

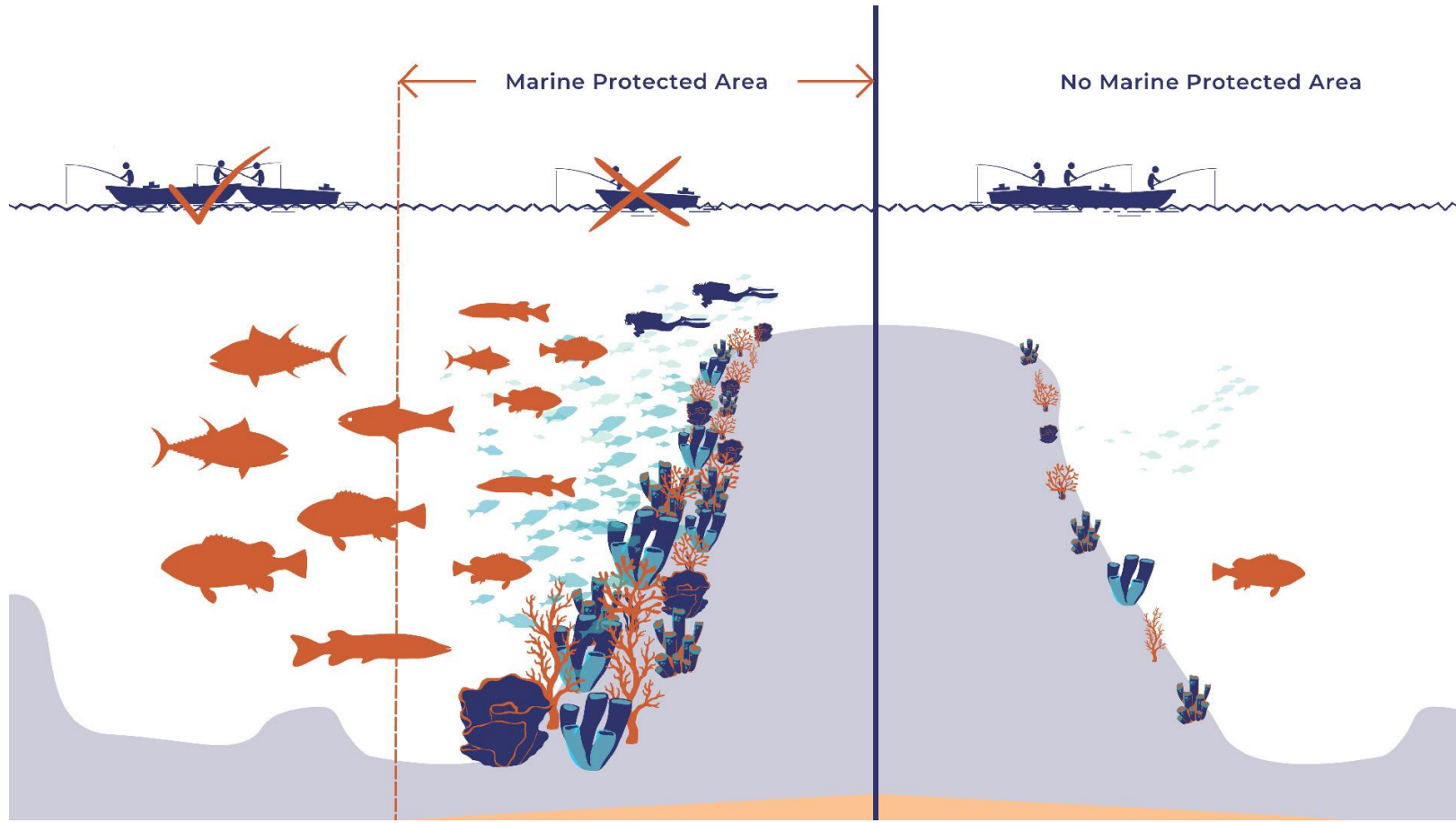


## AI in marine sciences:

Detection and classification of marine vessels with underwater acoustic data

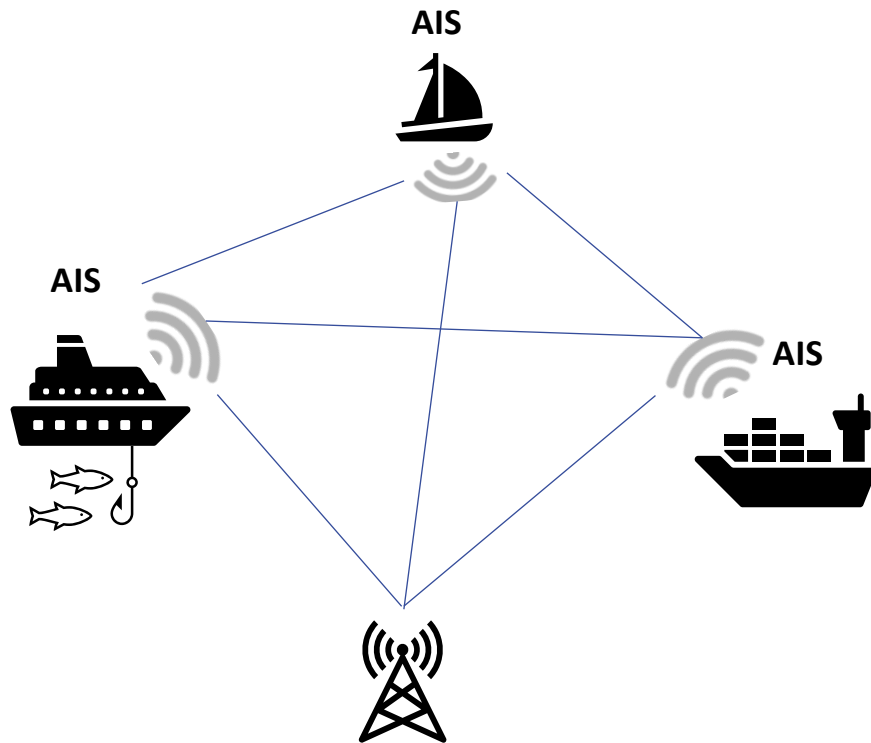
Decrop Wout, Parcerisas Clea, Schall Elena, Debusschere Elisabeth & Deneudt Klaas

# Marine Protected Areas (MPA's)



# Automatic Identification System (AIS)

## Monitoring shipping activity

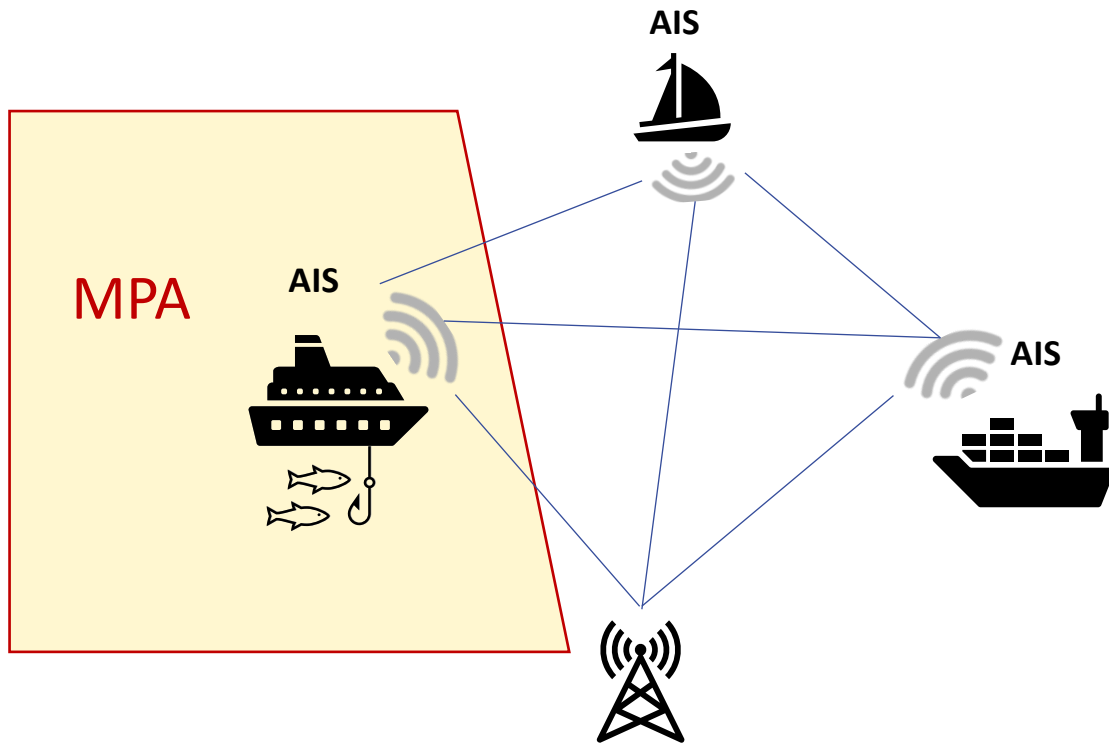


Automatic Identification System (AIS)

Long	Lat	Time	Ship_type	Activity
2.1912	51.3837	04/02/22	Cargo	underway
2.4912	51.6529	04/02/22	Recreation	Anchored
2.2107	51.6264	04/02/22	Cargo	Moored

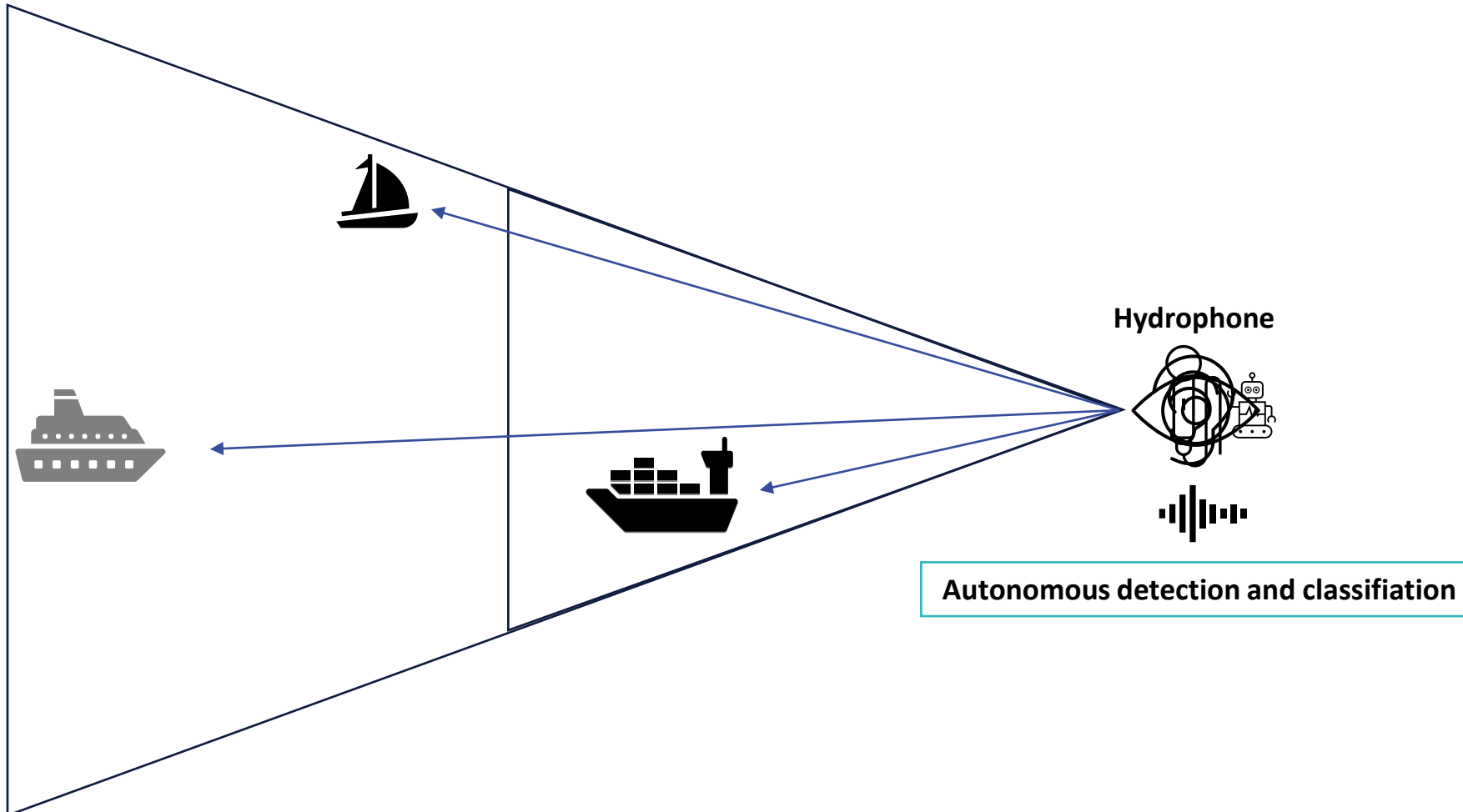
## Automatic Identification System (AIS)

### Monitoring shipping activity - MPA's and other regions



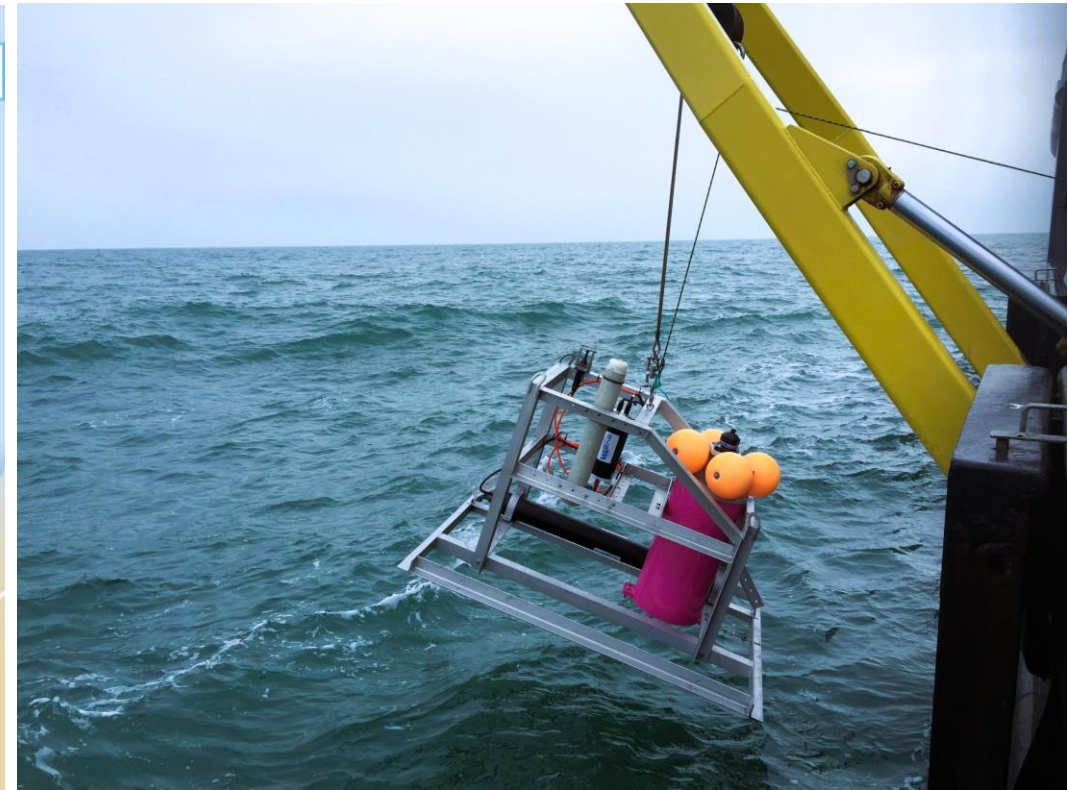
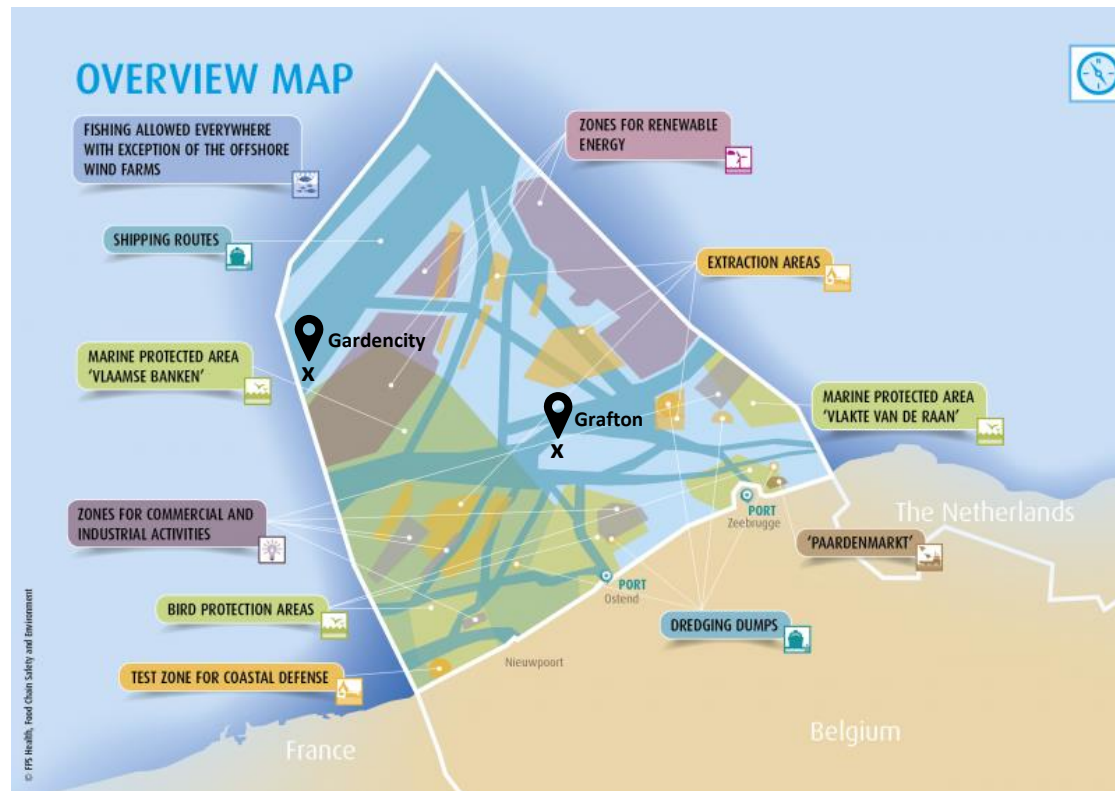
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## Monitoring shipping activity - MPA's and other regions



Where and when?

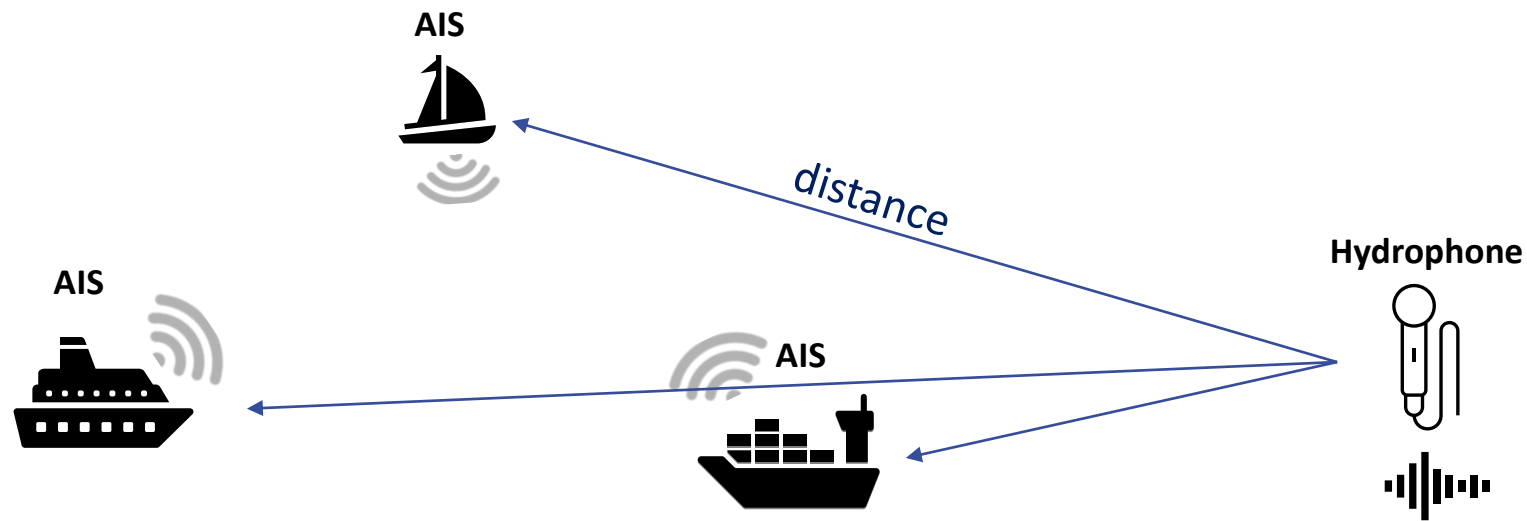
## Creating the database



Two stations with hydrophone recordings on mooring close to traffic lanes in 2022.

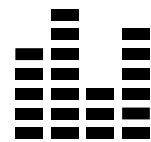
Calculating the distance through timestamps

## Creating the database



**AIS data:**  
Coordinates  
Timestamp  
vessel information

+



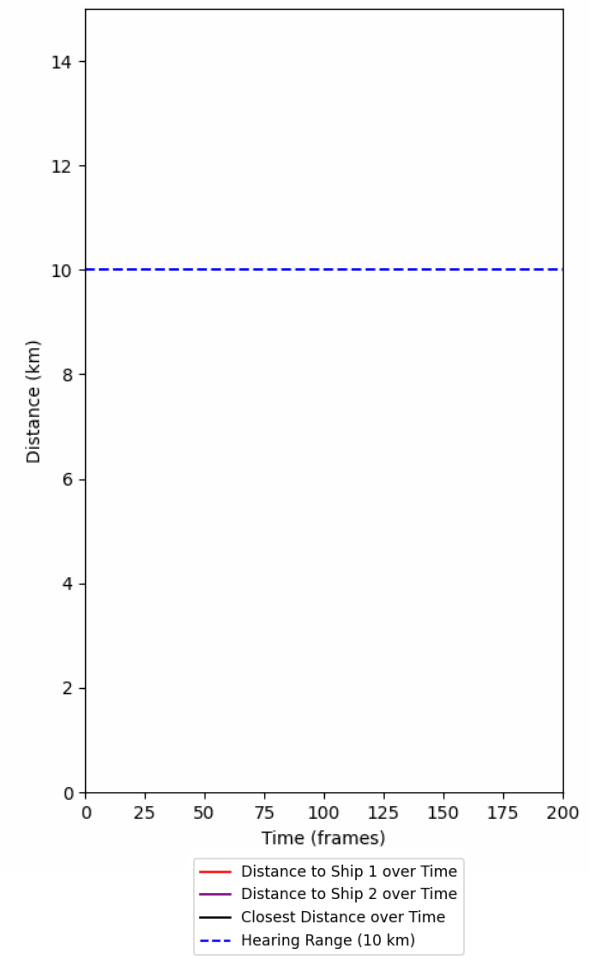
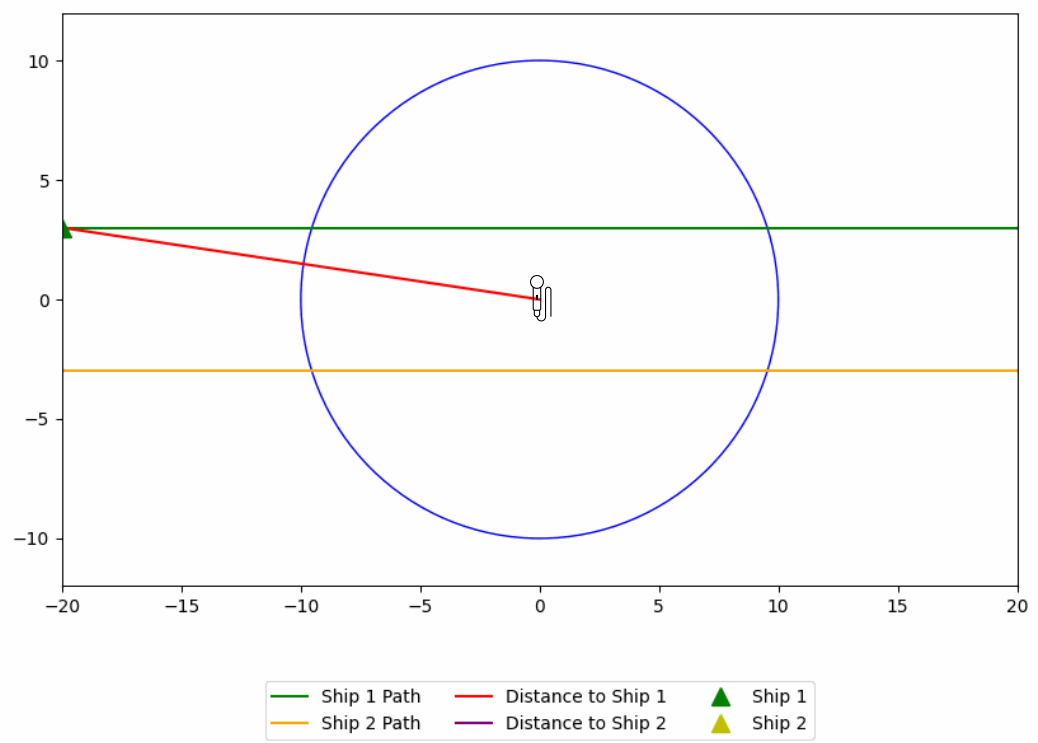
**Hydrophone recordings**  
Coordinates  
Timestamp  
recording



**Database**



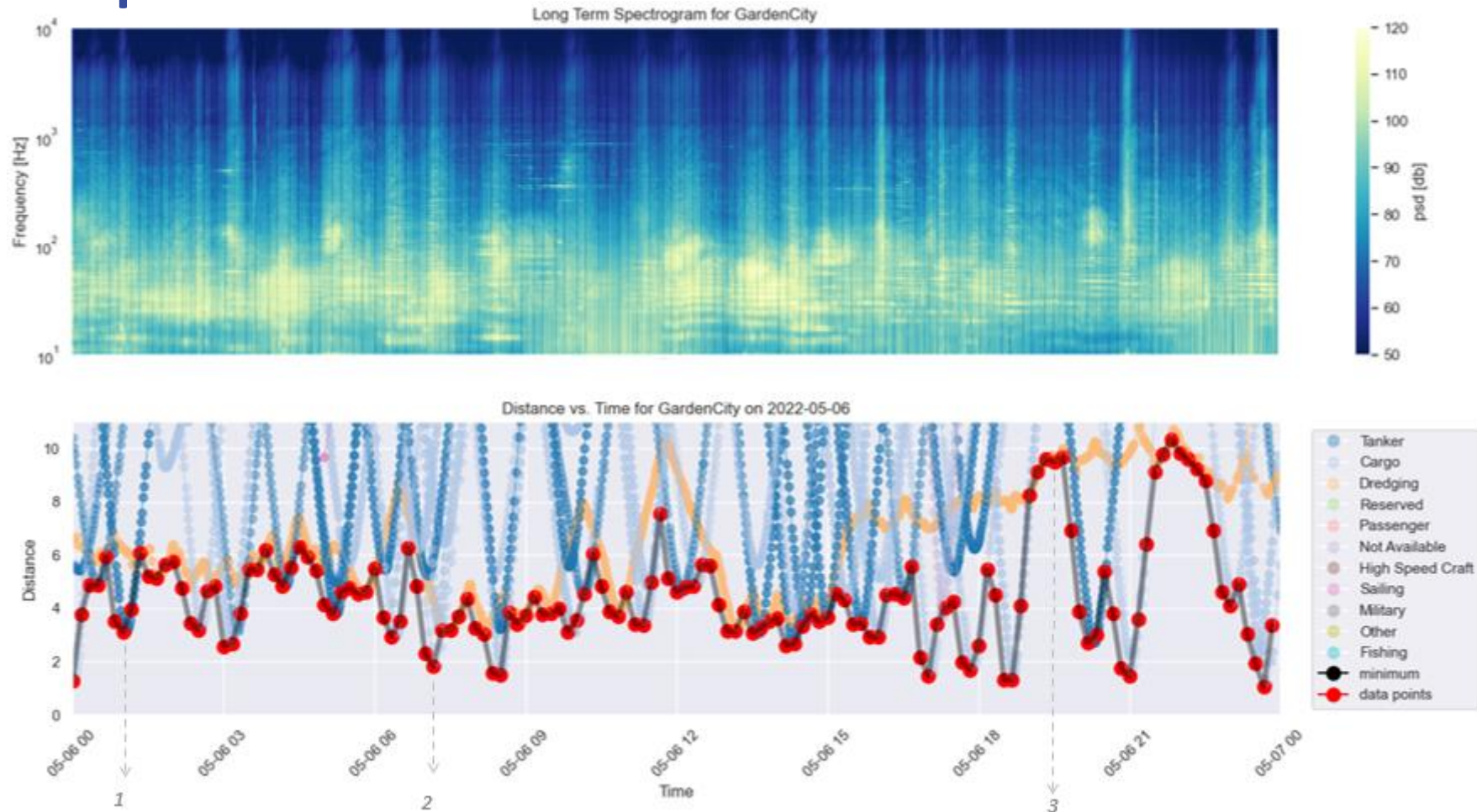
# Creating the database





The power spectral density is in function of the distance

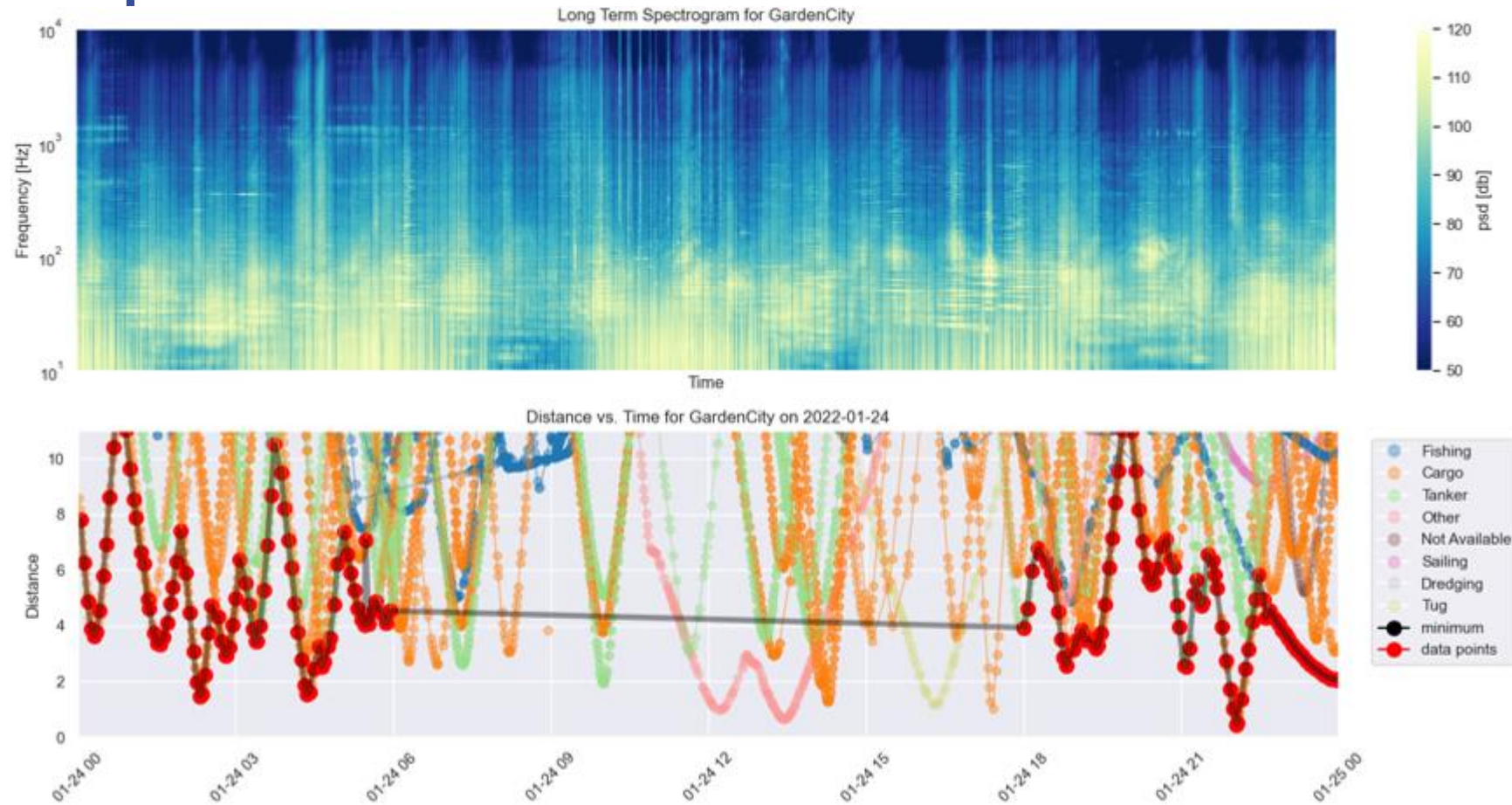
## Data exploration



Sample 10-second wav files every 4 min.

Filtering out some faulty data

## Data exploration



Filter out the data where AIS is messy

How features (spectrograms) are created

## Data exploration



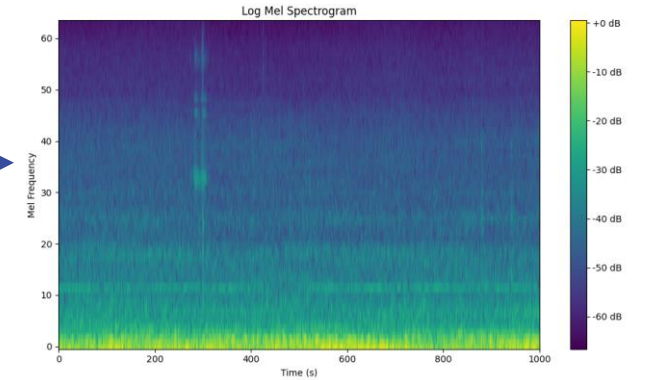
10 sec wav file



Feature extractor



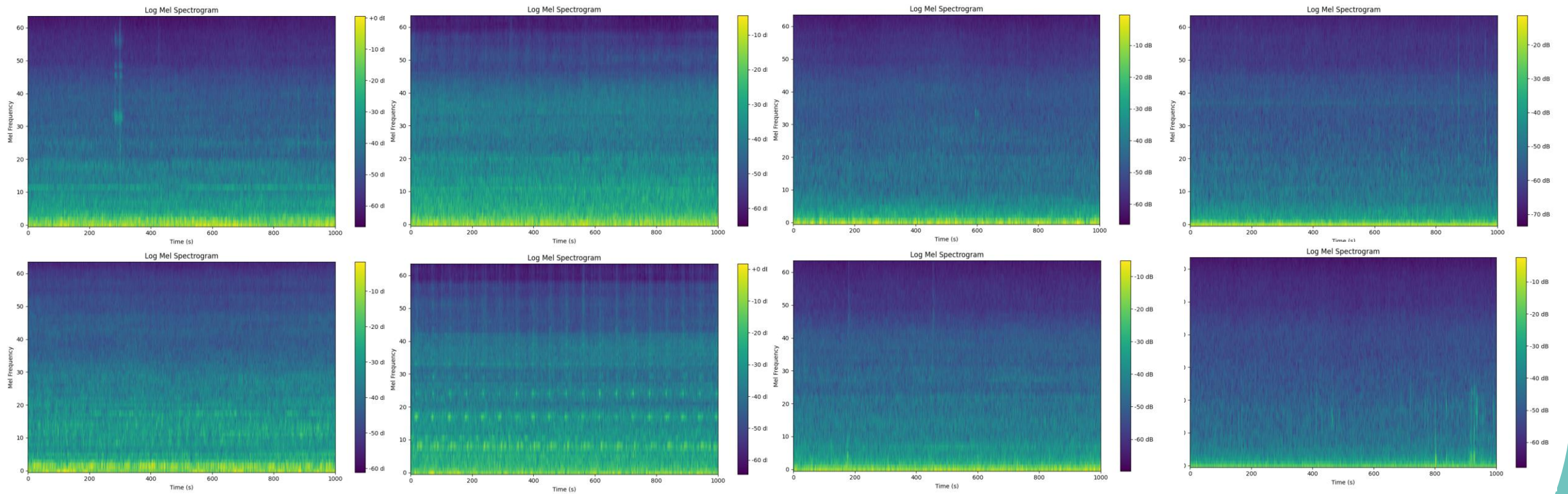
Variable	Value
Frequency range	0-14Khz
Sample rate	48 Khz
fft_window_size	1024
Hop length	480
Mel bins	64
window_function	Hann
Log mel	dB



Log mel spectrogram

# Comparing Spectrograms

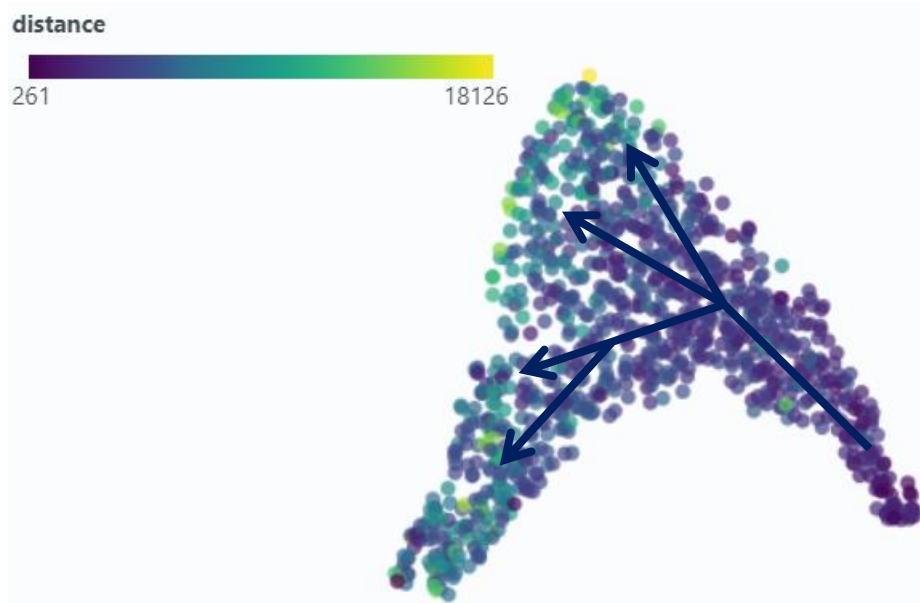
## Data exploration



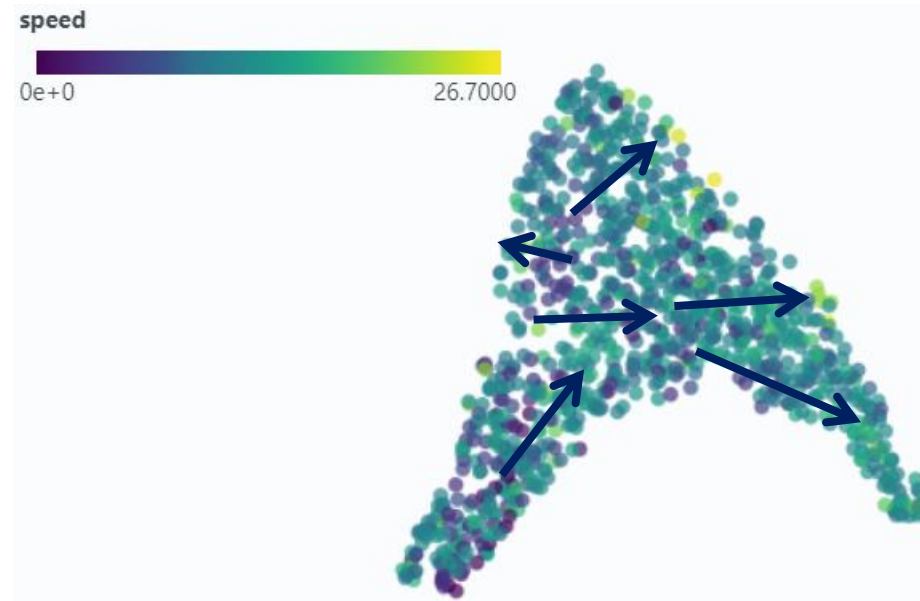
Boats close by vs far away

Conclusion: spectrograms give information about distance, possibly even activity

## Data exploration






Clear trend in distance

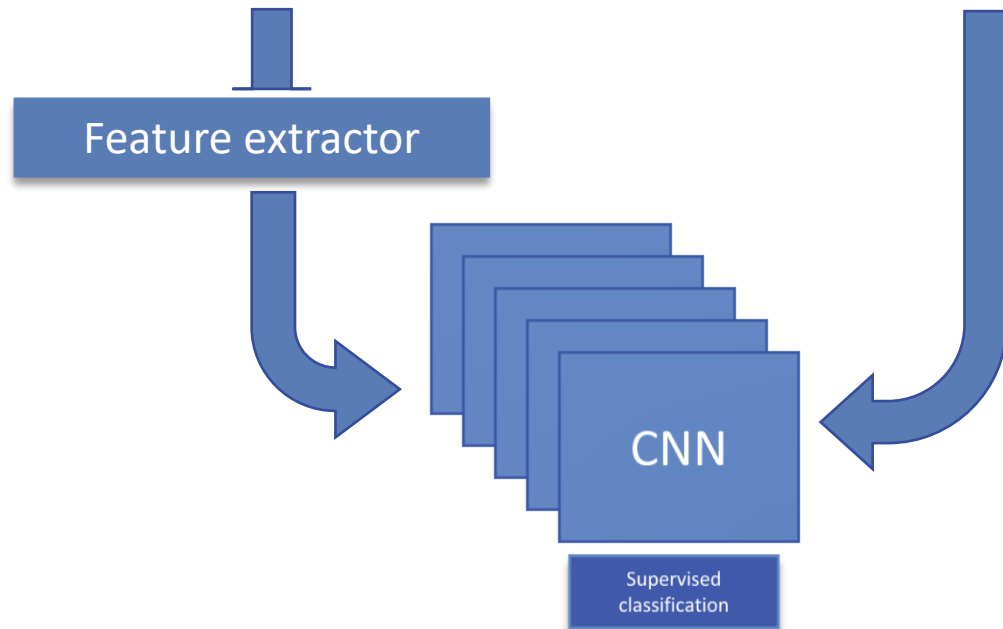


Less clear trend in speed

Conclusion: information about distance possible, the speed is more tricky.

## Building the model

audio	Ship distance to recorder (AIS)
	2-3 km
	1-2 km
	10+ km



Supervised audio classification

CLAP model pre-trained on bioacoustics by David Robinson

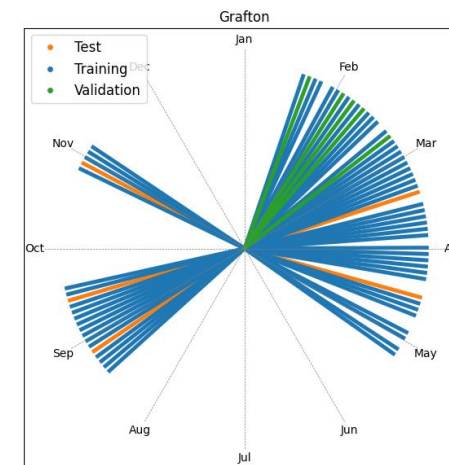
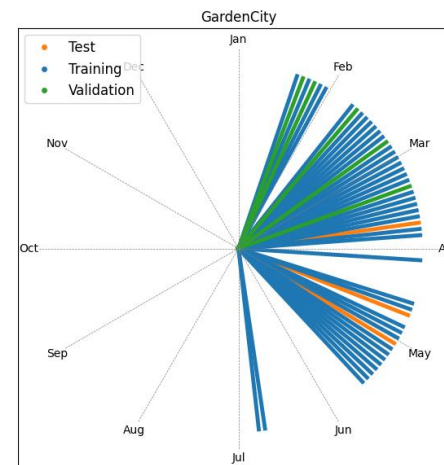
## Building the model

### Data architecture:

- Data filter
- Train/val/test: 81%/8%/11% (18915/1815/2558)
  - val/test: data sampled from full days from different deployments where the data seemed balanced (boats far away and close)
- Train: remaining days

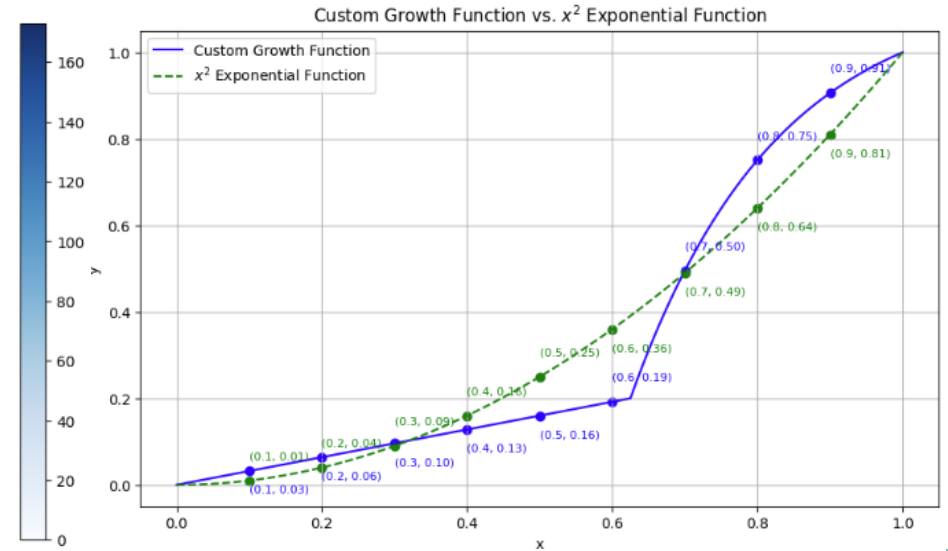
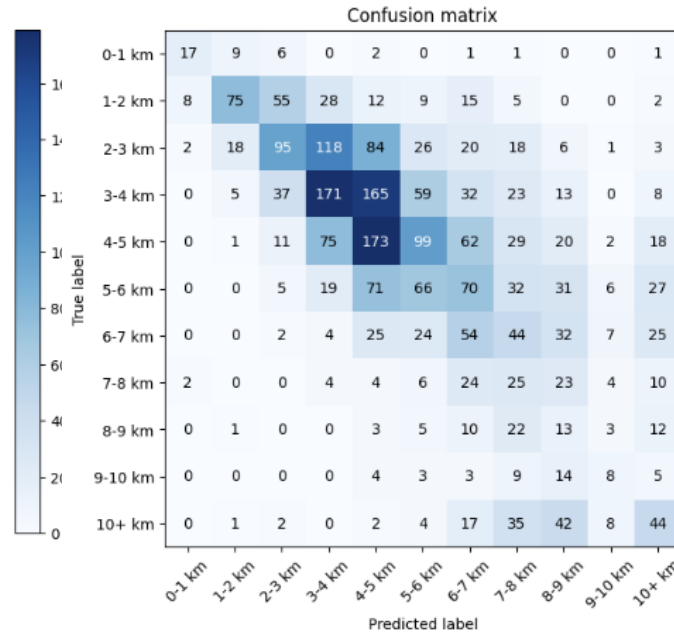
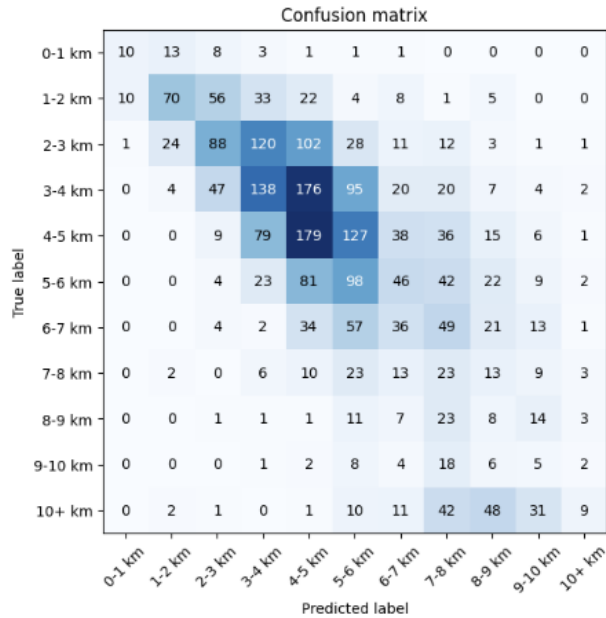
### Model architecture:

- Epochs: 10
- Early stop through validation set
- Adam optimizer



# Confusion matrix and RMSE

## Results

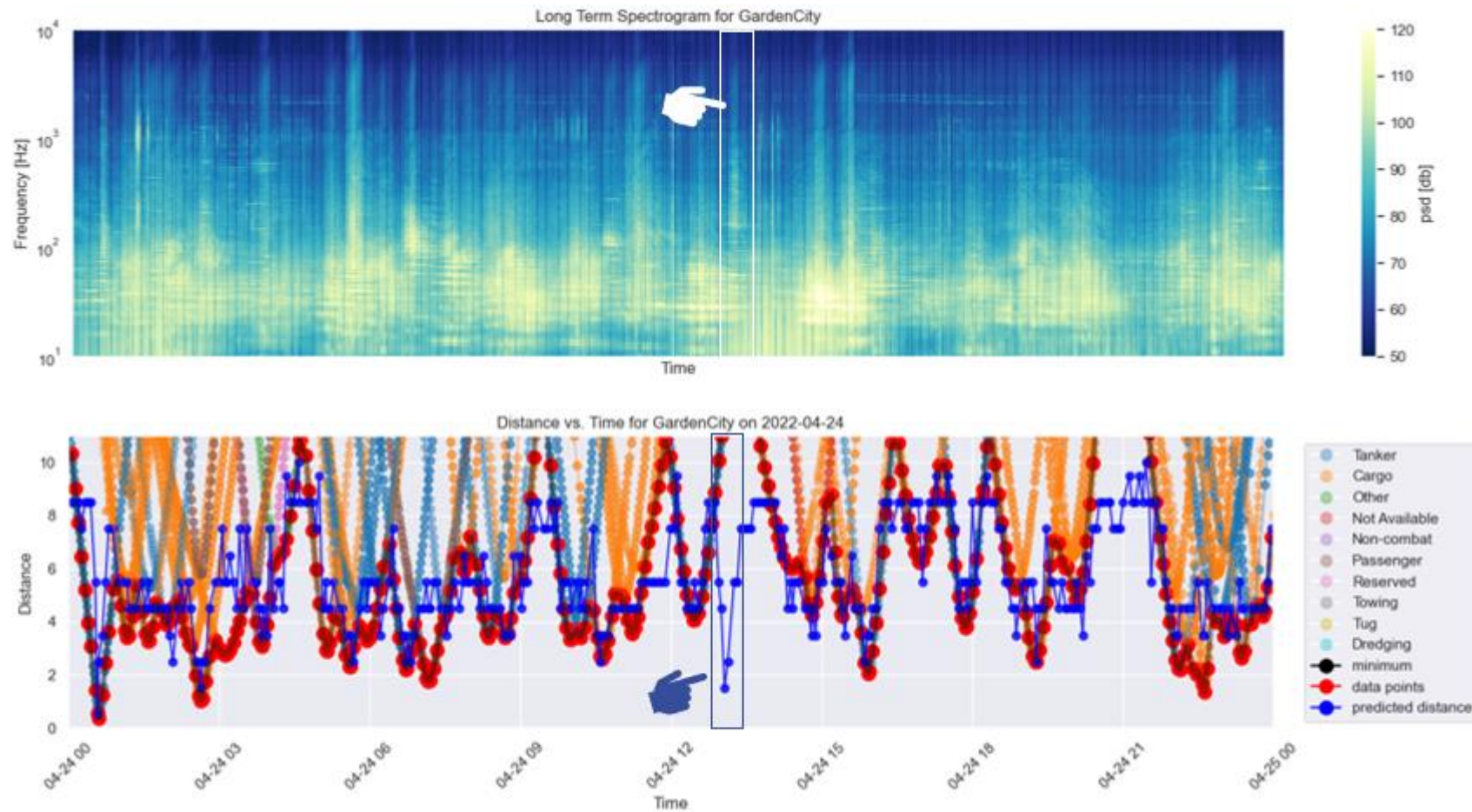


	Costum Loss function	X <sup>2</sup> loss function
MSE	3.34 km	4.07 km
RMSE	1.82 km	2.01 km



Predictions plotted on database

## Results

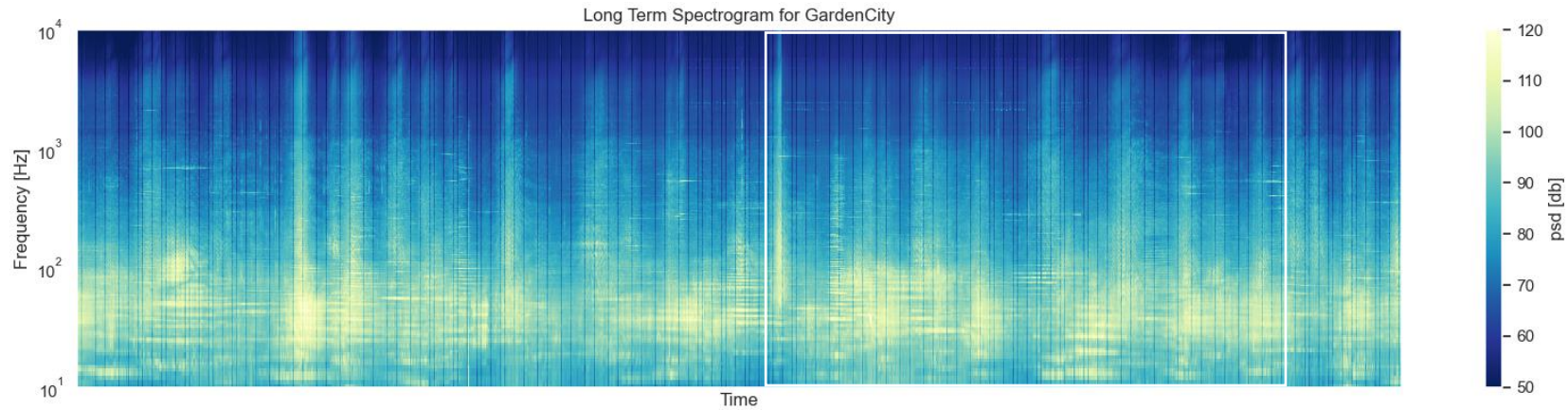


Model is able to identify false negatives from dataset.

Datapoints: from AIS  
Predicted: from model

# Predictions plotted on database

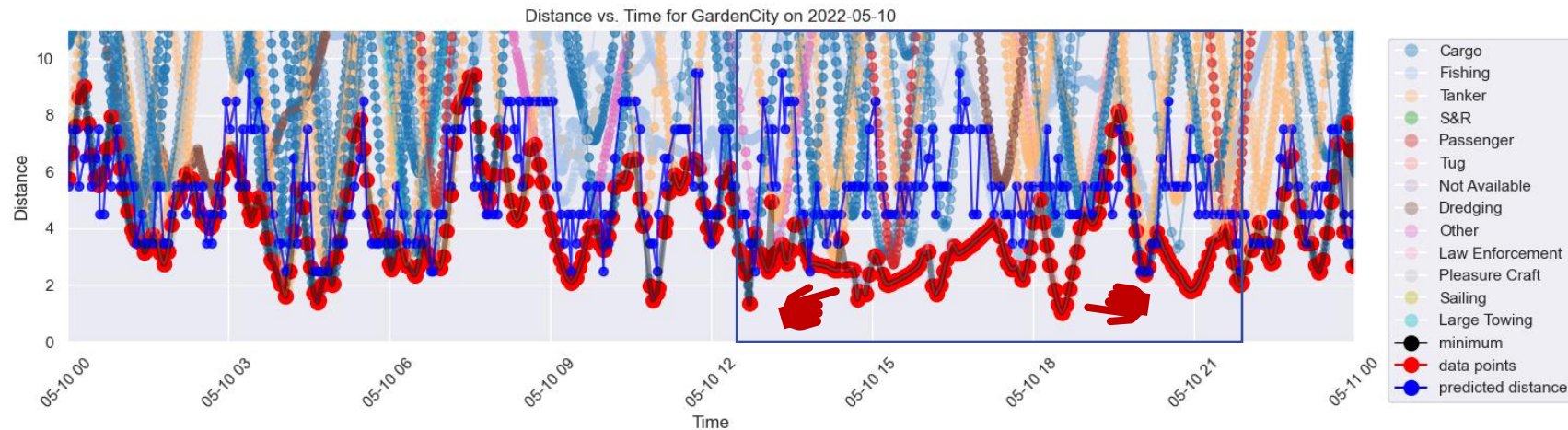
## Results



Model only detects vessels that are making noise.

If **silent** → next vessel

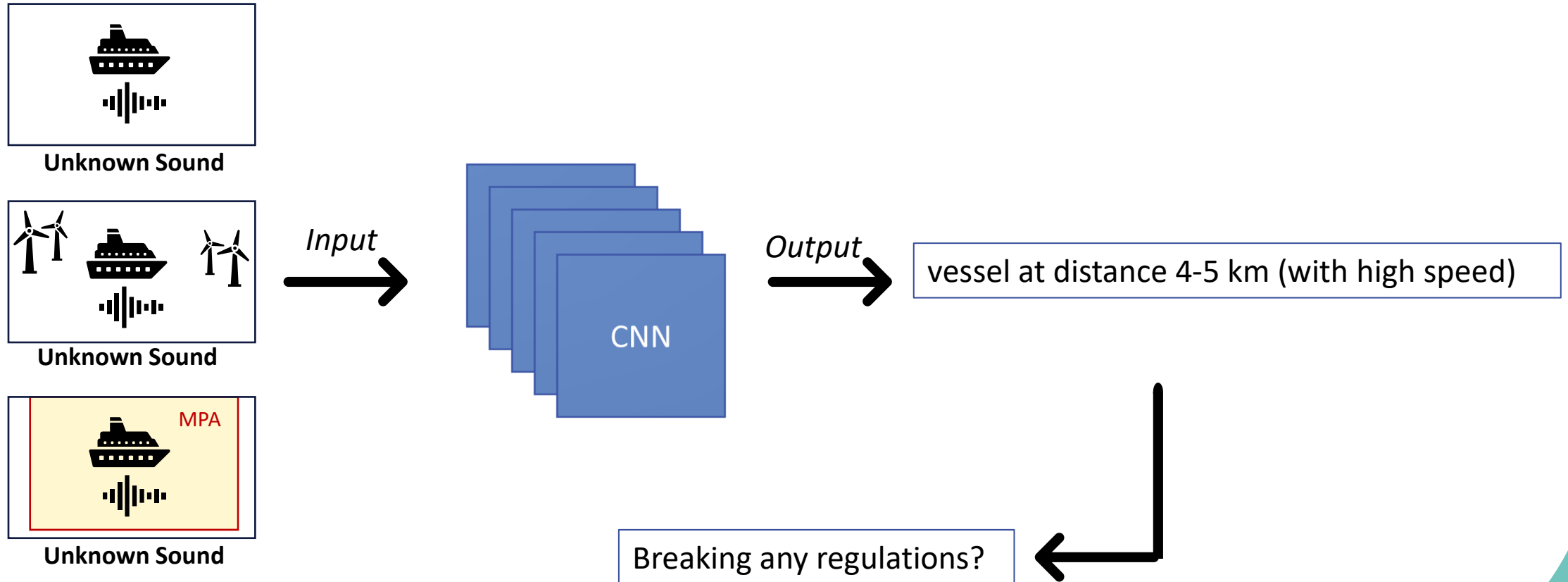
- Drifting
- Quiet engine



Datapoints: from AIS  
Predicted: from model

Future goal

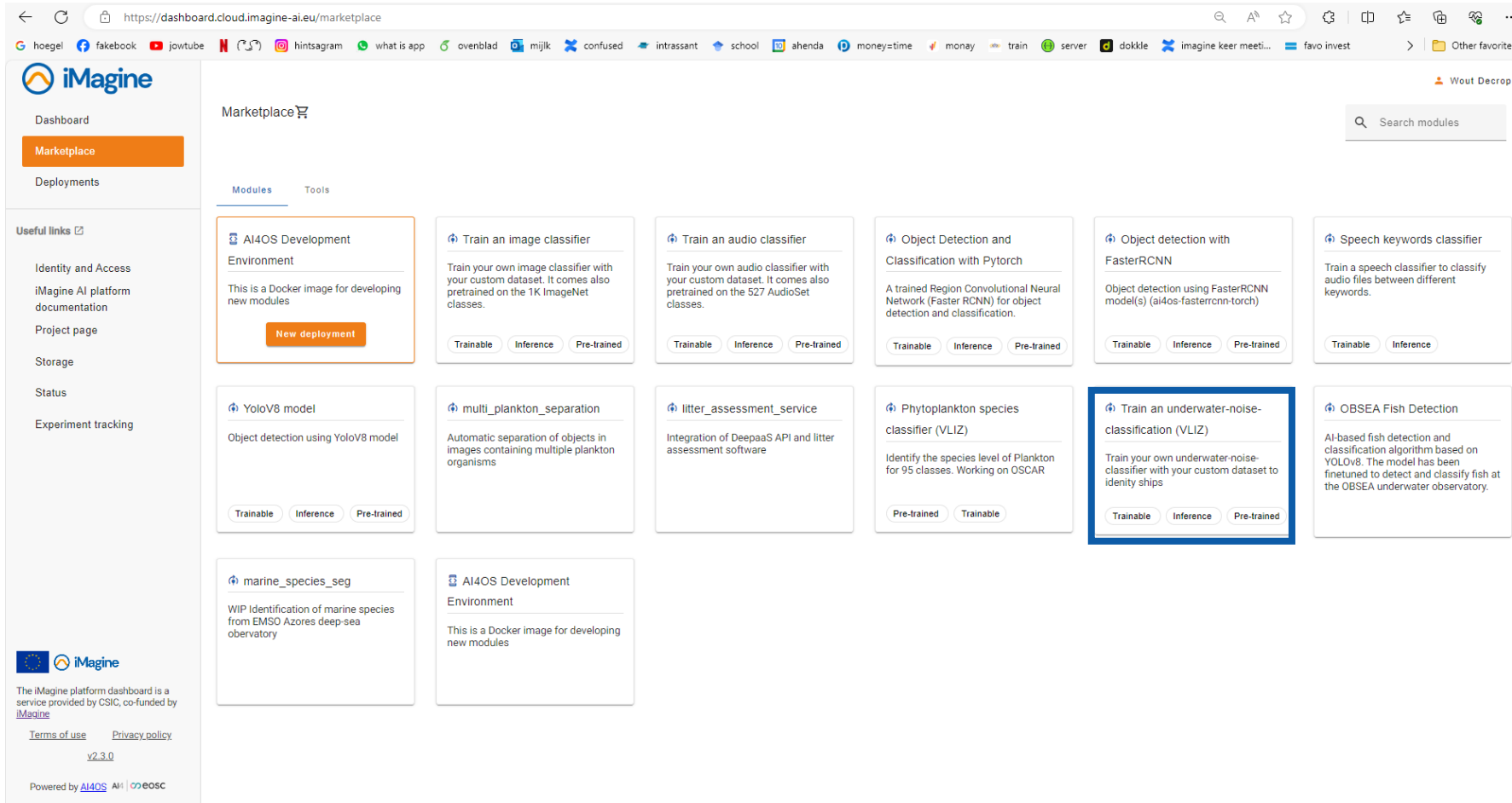
## Model interference: action on live data



## Next steps

1. Incorporate speed in to the model
2. Change some parameters:
  - Adaptation of creation of the log mel spectrogram?
  - Play with different outputs (classification vs regression)
3. Apply on different datasets?

## Soon available (model + dataset)



The screenshot shows the iImagine marketplace dashboard. The left sidebar contains navigation options: Dashboard, Marketplace (selected), Deployments, Useful links, Identity and Access, iImagine AI platform documentation, Project page, Storage, Status, and Experiment tracking. The main content area is titled 'Marketplace' and features a search bar and a grid of modules. The 'Train an underwater-noise-classification (VLIZ)' module is highlighted with a blue border. Other visible modules include AI4OS Development Environment, Train an image classifier, Train an audio classifier, Object Detection and Classification with Pytorch, Object detection with FasterRCNN, Speech keywords classifier, YoloV8 model, multi\_plankton\_separation, litter\_assessment\_service, Phytoplankton species classifier (VLIZ), OBSEA Fish Detection, and marine\_species\_seg.

Marketplace

Search modules

Wout Decrop

Modules Tools

- AI4OS Development Environment**  
This is a Docker image for developing new modules.  
New deployment
- Train an image classifier**  
Train your own image classifier with your custom dataset. It comes also pretrained on the 1K ImageNet classes.  
Trainable Inference Pre-trained
- Train an audio classifier**  
Train your own audio classifier with your custom dataset. It comes also pretrained on the 527 AudioSet classes.  
Trainable Inference Pre-trained
- Object Detection and Classification with Pytorch**  
A trained Region Convolutional Neural Network (Faster RCNN) for object detection and classification.  
Trainable Inference Pre-trained
- Object detection with FasterRCNN**  
Object detection using FasterRCNN model(s) (ai4os-fastercnn-torch)  
Trainable Inference Pre-trained
- Speech keywords classifier**  
Train a speech classifier to classify audio files between different keywords.  
Trainable Inference
- YoloV8 model**  
Object detection using YoloV8 model  
Trainable Inference Pre-trained
- multi\_plankton\_separation**  
Automatic separation of objects in images containing multiple plankton organisms
- litter\_assessment\_service**  
Integration of DeepaaS API and litter assessment software
- Phytoplankton species classifier (VLIZ)**  
Identify the species level of Plankton for 95 classes. Working on OSCAR  
Pre-trained Trainable
- Train an underwater-noise-classification (VLIZ)**  
Train your own underwater-noise-classifier with your custom dataset to identify ships  
Trainable Inference Pre-trained
- OBSEA Fish Detection**  
AI-based fish detection and classification algorithm based on YOLOv8. The model has been finetuned to detect and classify fish at the OBSEA underwater observatory.
- marine\_species\_seg**  
WIP Identification of marine species from EMSO Azores deep-sea observatory
- AI4OS Development Environment**  
This is a Docker image for developing new modules

The iImagine platform dashboard is a service provided by CSIC, co-funded by iImagine

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Powered by AI4OS AI | eoosc



## The team:

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The MOC and acoustics team

ChatGPT

## Thank you!

## Any questions?

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