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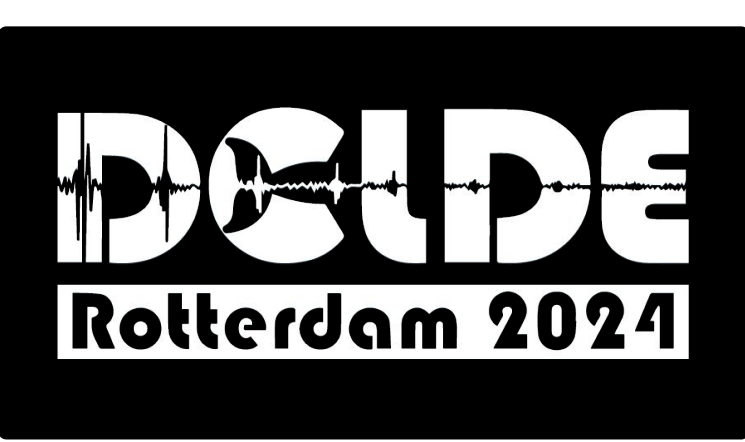


# Axis dependence of SNR and frequency of whistles of free-ranging *D. delphis* assessed by a portable hydrophone array



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## 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*

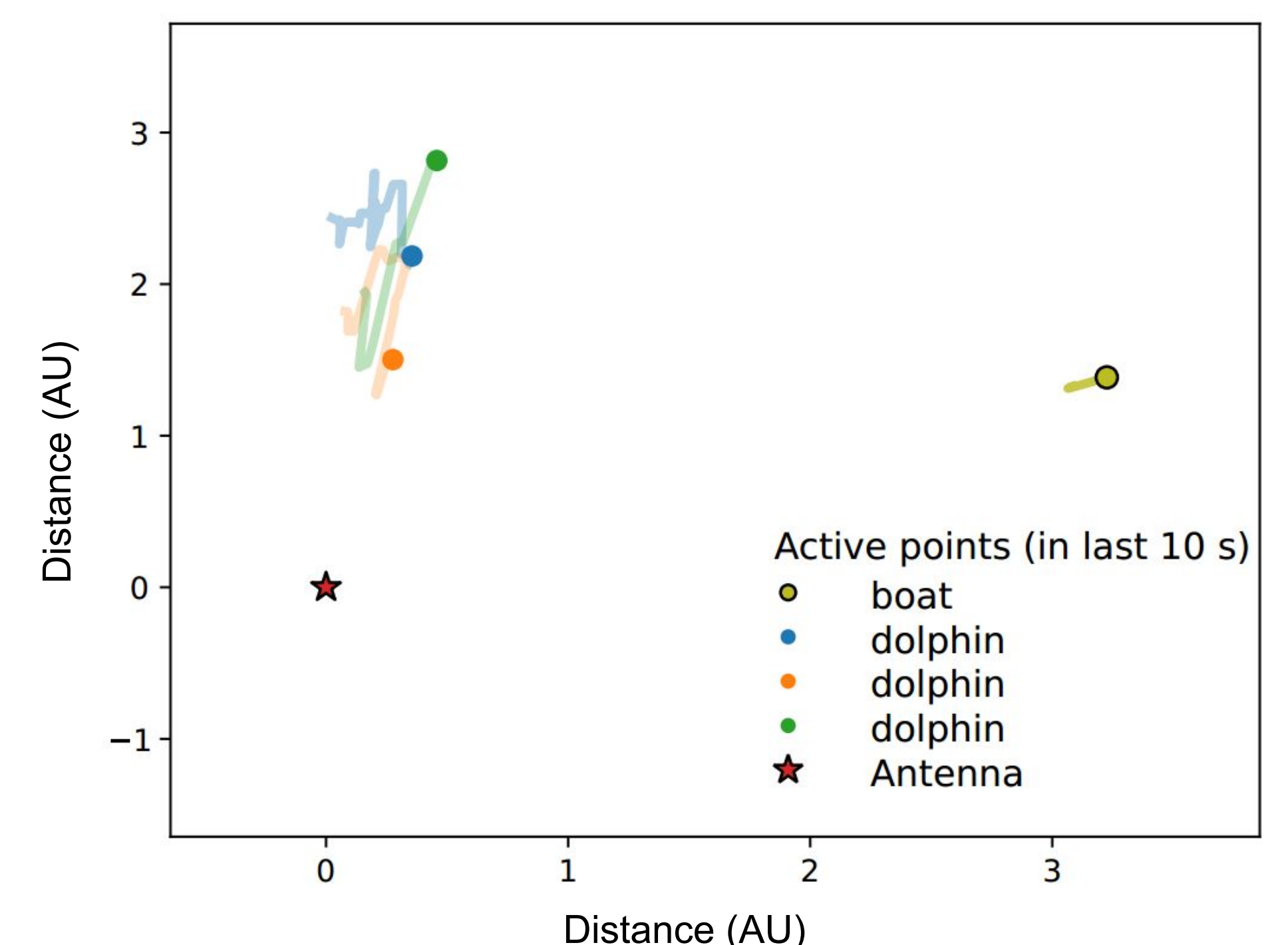
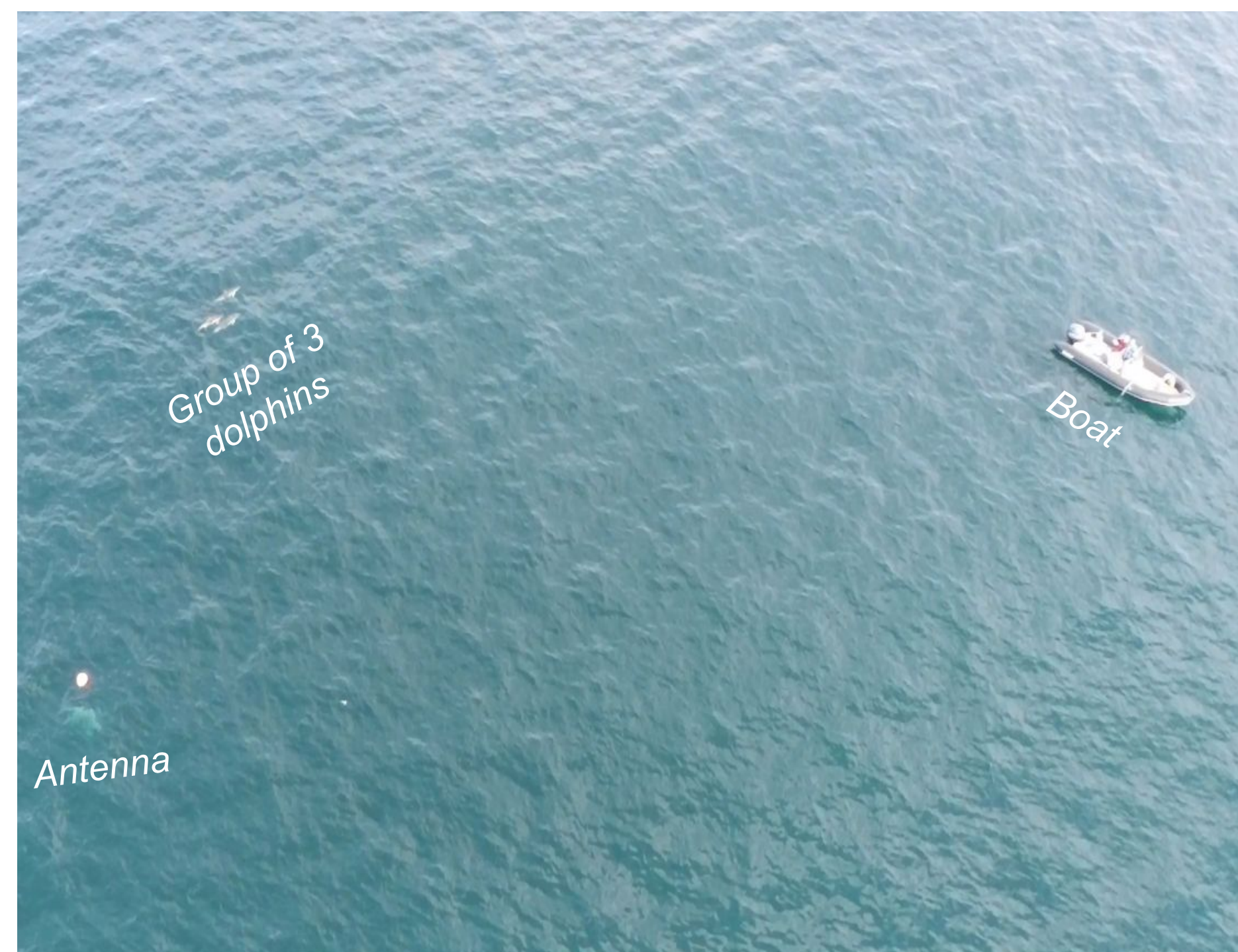


Fig.1 : (Left) Example of dolphins localisation by drone, (Right) positions computed from TDoAs.

## RESULTS

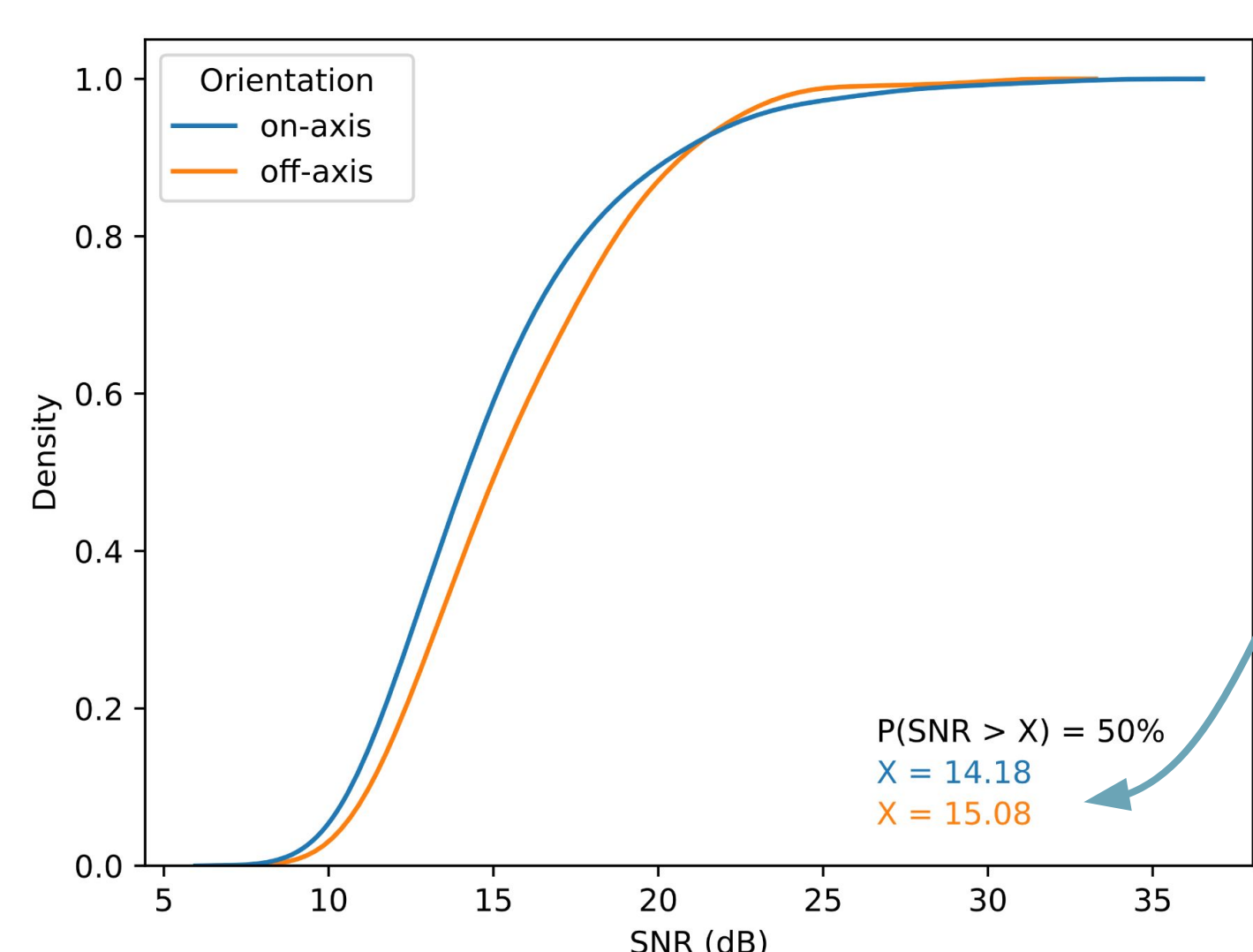


Fig.2 : CDFs of whistles SNRs

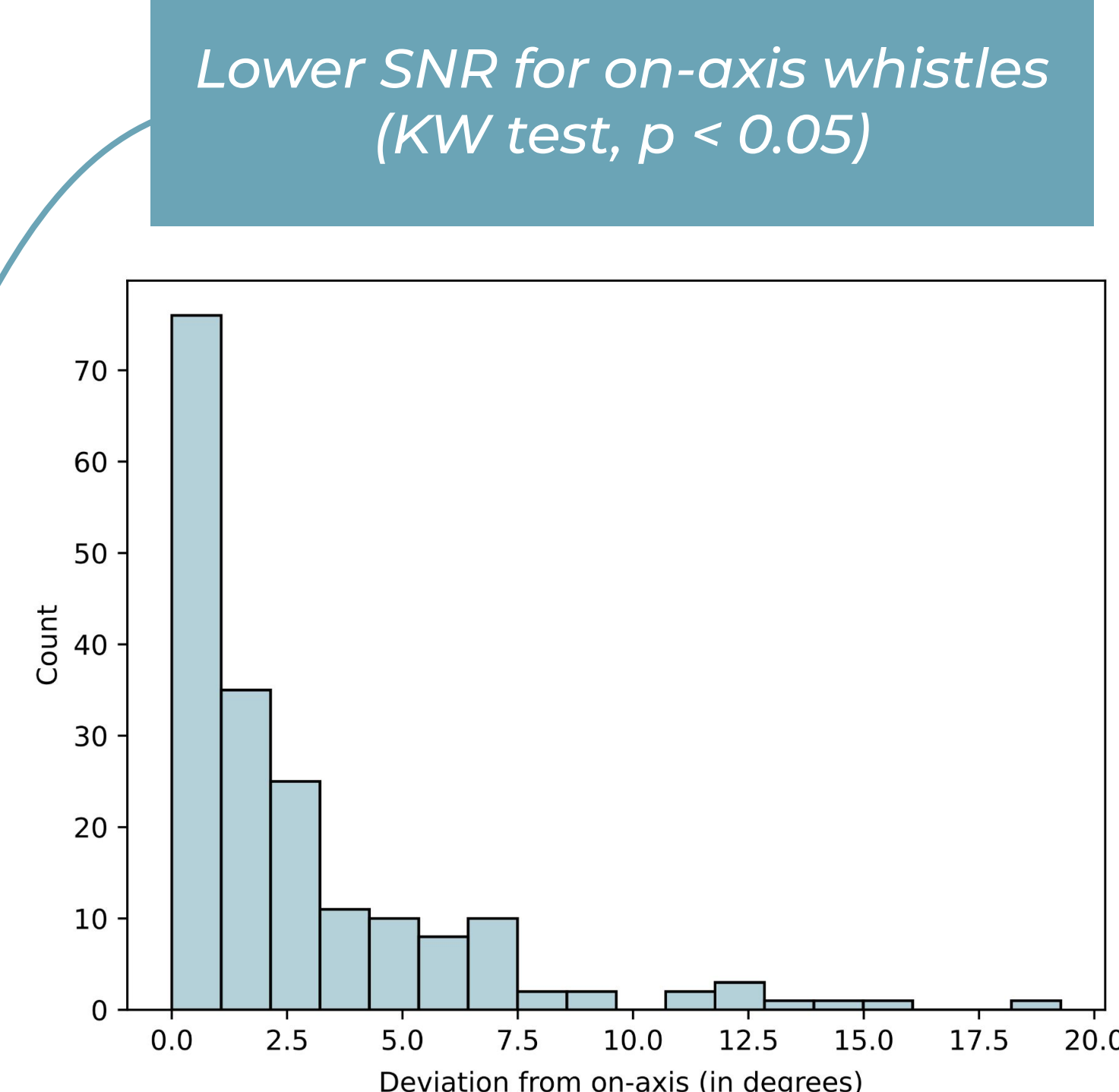


Fig.4 : Distribution of orientations associated with on-axis whistles

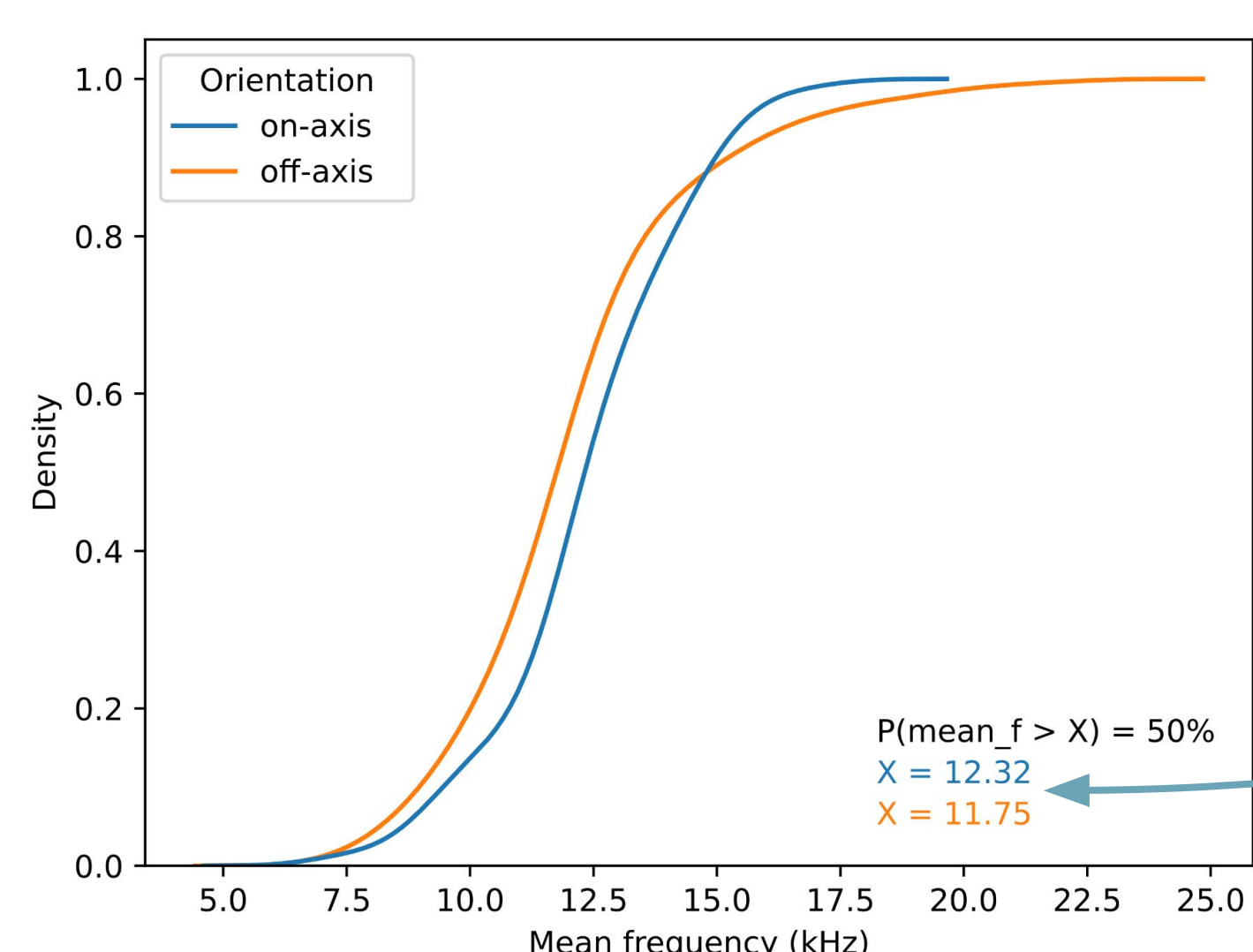


Fig.3 : CDFs of whistles mean frequencies

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

## 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.

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