Observing seismic activity in the Mediterranean with a float landed on the sea floor

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Summary of the mission

A joint study campaign has been initiated by OSEAN and the GEOAZUR laboratory with the objective of assessing the quality of records from a float on the ocean floor as a seismic observation platform in the Mediterranean.

In July 2024, the OSEAN float (s/n 467.120-T-0055) was deployed of the coast of Nice, France. The float was equipped with a hydrophone and a MERMAID acquisition system, which was dedicated to recording and detecting seismic events. Additionally, a guide rope was attached to the float, allowing it to land on the ground, thereby minimizing drift caused by oceanic currents.

The deployment of the float was made possible thanks to the efforts of Yann Hello and Sébastien Bonnieux, who provided generous support. The expertise of Sébastien Bonnieux and Karin Sigloch was also called upon in the subsequent study.

The float was deployed on 4 July 2024 and, following a period of 111 days and a distance of only 15 nautical miles at sea, was recovered on 23 October 2024.

During this period, the float completed eight cycles, landing as many times at depths exceeding 2000 m. It remained on the ground for periods between a few and 30 days, recorded over 100 days of low-frequency acoustic signals containing many seismic waves.

Example of the longest cycle performed by the float
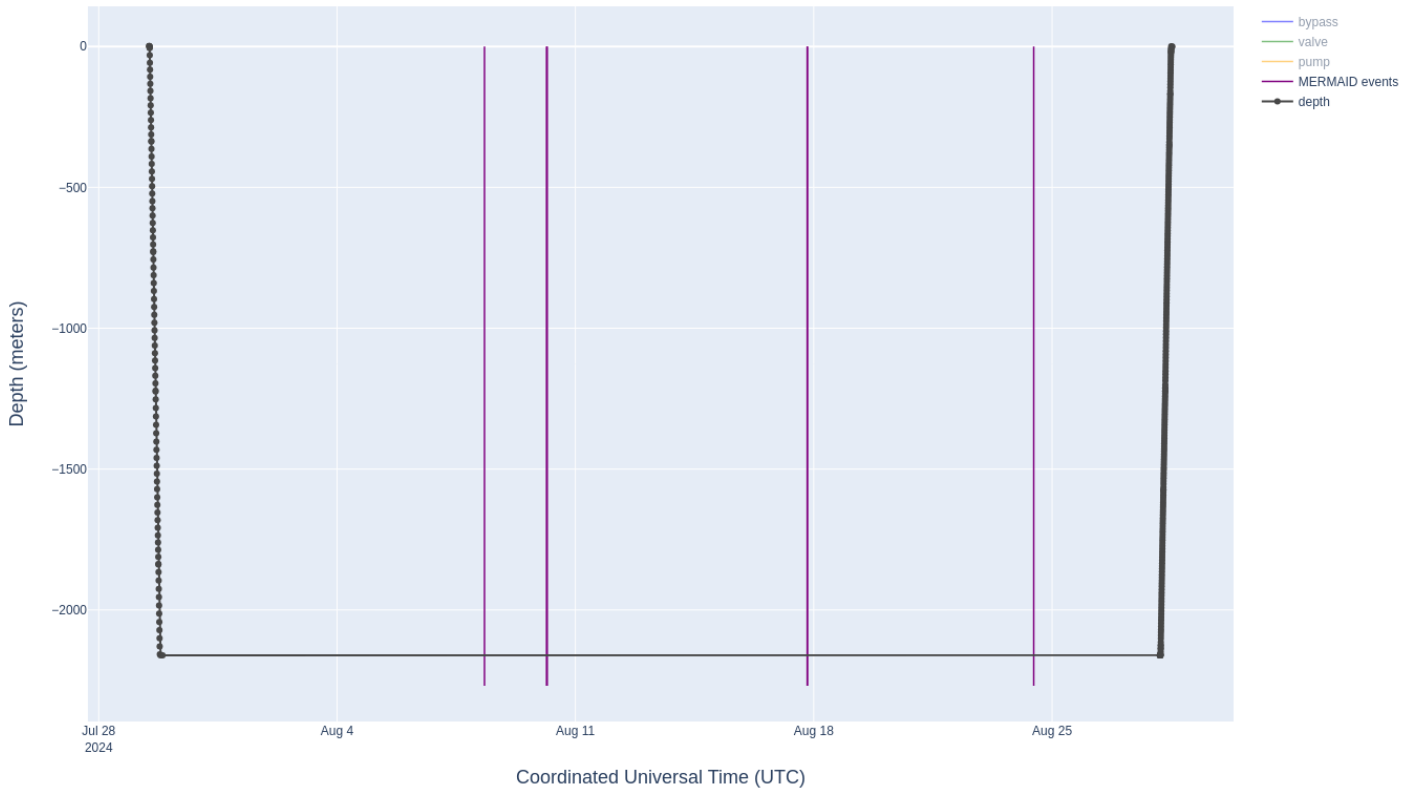
The float makes its descent on 29 July at 11:34 a.m., reaching the ground at 7:05 p.m. (2160 meters below sea level). The float remained on the ground for approximately 30 days. It departed from the bottom of the sea at approximately midday on August 28, having ascended to the surface at approximately 3:55 a.m.

The purple vertical lines indicate the instances where the float detection algorithm was triggered.

Scientific data analysis

*The embedded processing algorithm autonomously detected:*

- 11 teleseismic P and S waves from earthquakes of magnitudes 6.0 to 7.4
- 1 T wave from a nearby magnitude 4.1 earthquake in the Mediterranean

Manual post-processing of the buffer revealed:

- A total of 21 teleseismic waves were recorded, generated by earthquakes with magnitudes ranging from 4.5 to 7.9.
- Additionally, 85 T waves were recorded from earthquakes of magnitudes 1.6 to 4.5 in the Mediterranean basin.
- Additionally, 24 T waves were identified that could not be matched to events in the catalogues.

Example of a broadband time series recorded by the Mermaid hydrophone.

On 10 July 2024, a magnitude 6.6 earthquake was recorded by B55 at a distance of 98°. The epicenter was located in South Africa. The x-axis spans approximately two hours, with the absolute time (hh:mm:ss) starting from the beginning of this specific recording. It should be noted that the amplitude is presented as raw data (counts) and has not been converted to physical units. The P wave, occurring at approximately 34h:19min, and the PP wave, which follows approximately four minutes later, are both discernible and triggered the autonomous detection algorithm. Additionally, the dispersive, lower-frequency Rayleigh wave train, which begins around 35h00min, is also evident. The data were plotted with Raven Lite.
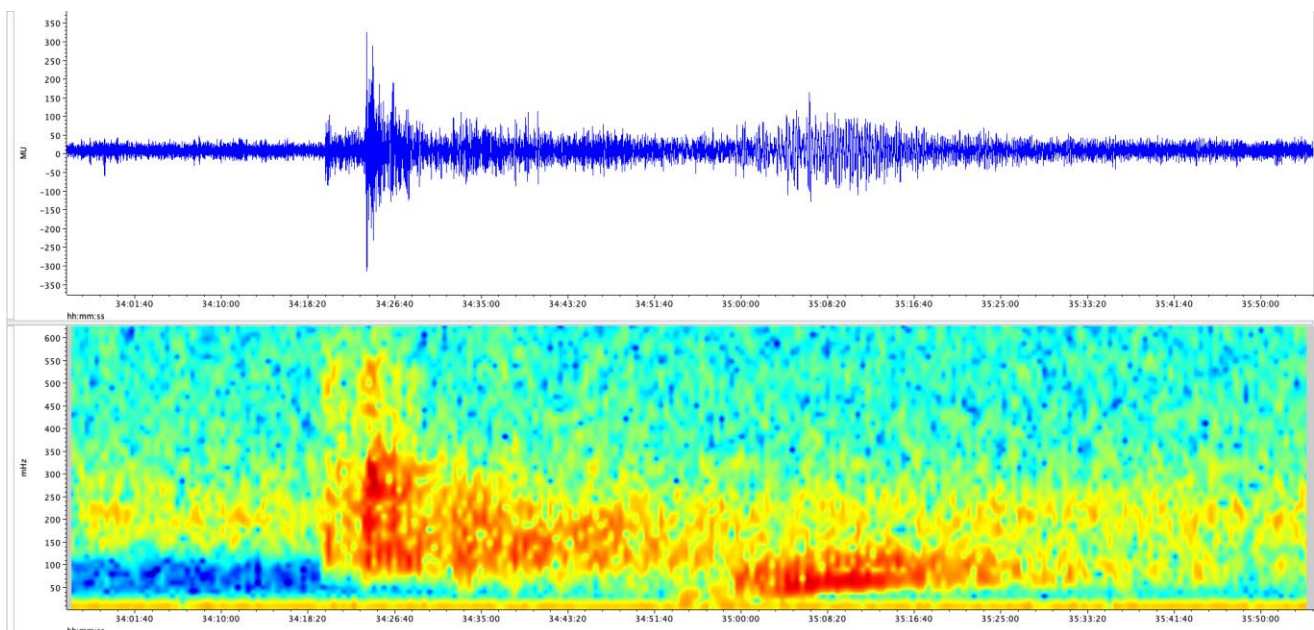
The Probabilistic Power Spectral Density (PPSD) plot demonstrates that the MERMAID float is capable of recording signals with sufficient quality. The amplitude is then converted to decibels relative to units of pressure (uPa). The horizontal blue-green bar represents the temporal availability of the time series that contribute to the PPSD calculations. The white areas indicate periods during which data were unavailable due to the float rising to the surface and subsequently communicating with the satellite link. The data were plotted using the Obspy software.