VLIZ pioneer in marine science

ICUA2024 International Conference on Underwater Acoustics 17-20 June 2024, Bath, UK

MOC Marine Observation Center

LifeWatch BELGIUM

iMagine

AI in marine sciences:

Detection and classification of marine vessels with underwater acoustic data

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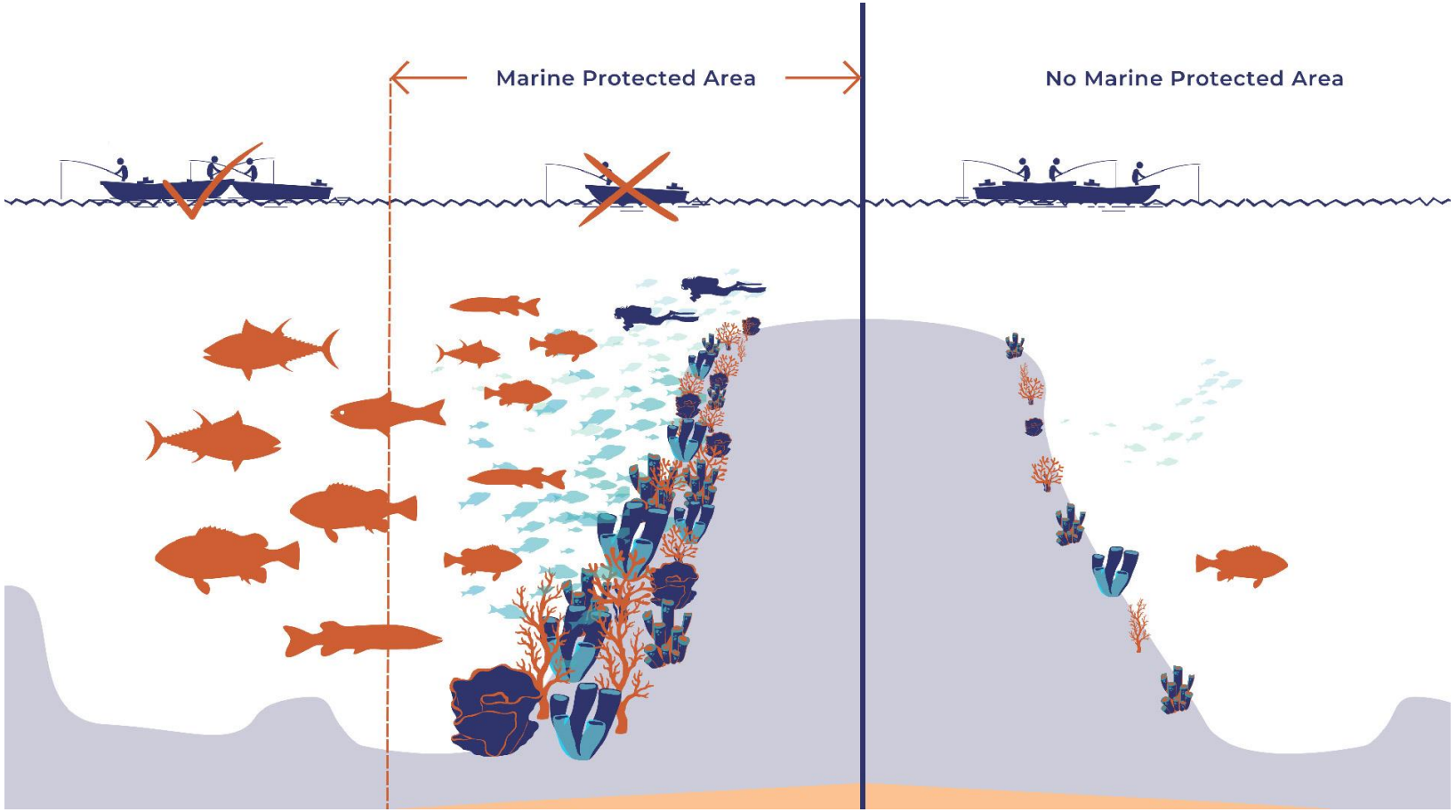
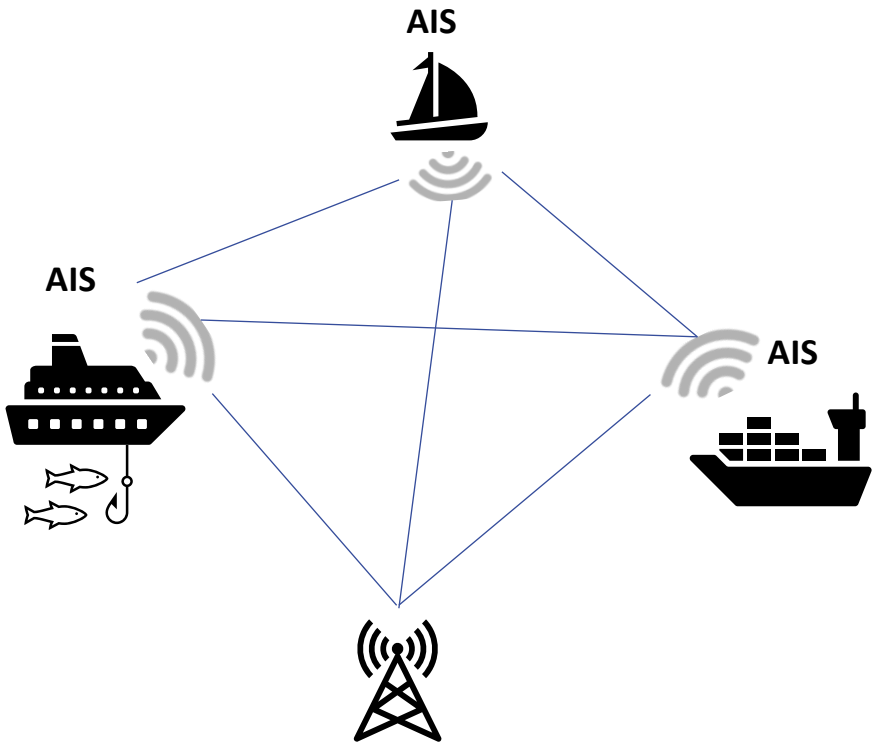
Marine Protected Areas (MPA's)



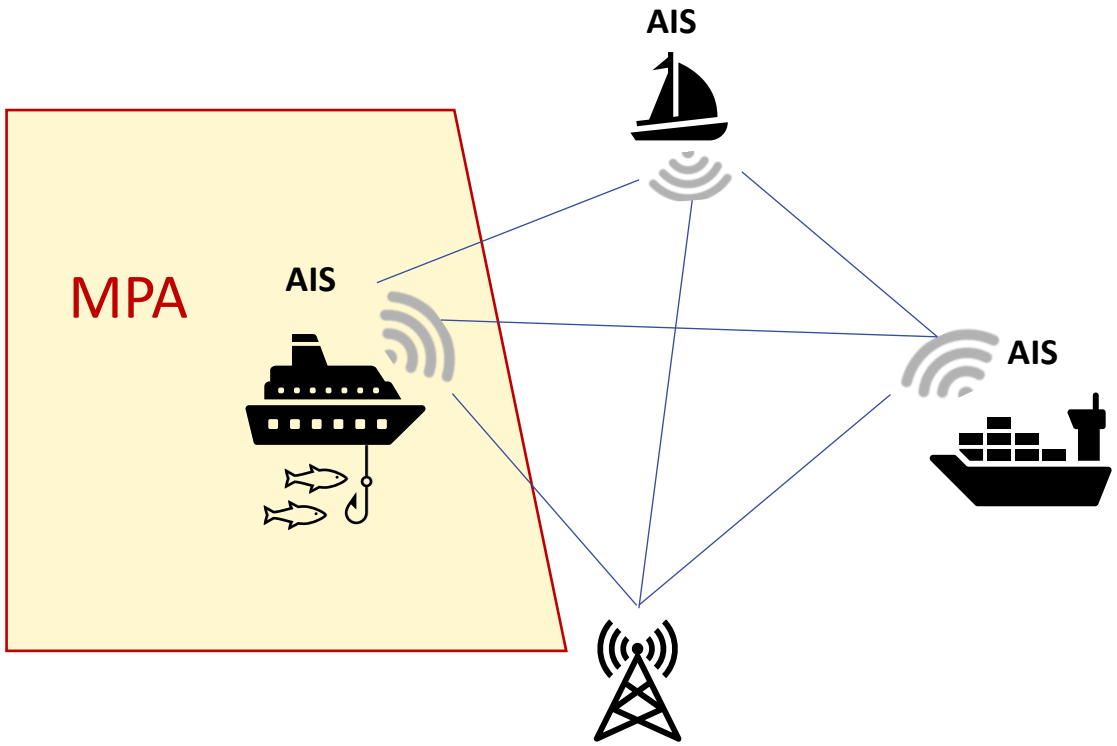
Monitoring shipping activity



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

Monitoring shipping activity - MPA's and other regions



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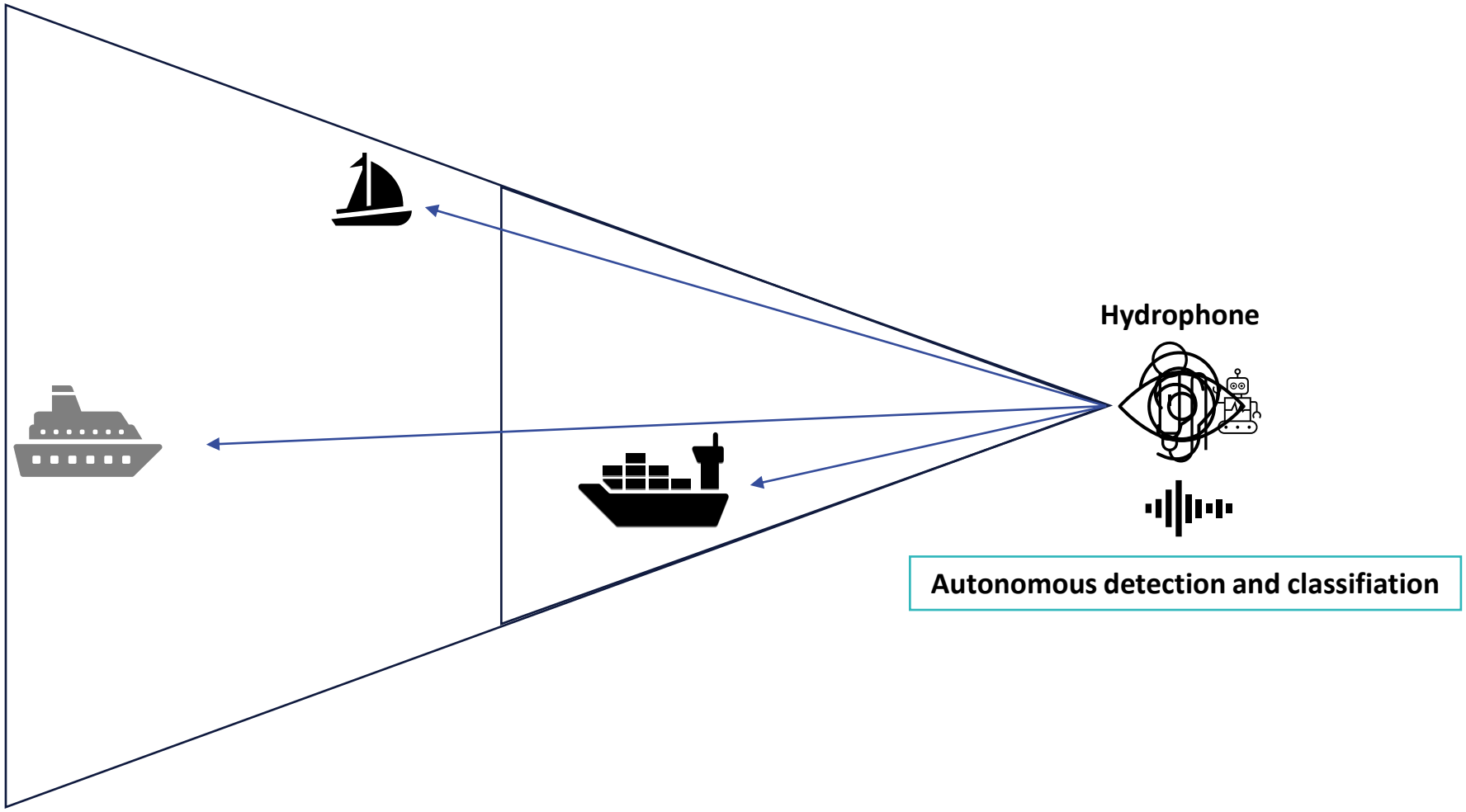
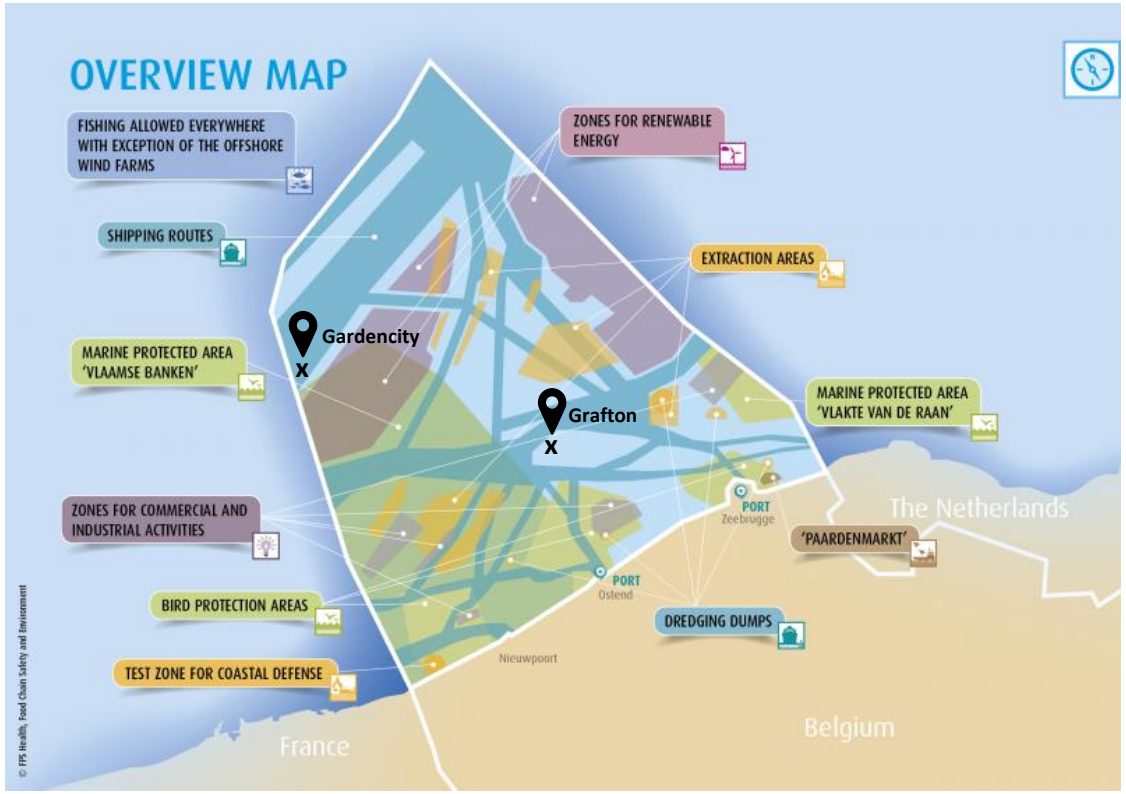
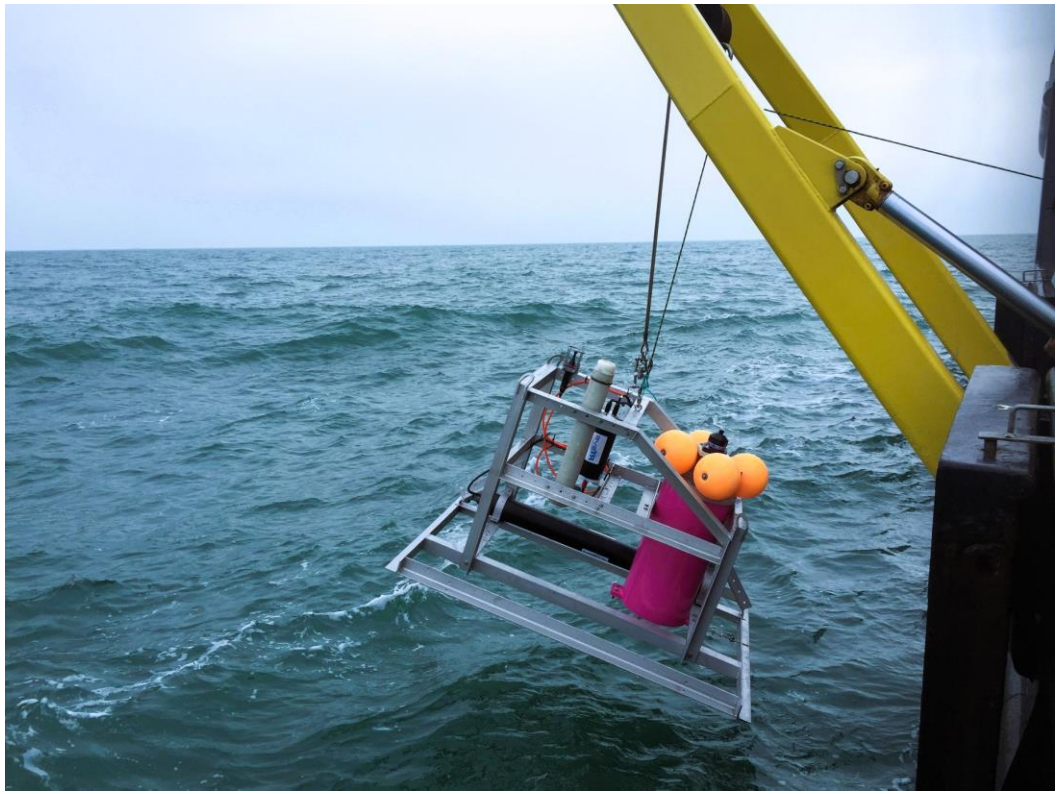


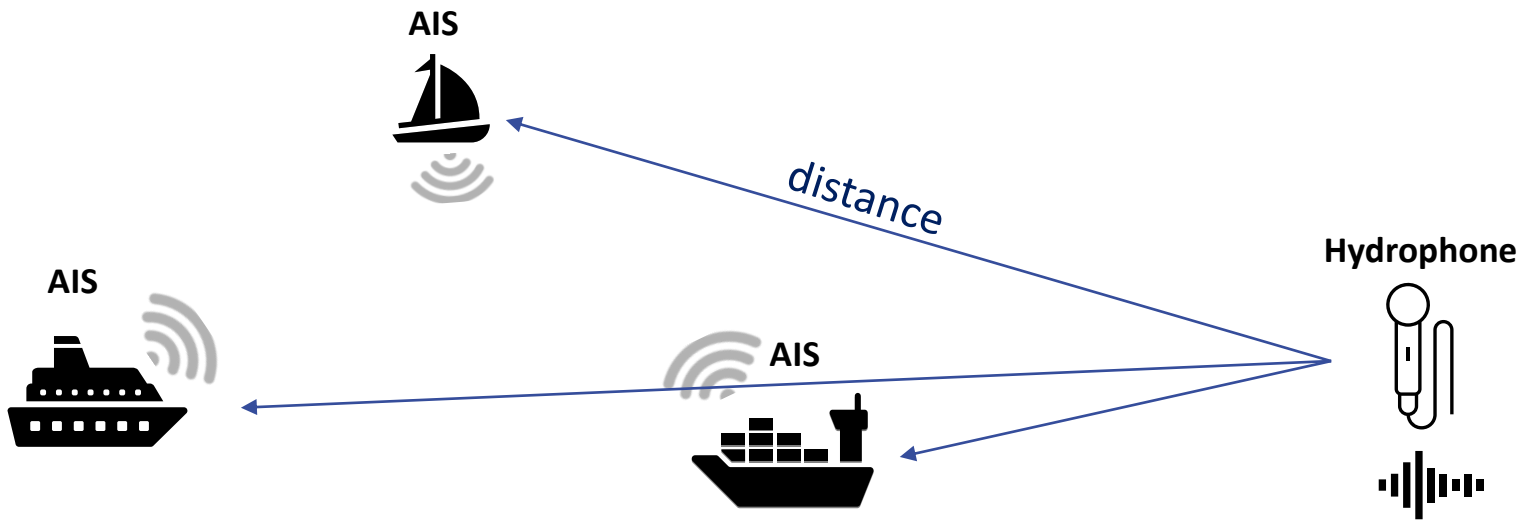
Creating the database





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

Creating the database



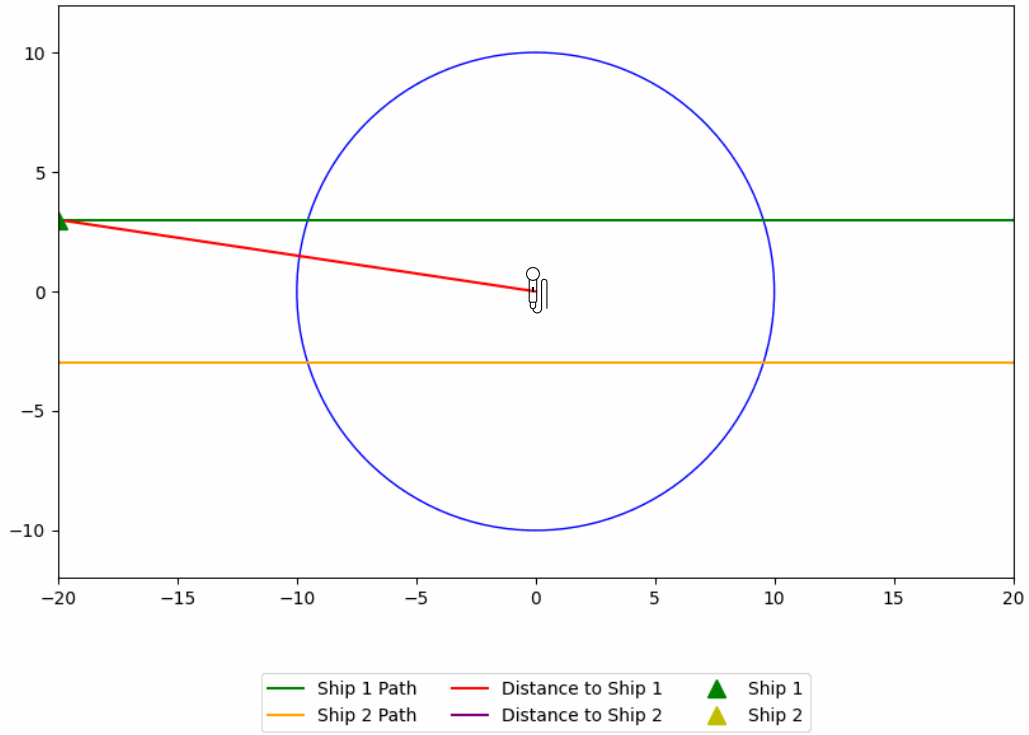
AIS data:
Coordinates
Timestamp
vessel information

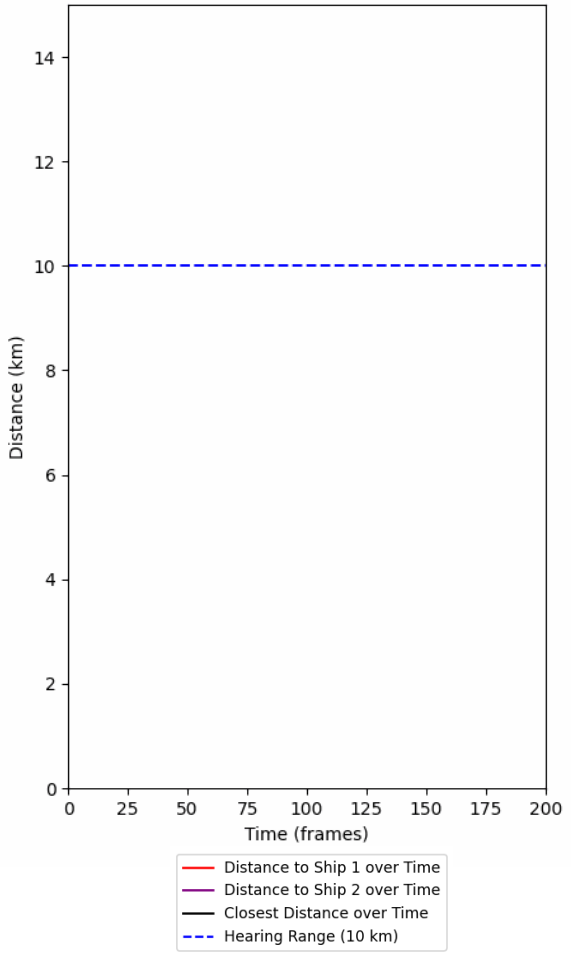
+

Hydrophone recordings
Coordinates
Timestamp
recording

Database

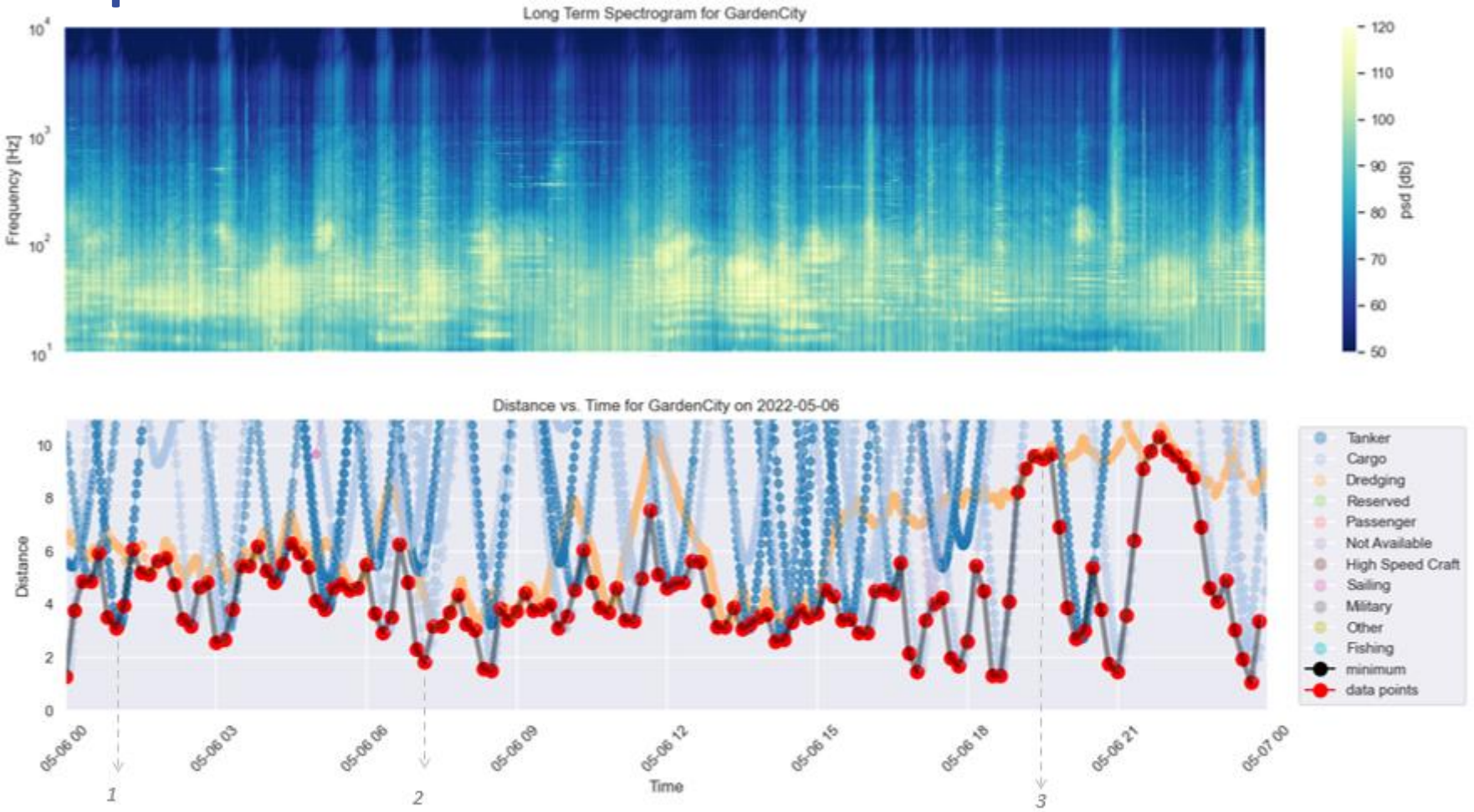
Creating the database





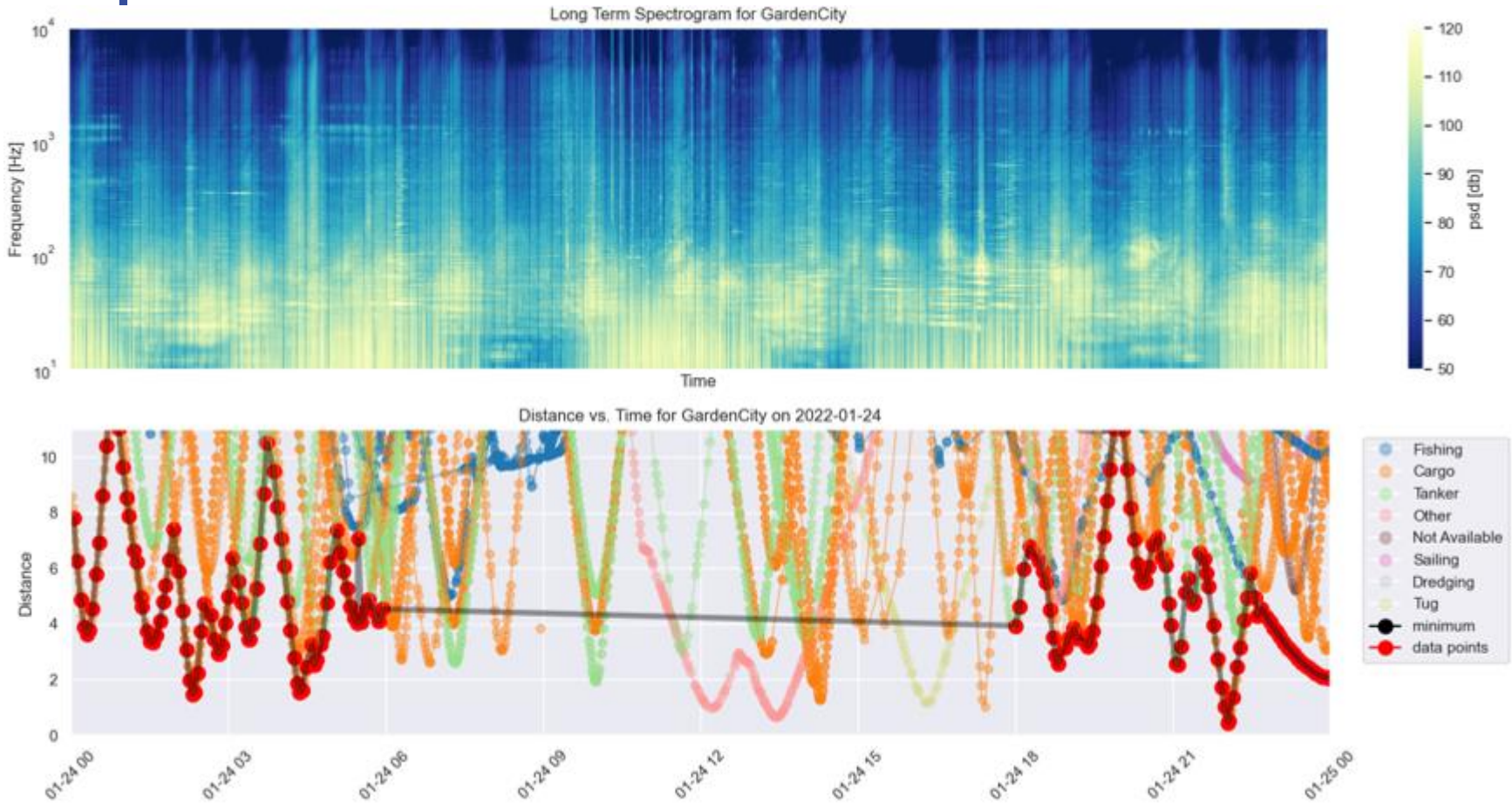
The power spectral density is in function of the distance

Data exploration



Sample 10-second wav files every 4 min.

Data exploration

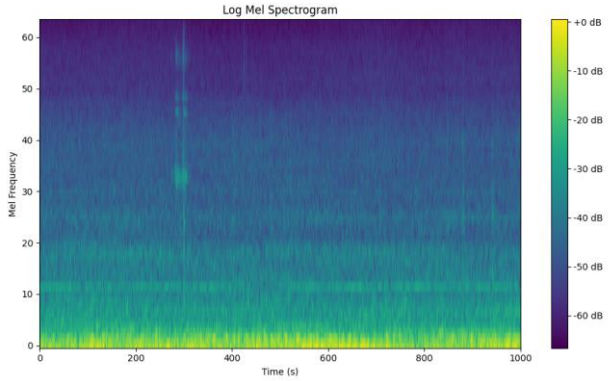


Filter out the data where AIS is messy

Data exploration

10 sec wav file

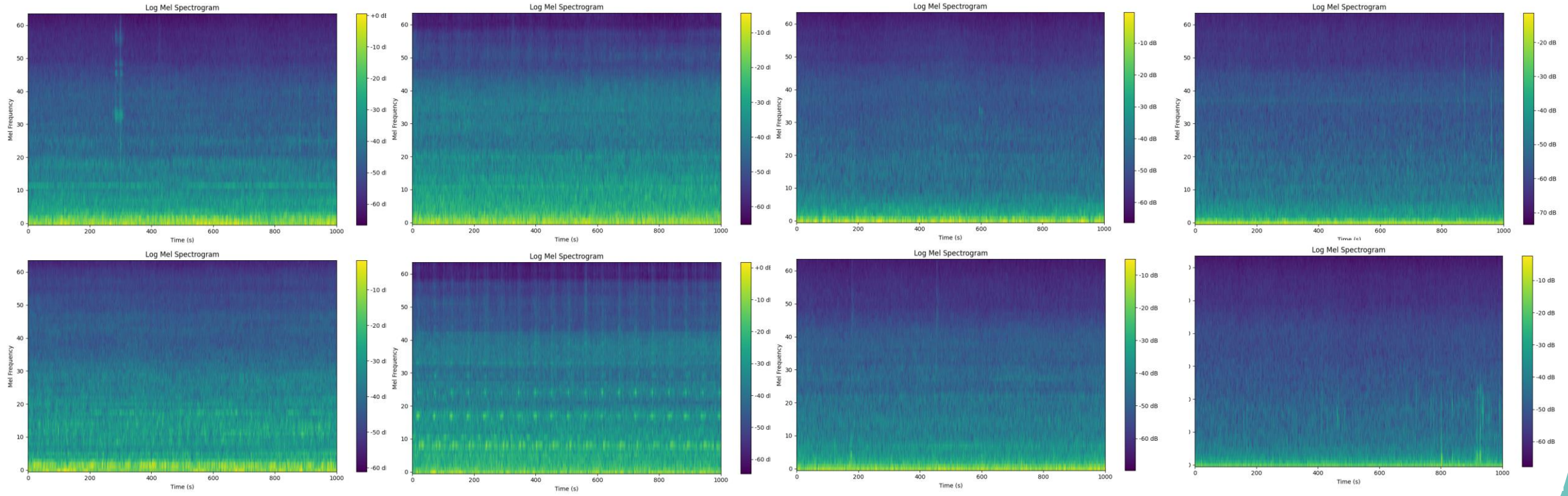
Feature extractor



Log mel spectrogram

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

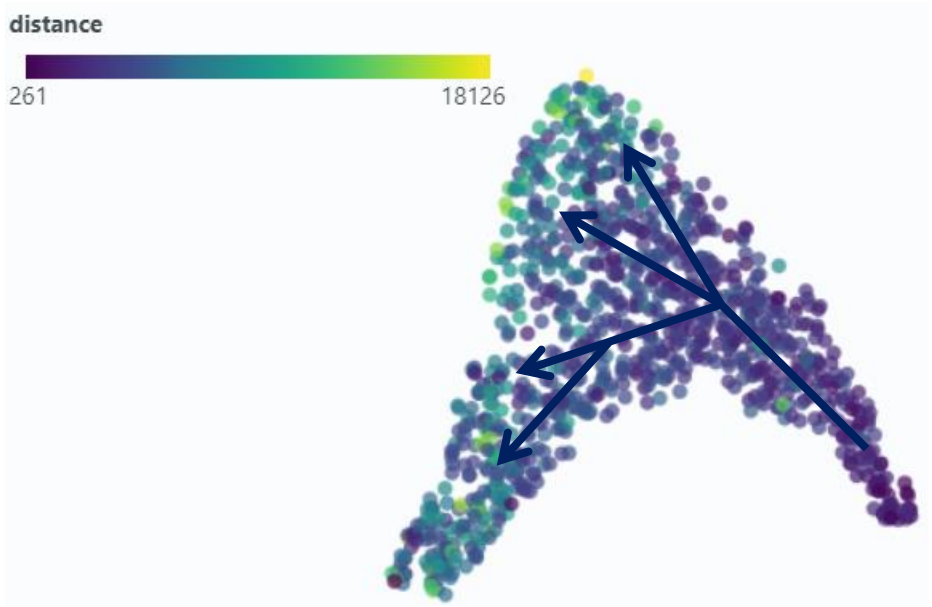
Data exploration



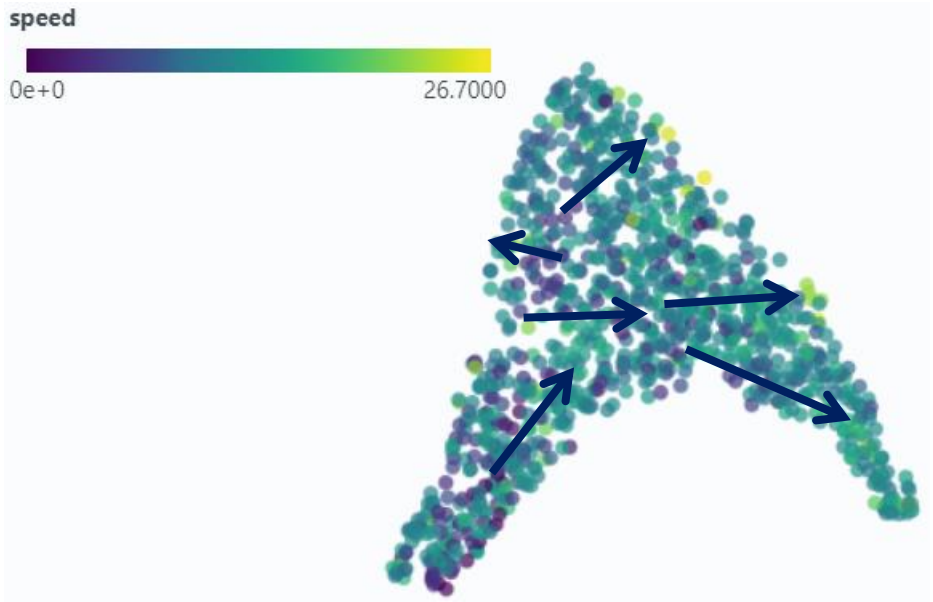
Boats close by vs far away

Conclusion: spectrograms give information about distance, possibly even activity

Data exploration



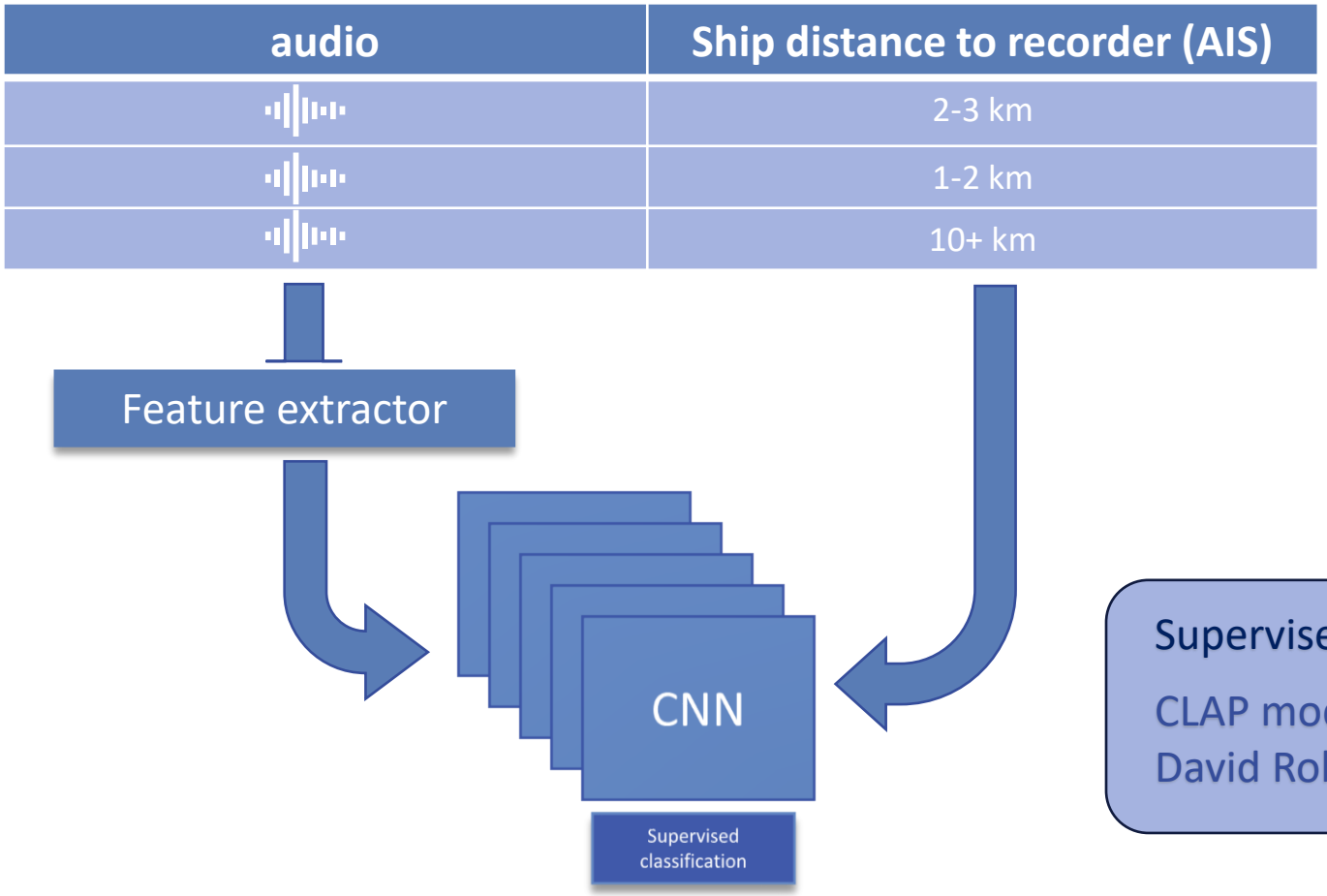
Clear trend in distance



Less clear trend in speed

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

Building the model



Supervised audio classification

CLAP model pre-trained on bioacoustics by David Robinson

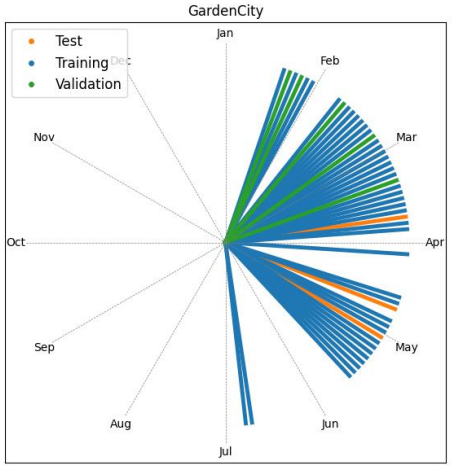
Building the model

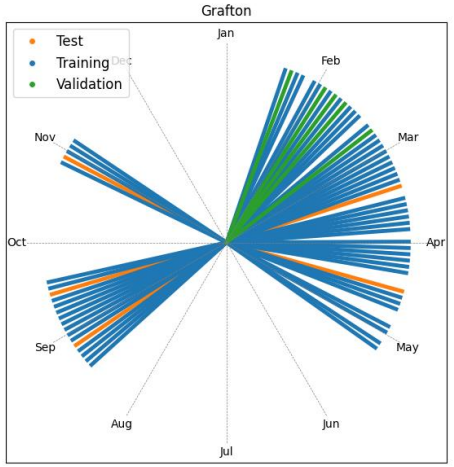
Data architecture:

- 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

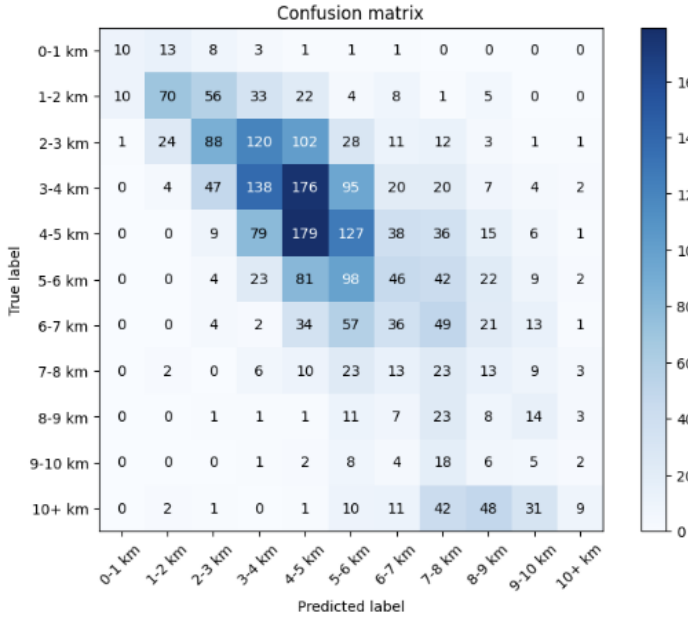
Model architecture:

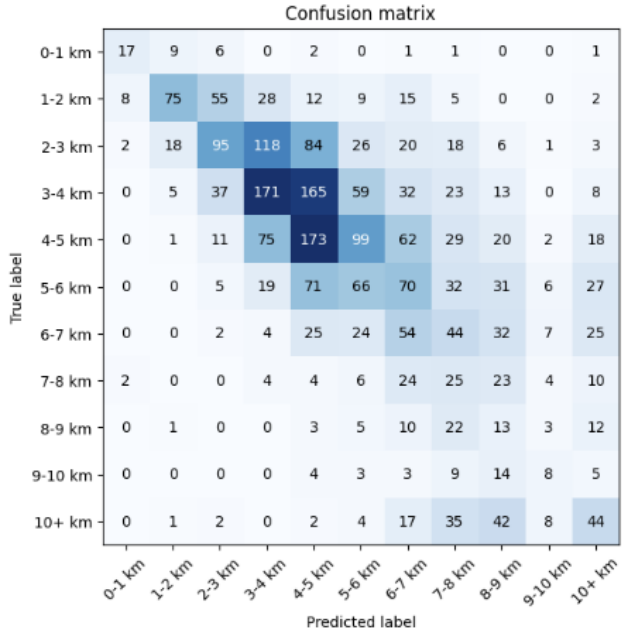
- Epochs: 10
- Early stop through validation set
- Adam optimizer

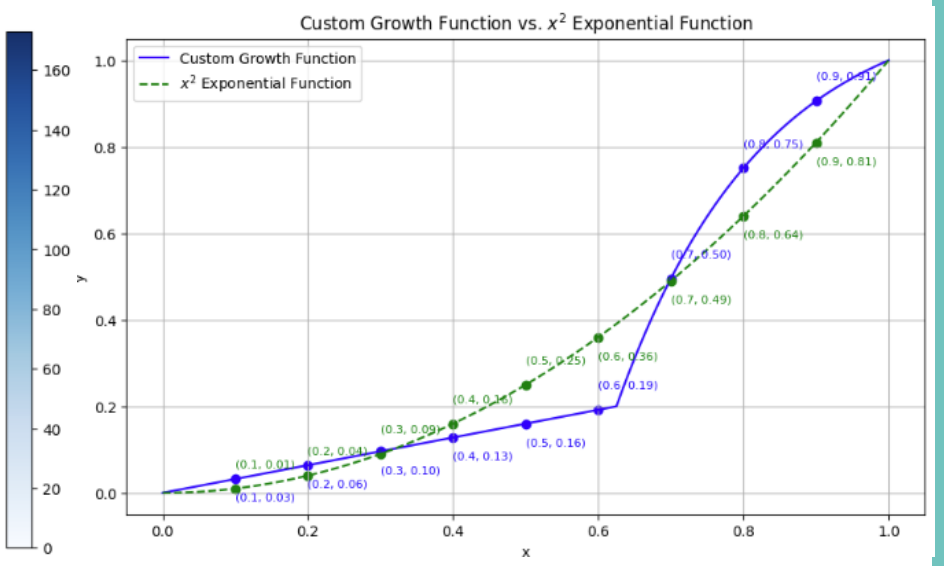




Results



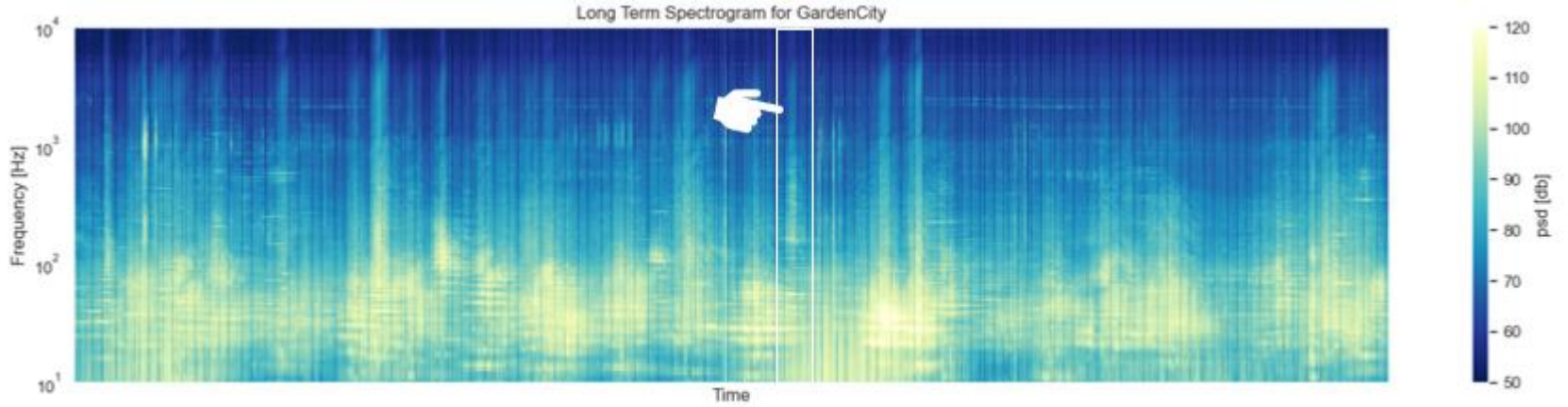


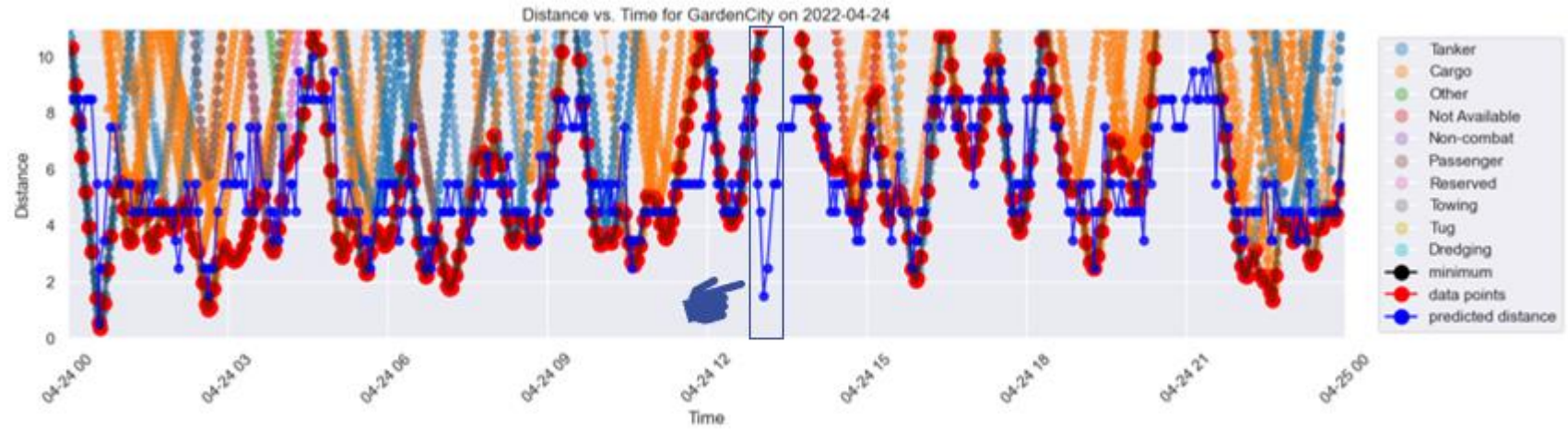


	Costum Loss function	X^2 loss function
MSE	*3.34 km*	*4.07 km*
RMSE	*1.82 km*	*2.01 km*

Predictions plotted on database

Results

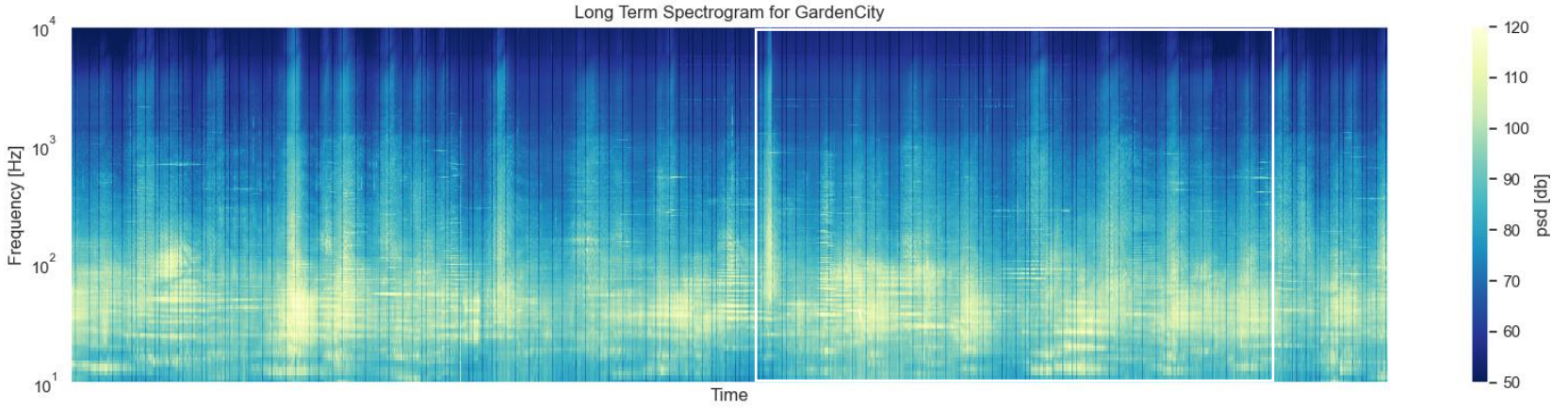




Model is able to identify false negatives from dataset.

Datapoints: from AIS
Predicted: from model

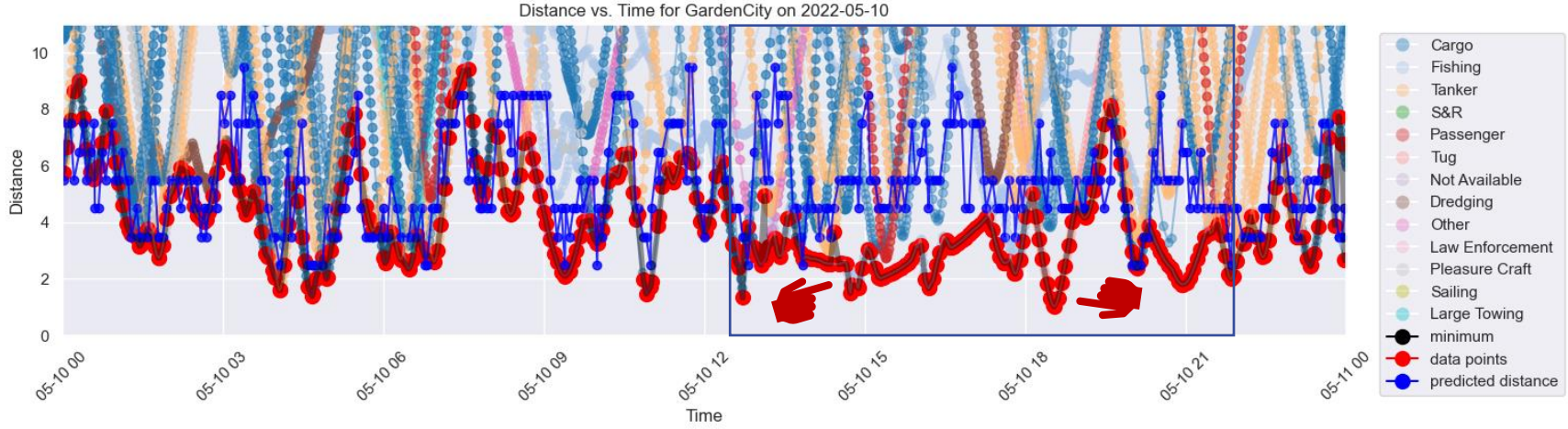
Results



Model only detects vessels that are making noise.

If silent → next vessel

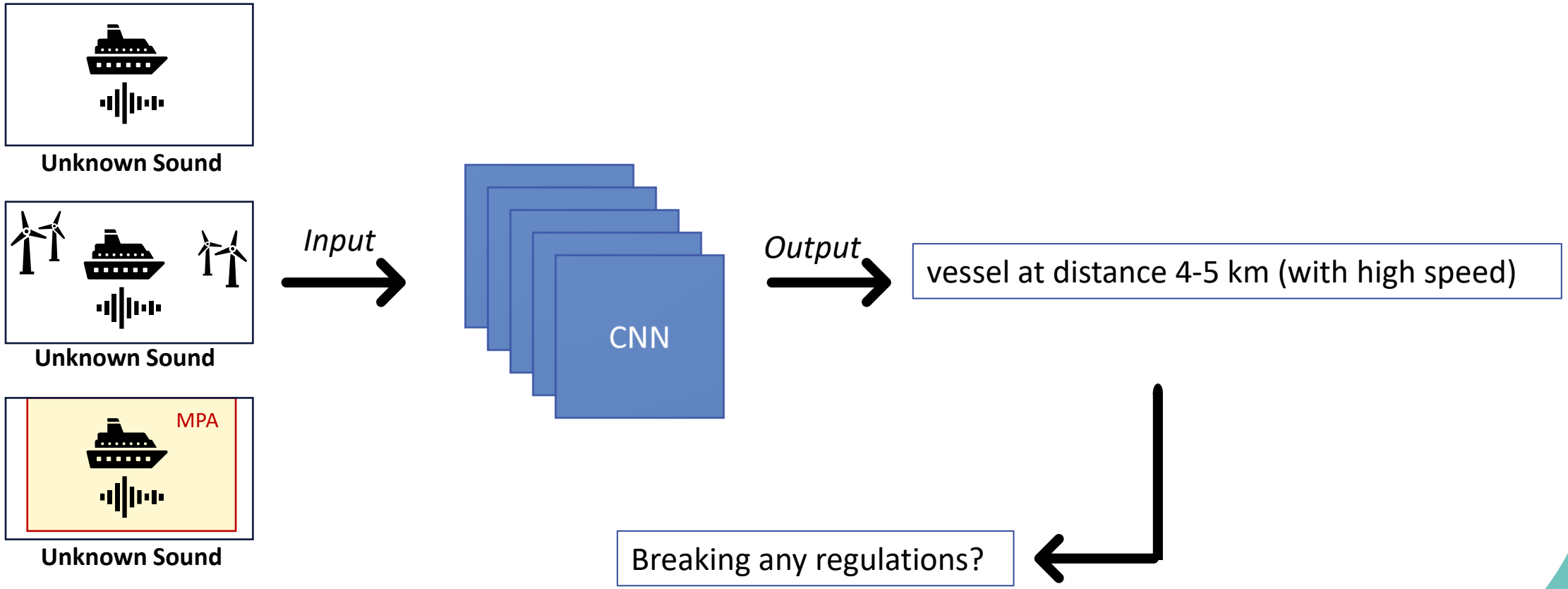
- Drifting
- Quiet engine



Datapoints: from AIS

Predicted: from model

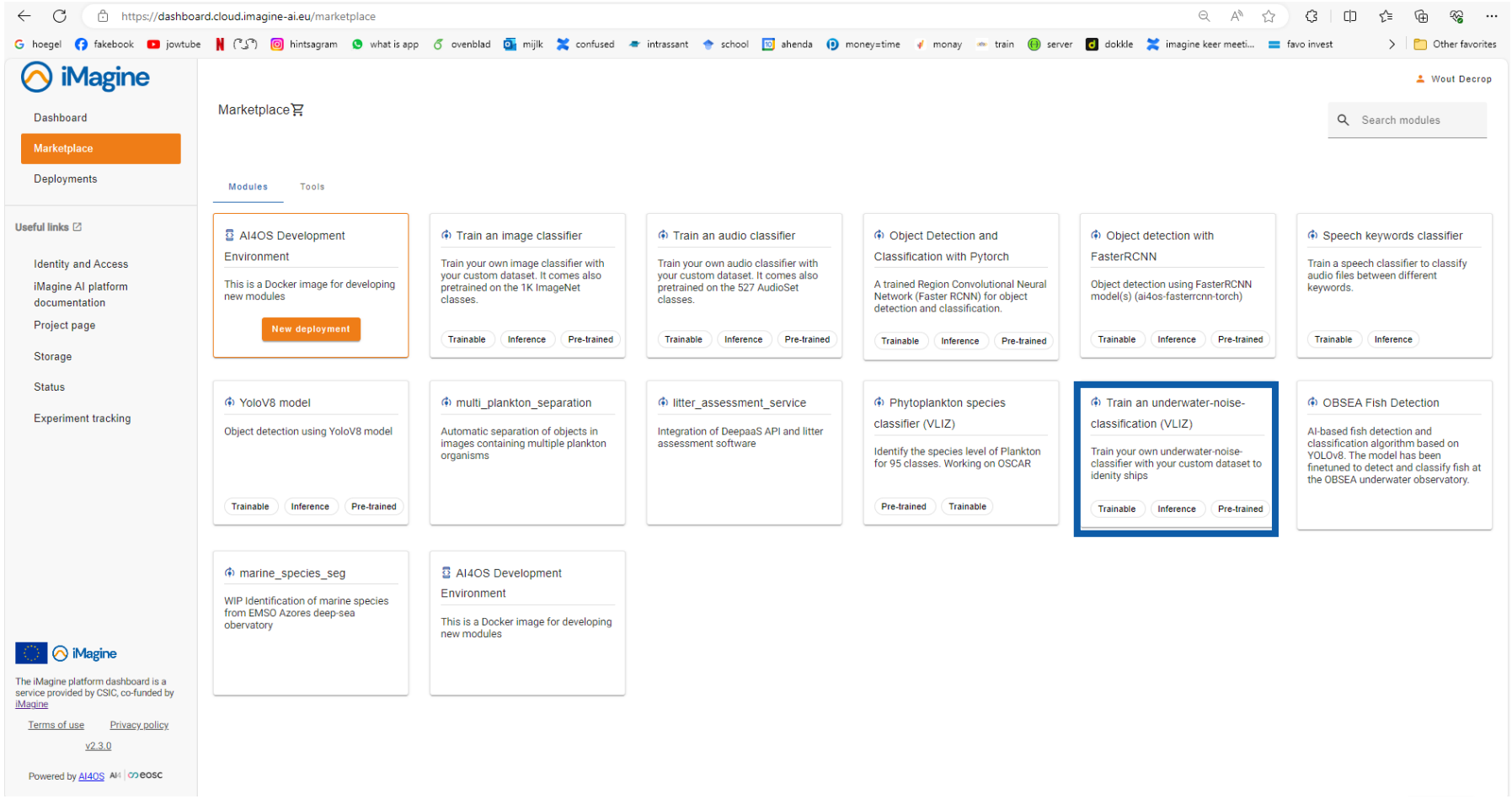
Model interference: action on live data



Next steps

1. Incorperate 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)



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The MOC and acoustics team

ChatGPT

Thank you!

Any questions?

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VLIZ