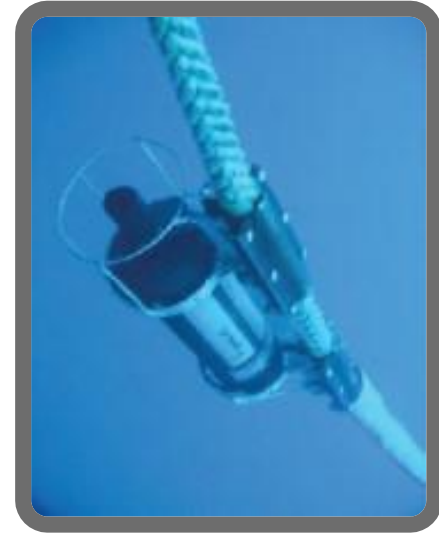


Underwater Passive Aquatic Listener (U-PAL)

The U-PAL sensor is a novel underwater instrument that provides *real-time* processing of underwater sound for continuous *acquisition, classification and quantification* of geophysical, biological and anthropogenic sounds. Due to its adaptive and low power sampling, U-PAL can be used for long-term observations of both near-shore and deep-ocean environments to support a variety of offshore applications.

Markets:

1. **Meteorological:** Quantifying wind speed and precipitation.
2. **Biological:** Detecting, tracking and protecting marine mammals and fisheries.
3. **Geological:** Detecting earthquakes and underwater landslides, and quantifying ice melting rates.
4. **Environmental Analysis:** Quantifying ambient sound levels and deriving sound budgets from long-term observations of processes at sea.
5. **Offshore Operations:** Detecting ships, quantifying sounds from wind farms and oil platforms.



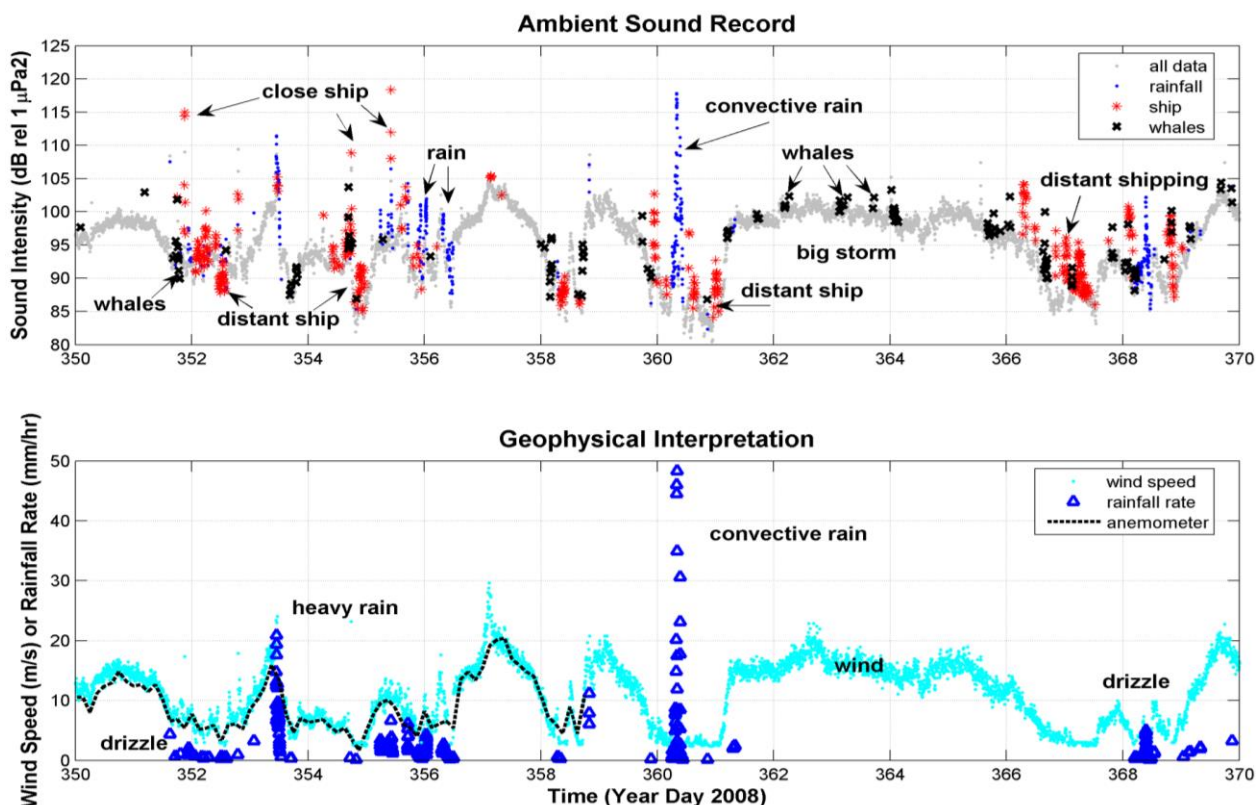
Technical Specifications:

Functional	<ul style="list-style-type: none">• Monitors acoustic frequency ranges between 2Hz and 80kHz• Offers large acoustical operational coverage ($> 4\text{km}^2$)
Operation and Maintenance	<ul style="list-style-type: none">• Current operating periods up to 1 year with no interruptions• Less susceptible to harsh weather events and vandalism• No maintenance required during operating periods
Modular Design	<ul style="list-style-type: none">• Deployable as a stand alone system• Existing surface buoy and submerged mooring platforms can easily integrate system• Other instruments, such as acoustic modems, can easily integrate system• Deployable up to 4,000m water depth
Data Collection	<ul style="list-style-type: none">• Adaptive sampling strategy• Real-time classification and quantification of sound• Optimized data storage ($>64\text{GB}$)

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Case Study:

The upper panel of the figure below shows time series of ambient total sound records (gray dots) taken from a deployment in the northern Aegean Sea, indicating a slowly varying wave-generated background sound punctuated by shorter duration acoustic events: rain storms (blue dots), ship passages (red stars), and whale vocalizations (black x). The lower-panel shows the quantitative interpretation of the sound record in terms of rainfall rate and wind speed. [Figure from Nystuen et al., *J. of Atmos. & Ocean. Technol.*, Vol. 32, No. 2, 334-349 2015]



Note: After day 358 the surface anemometer on this mooring failed, but the acoustical wind speed measurement continued.



U-PAL systems on ship deck prior to deployment at sea [photo from J. Nystuen]