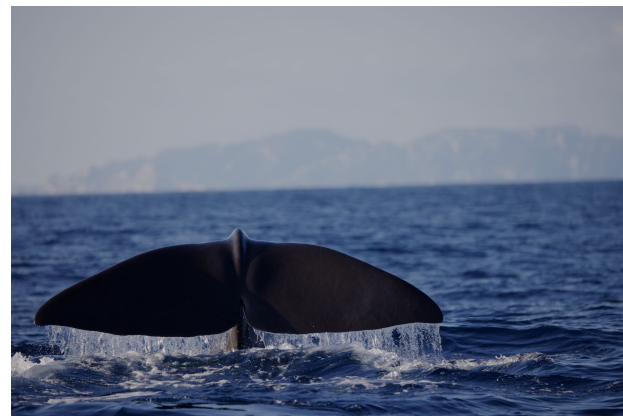
single individual

tracked over several diving cycles

photo-identification + IPI + size



Observation of “*Paladin*” during *Whale Way 6*
on October 2, 2025 (© Sarano F. et V.)



(Top) Photo-identification of “*Paladin*” (© Sarano F. et V.)
(Bottom) Aerial photos taken by drone (© Ody D.)

Thank you for your attention!

& thanks to our co-funders:

Chaire Int. Artificielle ADSIL AID DGA ANR-20-CHIA-0014,

Région Sud,

Fondation Prince Albert II,

ULPCochlea ANR-21-CE04-0020,

Europam Biodiversa 2021-488,

Longitude181,

UTLN, LIS, CIAN LIS.