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Global passive acoustic monitoring of the oceans with MERMAID Argo floats

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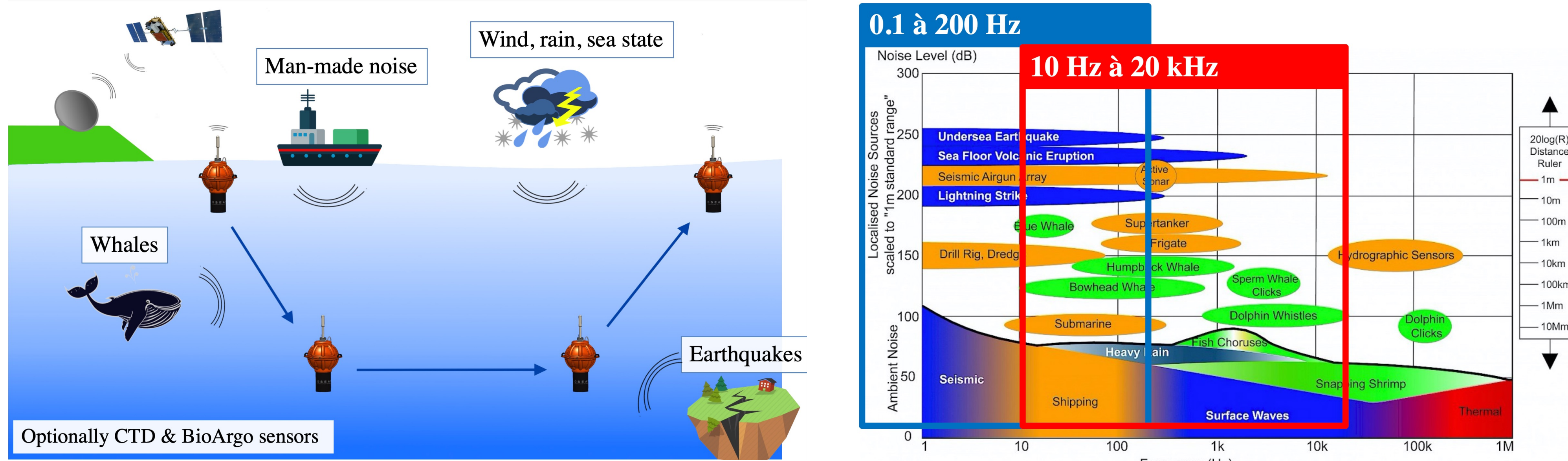
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MERMAID-MULTI

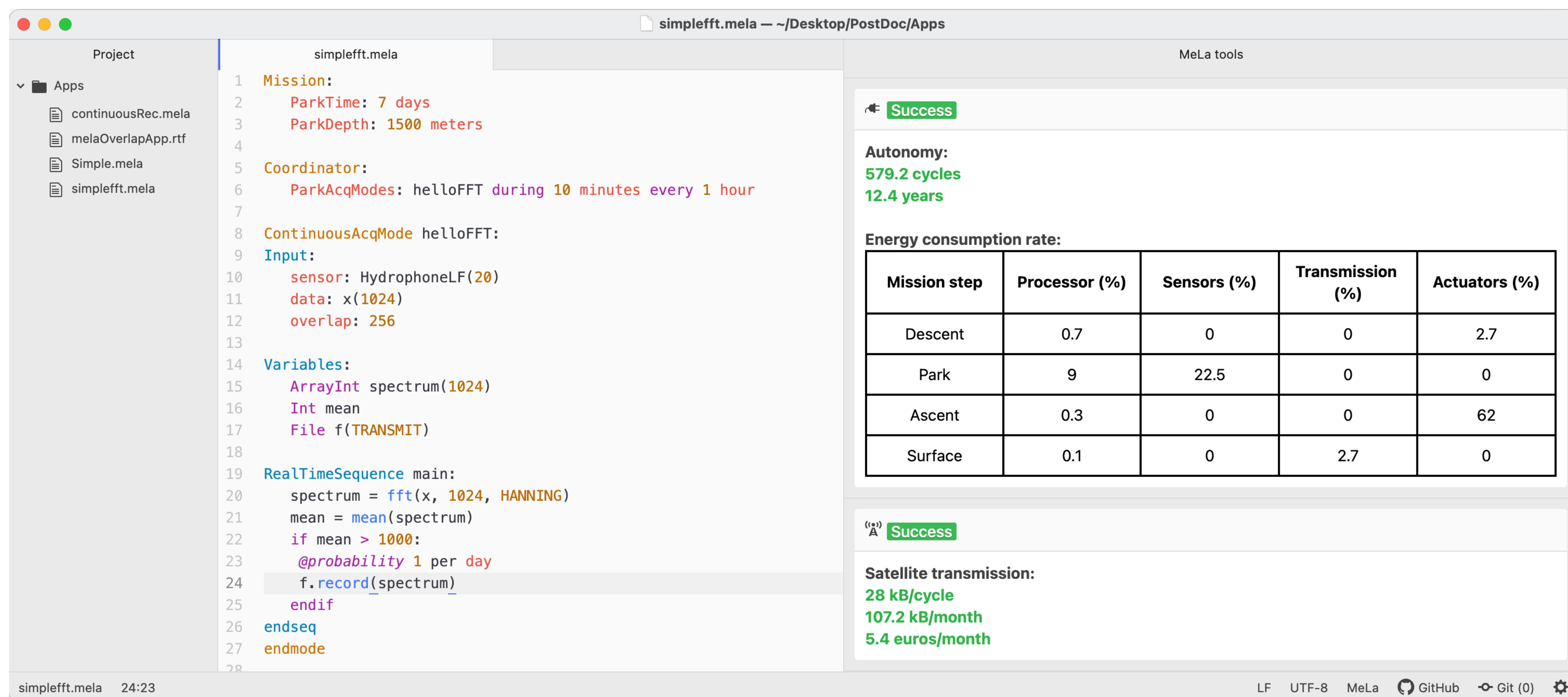
The MERMAID [1] is an autonomous seismometer floating at a depth of 2000 meters in the oceans. It rises to the surface every week to transmit data. We are developing a multidisciplinary version for passive acoustic monitoring from 0.1 Hz to 20 kHz, separated into 2 acquisition channels.



A typical MERMAID cycle (left) and monitored acoustic frequency bands (right)

Applications development

Acoustic data must be processed/compressed on board before being transmitted in near real time by satellite. A dedicated programming language (MeLa) aware of energy and processing power limits is used to develop algorithms without requiring embedded software expertise [2]. Several applications can be programmed over the air even after instrument deployment.

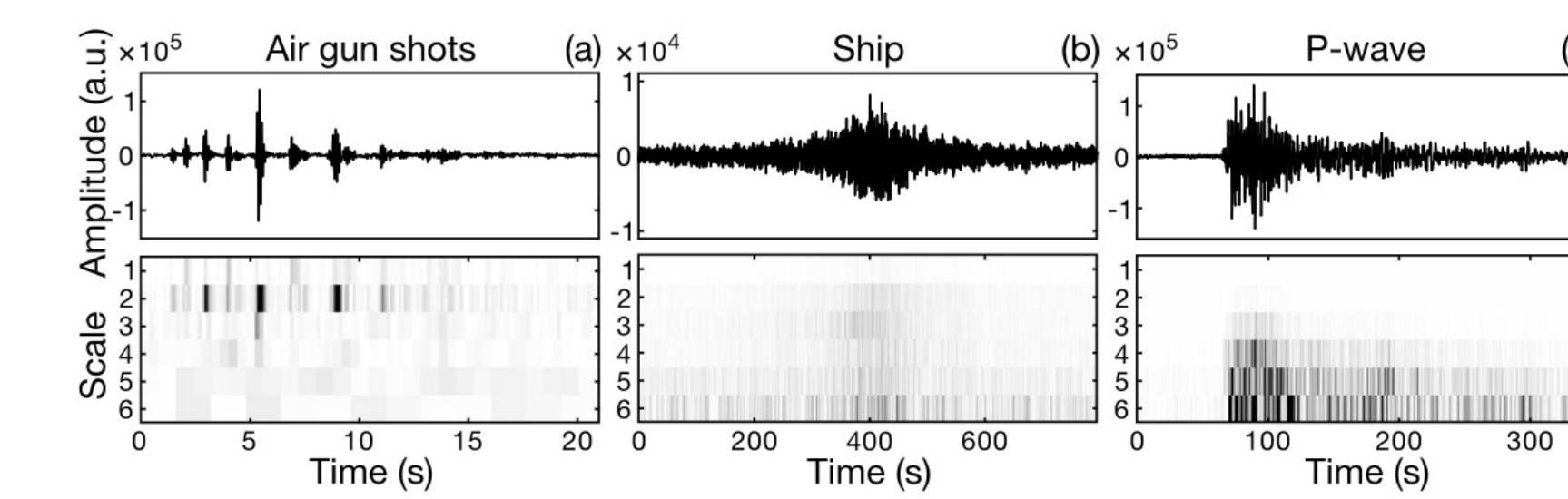


Example of a MeLa application in the Pulsar editor with energy and satellite transmission estimation on the right panel

Application examples

App 1:

Detection of seismic waves with the default MERMAID algorithm [3].



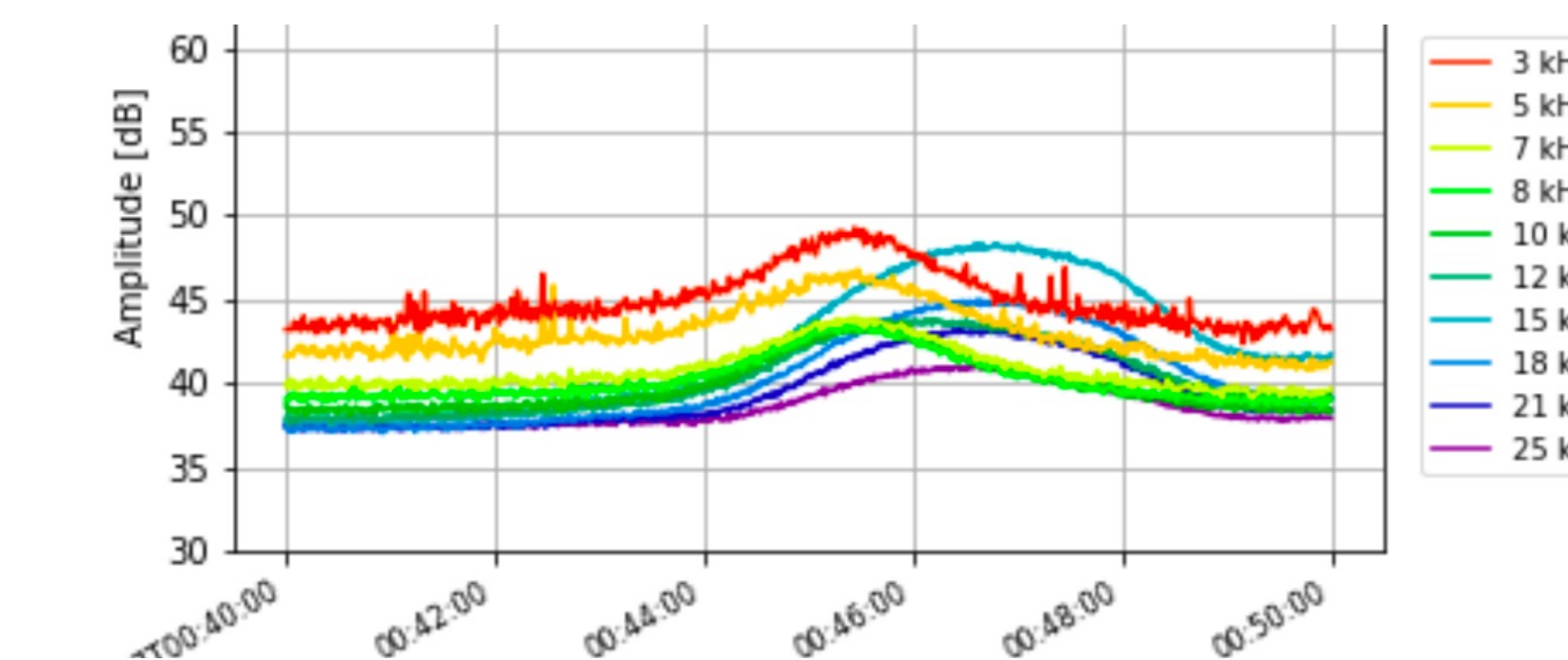
A wavelet transform is used for signal discrimination

App 3:

Continuous recording at a sampling frequency of 80 Hz to be compatible with apps 1 and 2 operating at 40 and 80 Hz respectively.

App 4:

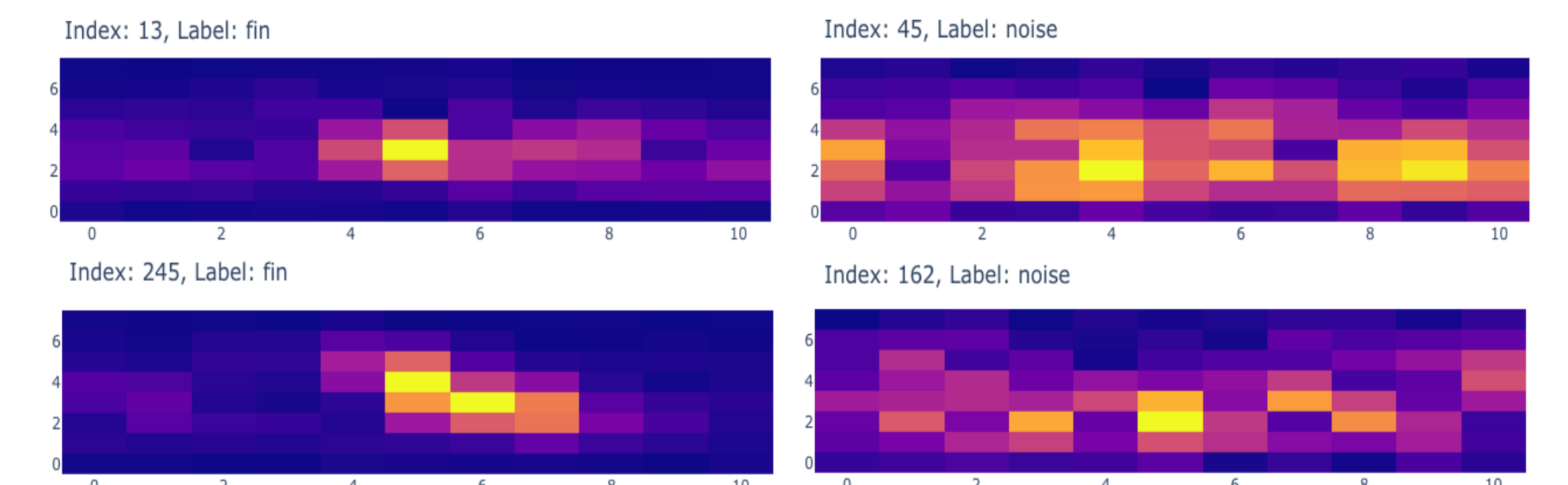
Sound pressure level is recorded at several frequency bands to monitor rain and anthropogenic noise pollution [4].



Example of a short rain - drizzle event recorded by the MBARI MARS hydrophone

App 2:

Detection of fin whales calls using a Dense Neural Network (DNN) trained on the Watkins Marine Mammal Sound Database.



The DNN is made of two layers of 10 and 5 neurons and trained with TensorFlow Lite.

Precision is 99 % i.e., 1 detection over 100 is not a fin whale call
Recall is 96 % i.e., 4 fin whales calls over 100 are not detected

Resource usage:

The MeLa language estimates the autonomy at 6 years, with an average processor utilization rate of 3 %, and 600 kB of data transmitted by satellite each month.

First trials at sea in 2024 !
Add your own app n°5 !



Toward a global network

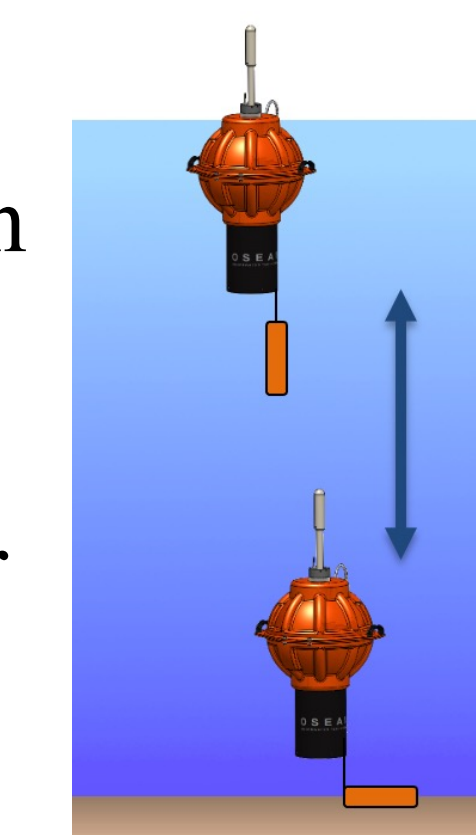
Records of seismic waves traveling through the earth's mantle are used to compute the earth tomographic image. More than 50 floats have been deployed by the Earthscope-Oceans organization since 2016 [5].



Maps of the last known position of Earthscope-Oceans floats

Lander and moored versions

The float can be configured to settle down to the ocean floor with a small anchor, preventing drifting on the ocean floor. This operating mode has been thought for local seismic crisis monitoring.



The float can be fixed on a subsurface mooring to avoid any drift. This is useful for coastal operation, but deployment requires more resources.

