



HAL
open science

Axis dependence of SNR and frequency of whistles of free-ranging *D. delphis* assessed by a portable hydrophone array

Loïc Lehnhoff, Hervé Glotin, Bastien Mérigot

► **To cite this version:**

Loïc Lehnhoff, Hervé Glotin, Bastien Mérigot. Axis dependence of SNR and frequency of whistles of free-ranging *D. delphis* assessed by a portable hydrophone array. DCLDE 2024, Jun 2024, Rotterdam, Netherlands. hal-04650132

HAL Id: hal-04650132

<https://hal.science/hal-04650132>

Submitted on 16 Jul 2024

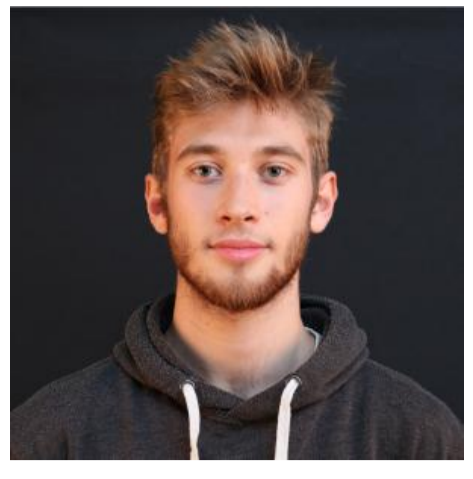
HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



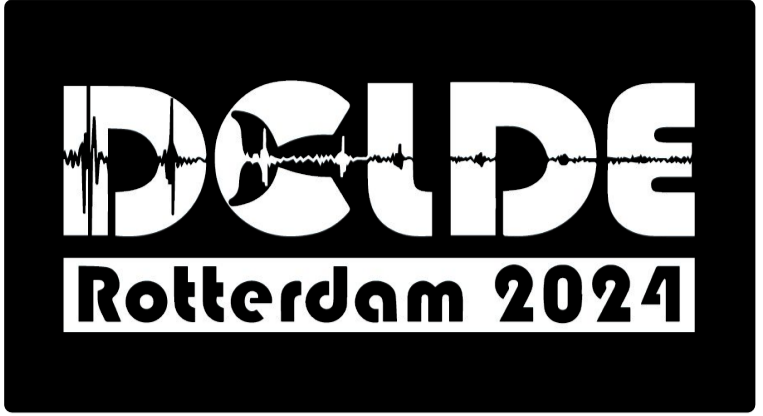
Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

Axis dependence of SNR and frequency of whistles of free-ranging *D. delphis* assessed by a portable hydrophone array



Loic Lehnhoff (a,b,c), Hervé Glotin (b,c), Bastien Mérigot (a,c)

(a) MARBEC, Université de Montpellier, CNRS, IRD, Ifremer, Sète, France
 (b) Université de Toulon, AMU Univ, CNRS, LIS, DYNI team, Marseille, France
 (c) CIAN, Centre int. d'Intelligence Artificielle en Acoustique Naturelle, Toulon, France
 loic.lehnhoff@gmail.com, glotin@univ-tln.fr, bastien.merigot@umontpellier.fr



INTRODUCTION

- Acoustic recordings of cetaceans often replaces visual observations
- No previous studies on whistles of *D. delphis* in the Bay of Biscay
- Medium frequency whistles of *D. delphis* are usually considered to be nearly omnidirectional [1,2]

Our objectives :

To determine the orientation of free-ranging *D. delphis* from passive acoustic monitoring. Then, to investigate the variations of whistles, based on these orientations, in order to study whistling patterns in dolphin-fisherboat interactions [3]

METHOD

Echolocation clicks are detected **automatically** in recordings [3], then cross-correlated [5] to determine their **Time Delay of Arrival (TDoA)** between each pair of hydrophones.

Knowing the position of the hydrophones, we estimate **azimuth and elevation** for each source of clicks (*distance is too difficult to determine with this small array*). These estimated angles were validated using aerial drone images (Fig. 1) and then, used to determine the **orientation of each dolphin** towards the antenna.

From the recordings, we annotated 411 whistles using our **custom-made annotation tool** [6], and extracted some features : duration, Signal-to-Noise Ratio (SNR) and min/max/mean frequencies. These whistles are also grouped into two categories according to the estimated orientation they have towards the antenna at the same time : **on-axis** versus **off-axis**.

Data collected in **Brittany** from experiments at sea with free-ranging *D. delphis*

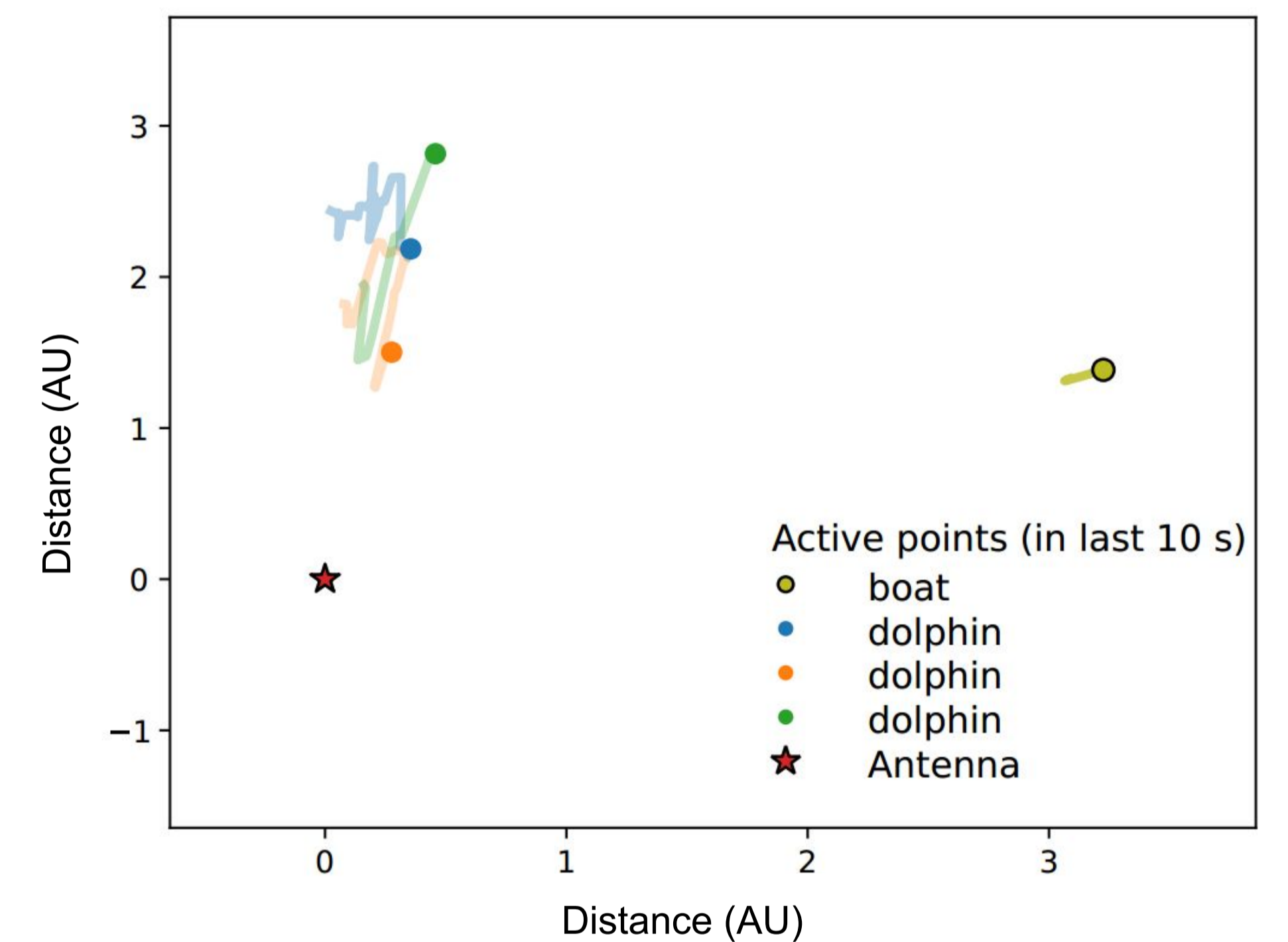
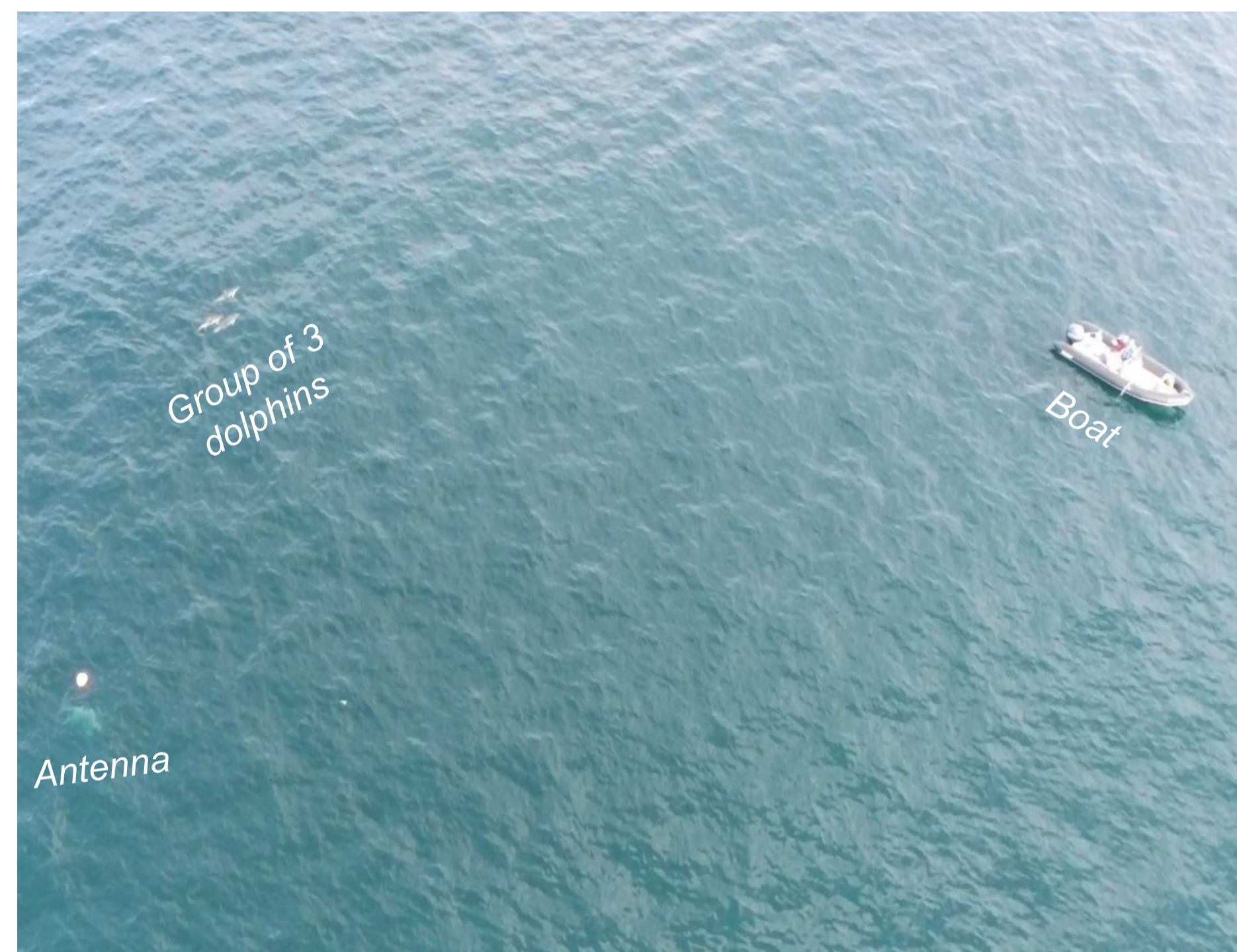


Fig.1: (Left) Example of dolphins localisation by drone, (Right) positions computed from TDoAs.

RESULTS

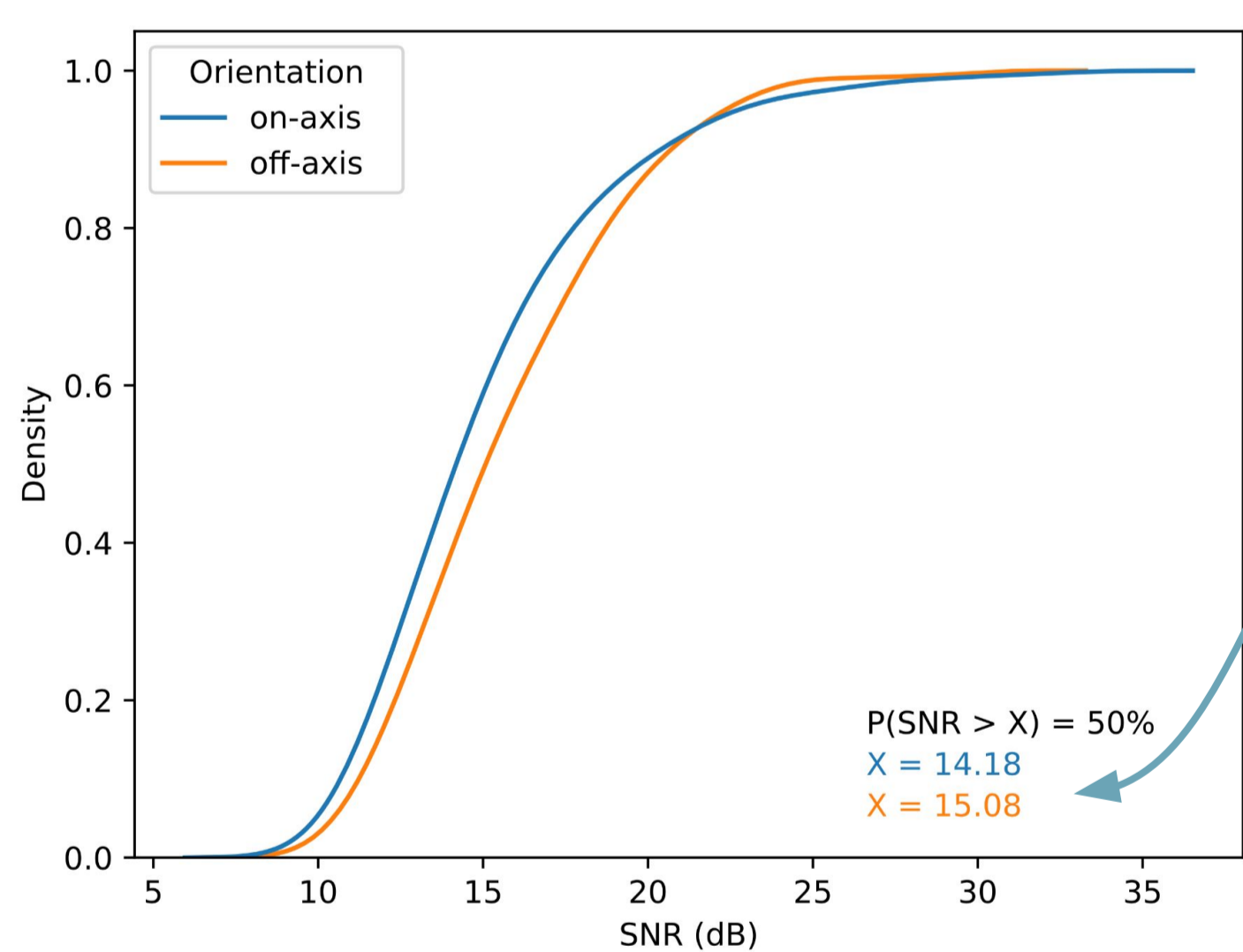


Fig.2: CDFs of whistles SNRs

Lower SNR for on-axis whistles (KW test, $p < 0.05$)

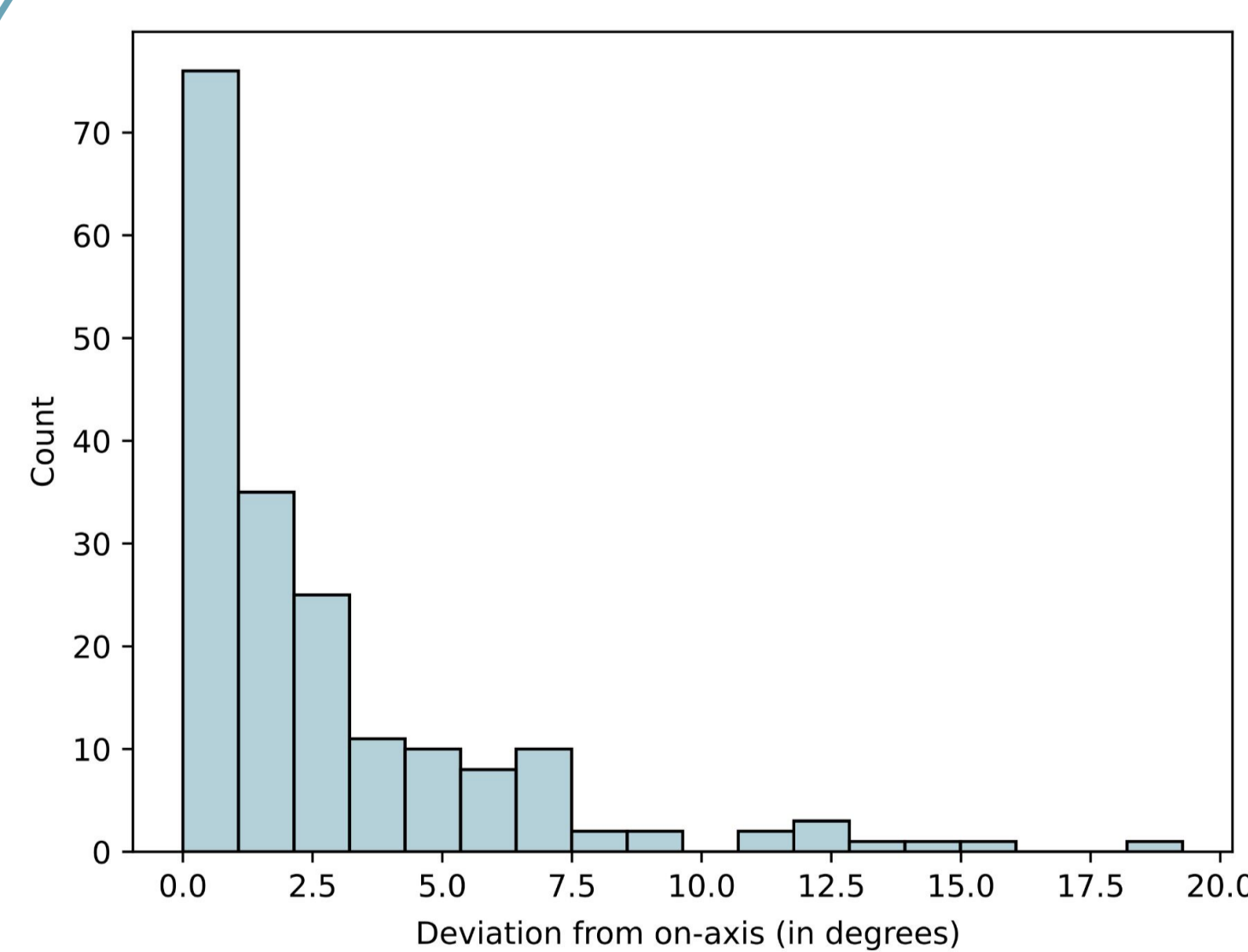


Fig.4: Distribution of orientations associated with on-axis whistles

Higher mean frequency for on-axis whistles (KW test, $p < 0.01$)

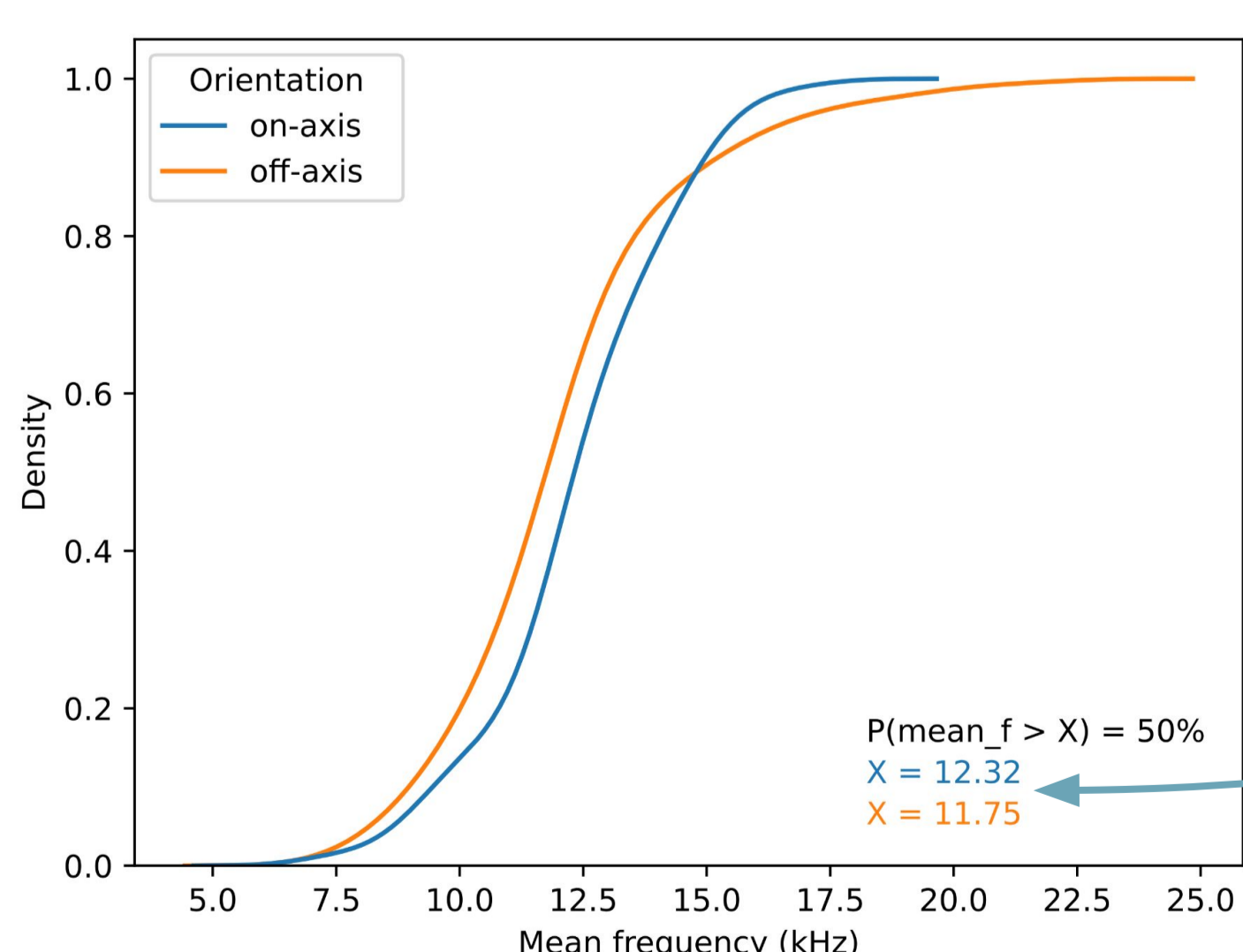


Fig.3: CDFs of whistles mean frequencies

DISCUSSION

We were able to record echolocation clicks joint to whistles of free-ranging short-beaked common dolphins with a small array of 4 hydrophones [4].

Thus, we determined the position of echolocation click sources (also known as *dolphins*) in 2D (azimuth and elevation). Then, we extracted features from whistles emitted at the same time.

Our results show that whistles emitted from on-axis groups of dolphins are more likely to be recorded at lower SNRs and higher frequencies than others. This shows that the diffusion of whistles of short-beaked common dolphin is not omnidirectional, though differences are slight. Such empirical results on free-ranging *D. delphis* were not observed yet. This information is useful to assess dolphin vocal variations and behaviors in presence of fisherboats, in order to better understand the causes of dolphin by-catch [3].

Further work is needed to assess with more accuracy the diffusion of those whistles depending on the orientation of the dolphins by determining their positions using whistles directly.

Ack.: H.G. thanks ANR for grants ULPCochlea ANR-21-CE04-0020 & DGA IAD for AI Chair ADSIL ANR-20-CHIA-0014. B.M. thanks EMFF and FFP for their fundings. L.L. thanks the University of Montpellier for its PhD's grant.



[1] Lammers, M. O. and Au, W. W. L. "Directionality in the whistles of hawaiian spinner dolphins (*Stenella I.*): a signal feature to cue direction of movement?" *Marine Mammal Science*. 2003; 19, 249-264. <https://doi.org/10.1111/j.1748-7692.2003.tb01107.x>
 [2] Branstetter, B. K., Moore, P. W., Finneran, J. J., Tormey, M. N. & Aihara, H. Directional properties of bottlenose dolphin (*Tursiops t.*) clicks, burst-pulse, and whistle sounds. *J. of the Acoustical Society of America*. 2012; 131, 1613-1621.
 [3] Lehnhoff L et al. Behavioural Responses of Common Dolphins *Delphinus d.* to a Bio-Inspired Acoustic Device for Limiting Fishery By-Catch. *Sustainability*. 2022, 14(20):13186. doi.org/10.3390/su142013186
 [4] Glotin H. et al. A versatile super resolution portable array for ethoacoustics: QHB Opale, Tetra or Penta arrays, in DCLDE 2024.
 [5] Ferrari M. GSPR TDOA Hyper resolution. 2022. gitlab.lis-lab.fr/maxence.ferrari/gspr-tdoa (Accessed on 05/2024).
 [6] Lehnhoff, L. PyAVA [computer software]. 2024. <https://gitlab.lis-lab.fr/loic.lehnhoff/PyAVA> (Accessed on 05/2024).