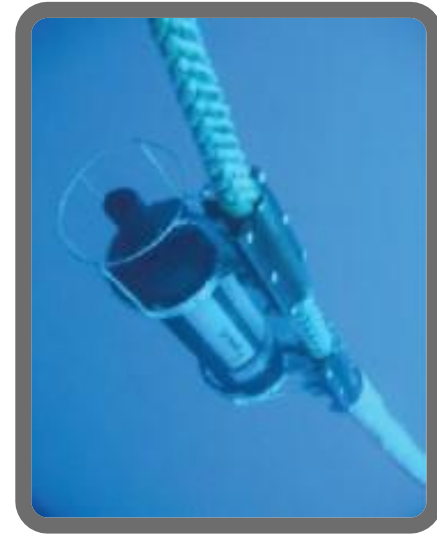# Underwater Passive Aquatic Listener (U-PAL)

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	• Monitors acoustic frequency ranges between 2Hz and 80kHz • Offers large acoustical operational coverage ($>$ 4km^2)
Operation and Maintenance	• 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	• Can be deployed as a stand alone system • Can be integrated into existing surface buoy and submerged mooring platforms • Can be integrated into other instruments • Deployable up to 4,000m water depth
Data Collection	• Adaptive sampling strategy • Real-time classification and quantification of sound • Optimized data storage (>64GB)

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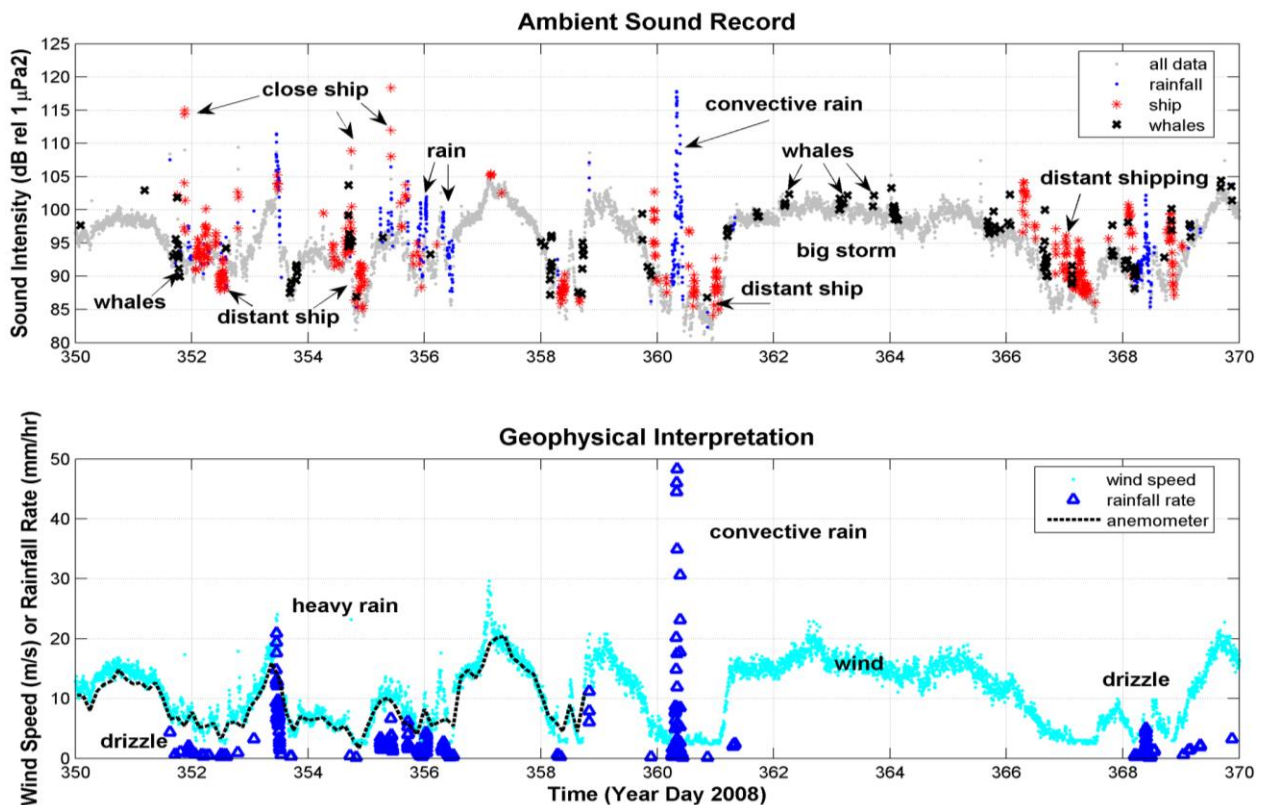
Note: After day 358 the surface anemometer on this mooring failed, but the acoustical wind speed measurement continued.

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