

# USING ACTIVE AND PASSIVE ACOUSTICS TO ASSESS O<sub>2</sub> PRODUCTION OF A POSIDONIA OCEANICA MEADOW

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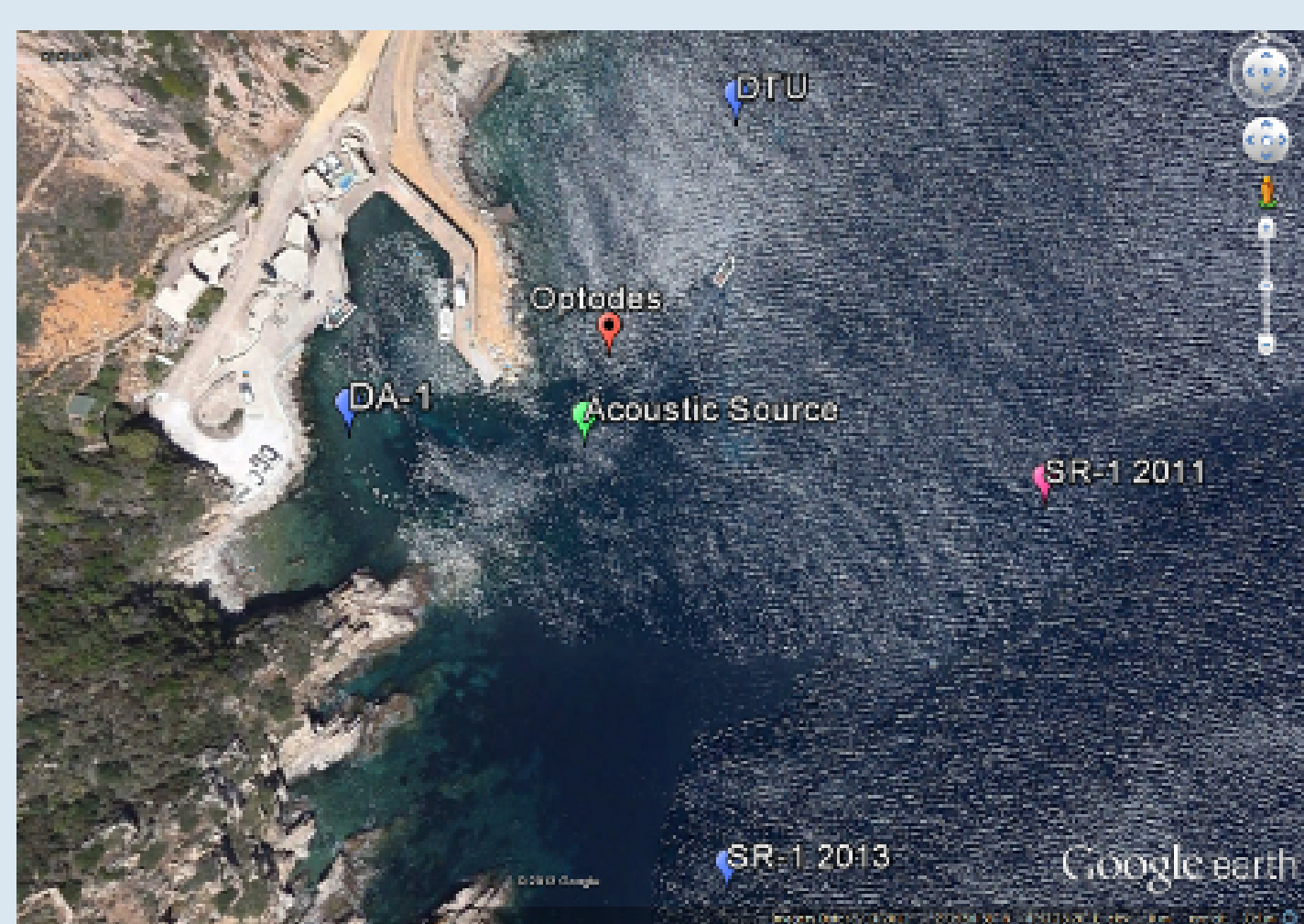
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## Objectives

- to develop a simple (passive) acoustic system to monitor the O<sub>2</sub>-based productivity of a seagrass meadow at the ecosystem level with high time resolution
- to estimate the production of O<sub>2</sub> as bubbles, which is difficult to assess by other methods

## The experiment

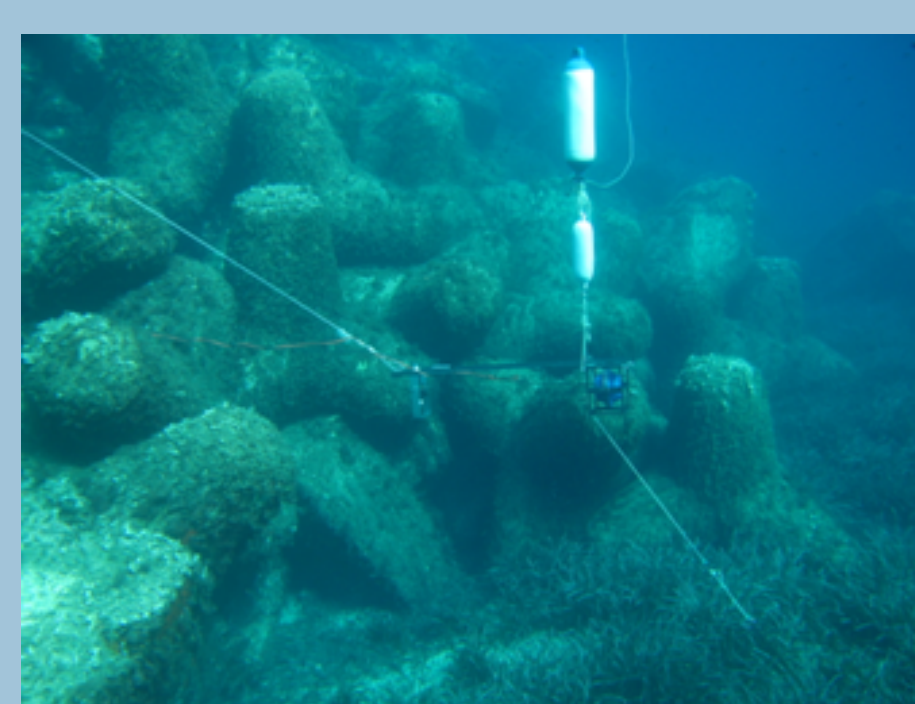


The data were gathered in front of the Station de Recherches Sous-marine et Oceanographiques (STARESO) Calvi, Corsica, over a *Posidonia oceanica* meadow from October 10 to 19, 2011, and from May 9 to 15, 2013.

In both periods, a sound source (**Acoustic Source**) transmitted every 5 min, 2 min long sequences of low frequency signals.

The acoustic signals were recorded by SR1-1 self-recording hydrophones 100 m distant from the source: 3 hydrophones in October 2011 (**SR1-1 2011**) and 2 hydrophones in May 2013 (**SR-1 2013**). Additionally, in May 2013, the acoustic signals were recorded continually (transmissions and environmental noise) by the single-hydrophone (**DA1**) and the 8 hydrophone short array (**DTU**) moored at approximately 50 m from the source.

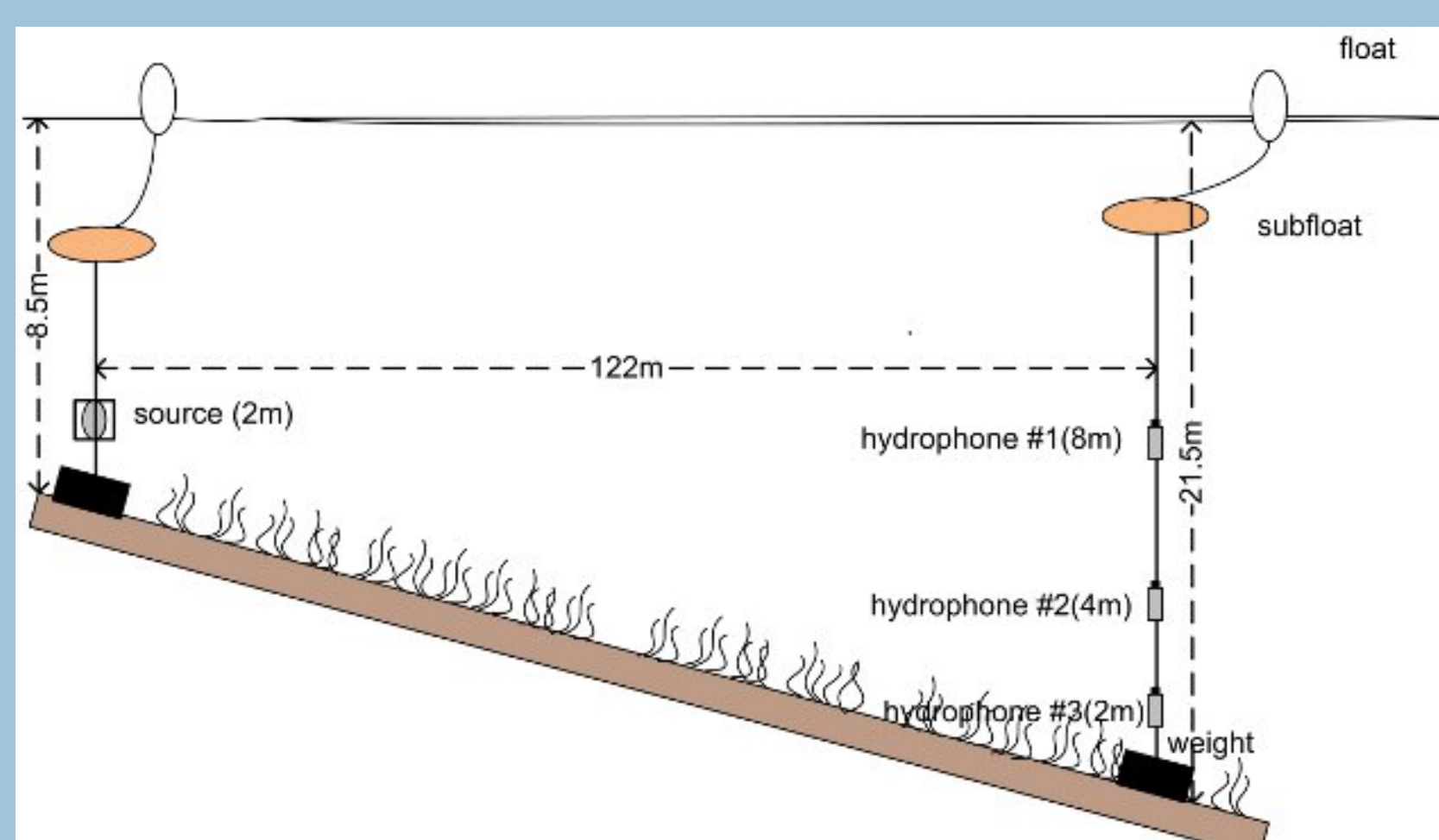
Dissolved O<sub>2</sub> data was acquired hourly at 4.5, 7.0 and 9.5 m depth above the meadow by a 3-optode array (**Optodes**) moored at 10 m depth.



source mooring



SR-1 hydrophones

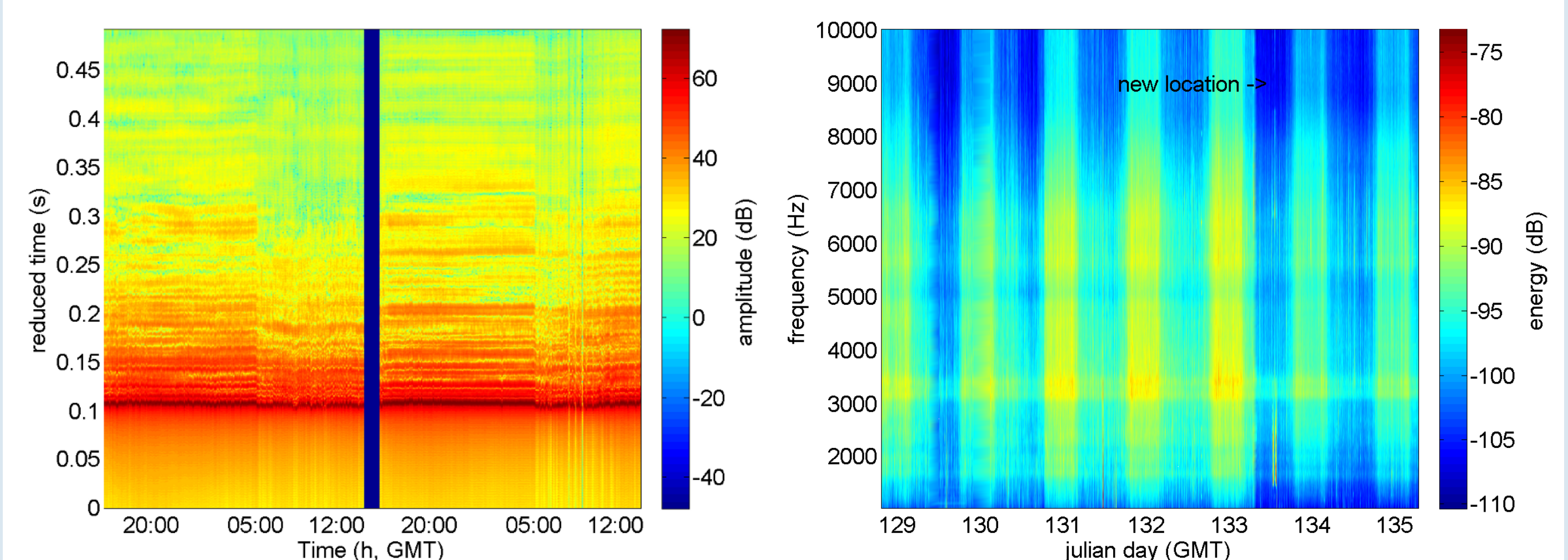


schematic of the moorings

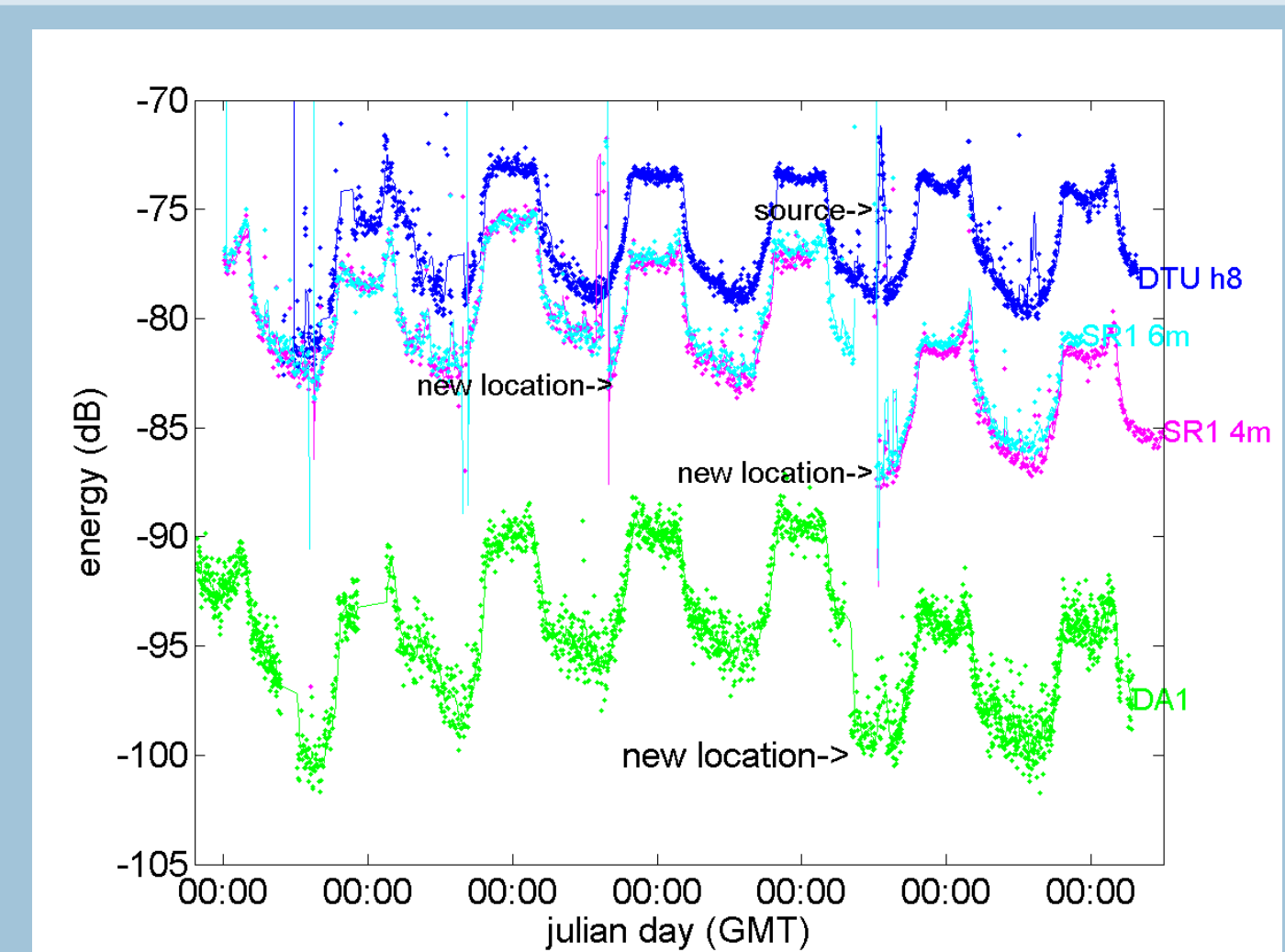
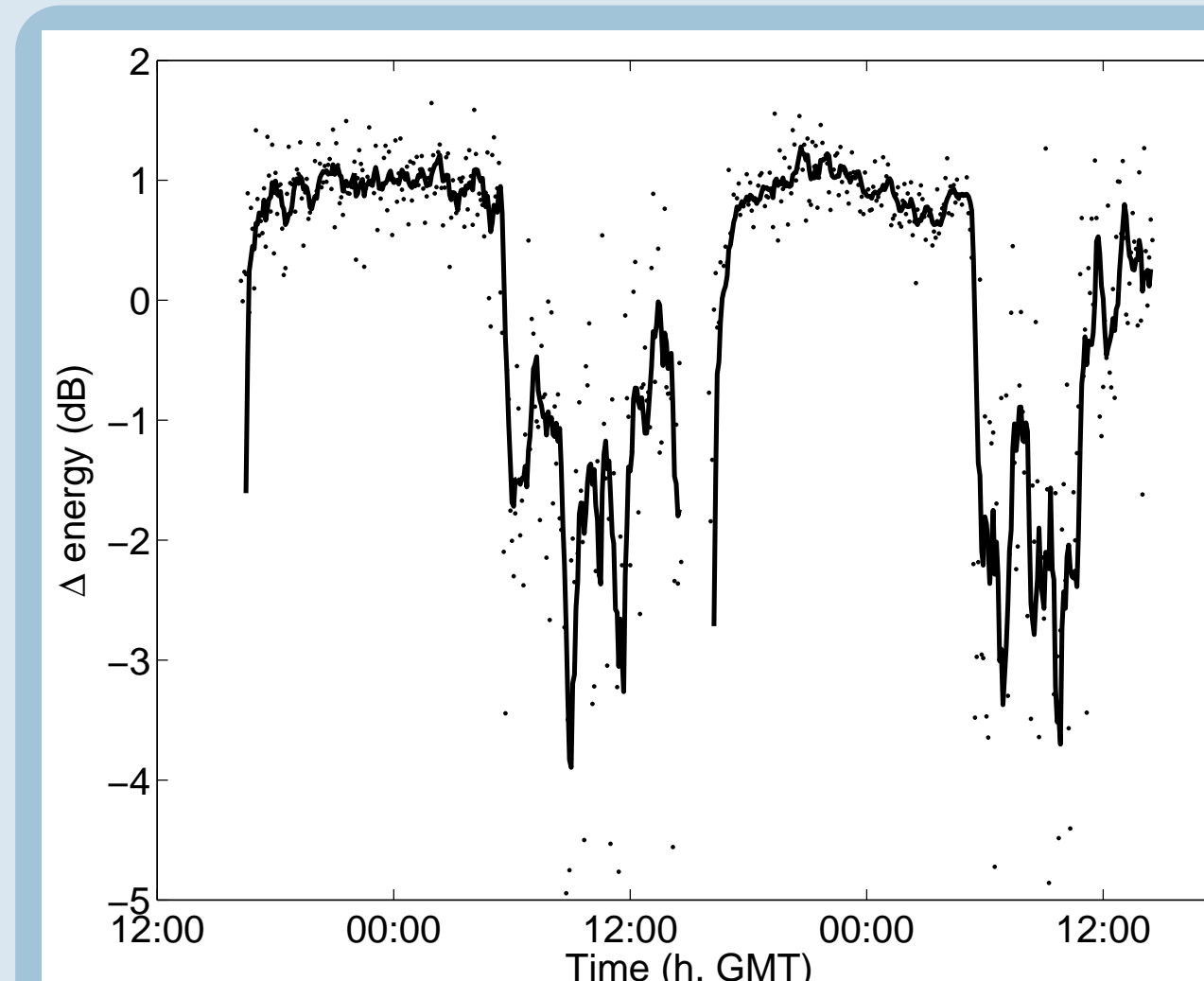
## Conclusions

- O<sub>2</sub> production of a seagrasses give rise to a visible acoustic signature in
  - low frequency signals (< 10 kHz) transmitted through the meadow
  - environmental noise
- changes in acoustic energy were highly correlated with dissolved O<sub>2</sub> measurements
  - the sudden change of acoustic energy at sunrise occurs earlier than the change of dissolved O<sub>2</sub>, what can be ascribed to the formation of O<sub>2</sub> bubbles within plant aerenchymas
- since the amount of O<sub>2</sub> bubbles are not assessed by conventional chemical methods, combining the acoustic method with those methods will allow to obtain more robust, and accurate in situ estimates of the productivity of seagrass meadows

## Experimental results

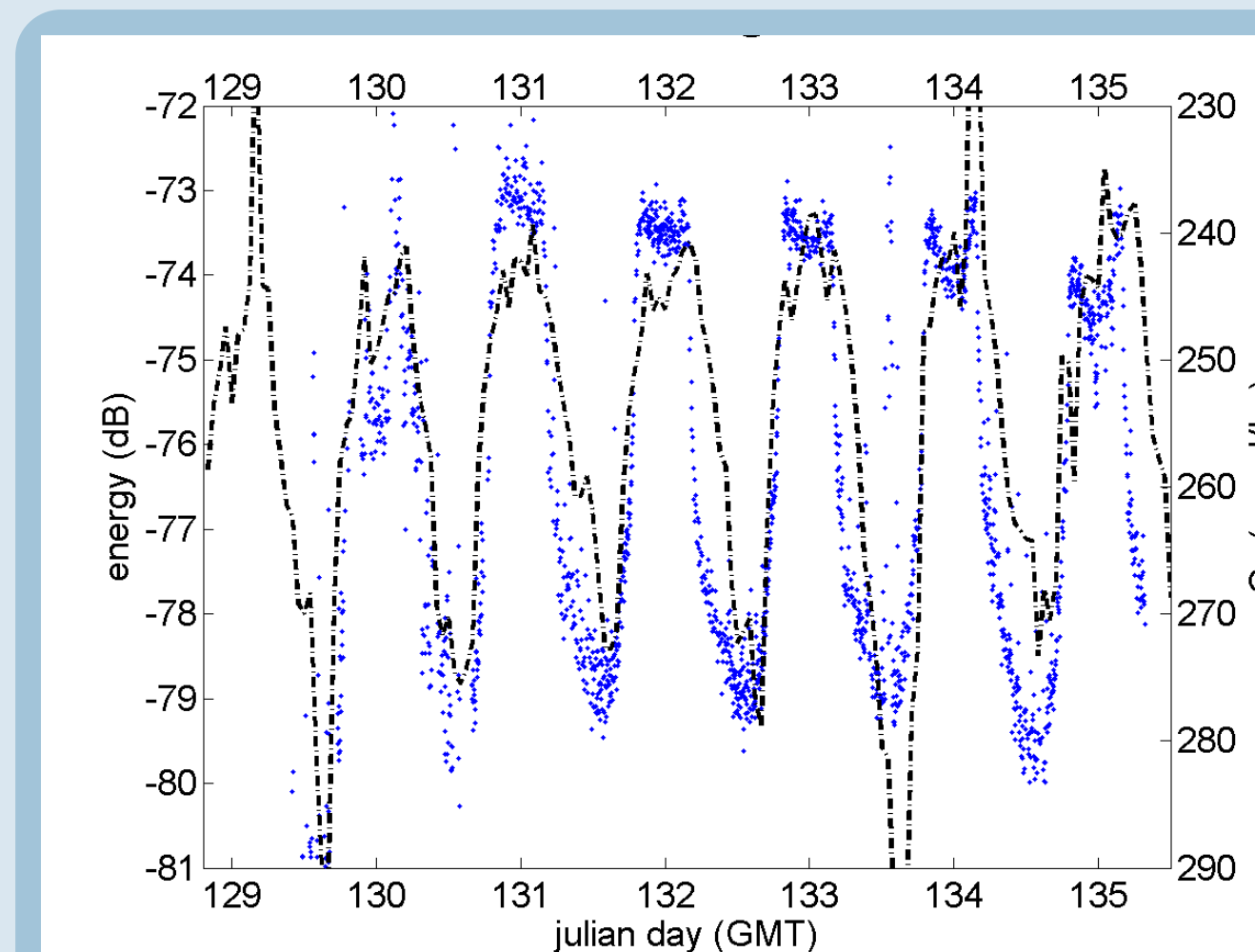


The echoes of the transmitted signals acquired in SR-1 hydrophone and the power spectral density of the environmental noise acquired in DA1 hydrophone were highly attenuated during the daylight period.



The instantaneous (dots) and half-hour moving average (solid lines) received energy from the transmitted signals (left panel) or environmental noise (right panel) show a diurnal pattern, where the energy suddenly decreases at sunrise and increases at sunset.

The magnitude of the variability observed during the period of one week was similar at the various receivers/locations. Due to different system gains and location of the receivers the absolute values changed among hydrophones and/or periods.

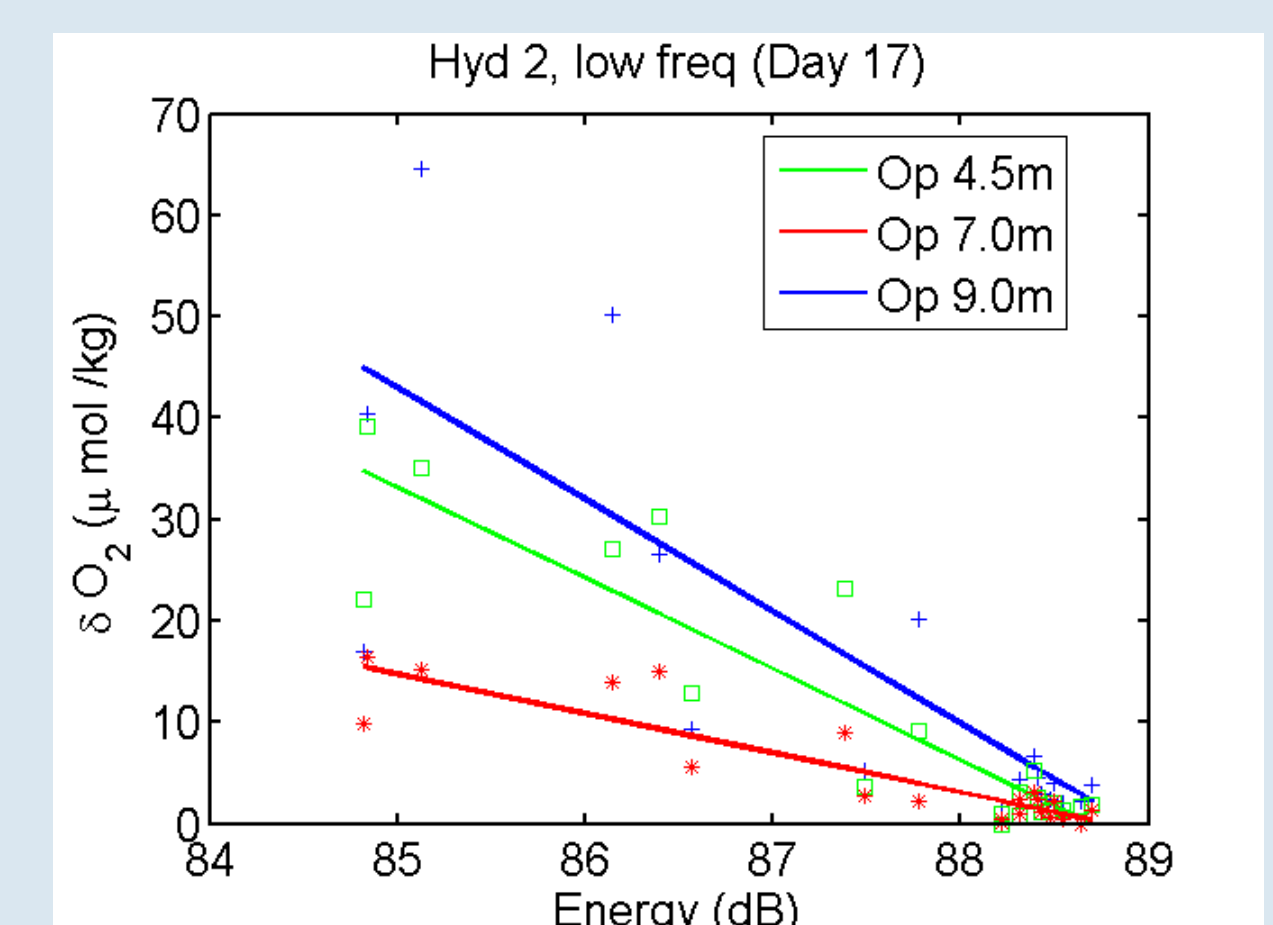


The comparison between the changes in dissolved O<sub>2</sub> and the changes in noise power shows a high correlation.

At sunrise the high gradient of change occurs earlier in acoustic data than in dissolved O<sub>2</sub>, what could suggest that the air in plant tissues (aerenchymas) plays a major role in the acoustic signature of photosynthetic activity.

The relation between changes in acoustic energy and dissolved O<sub>2</sub> was fitted using a linear model. The model parameters were estimated by least square regression at 5% confidence level.

The statistical values,  $P < 0.001$  and  $r^2 > 0.6$ , suggest that the linear model can be accepted.



## Acknowledgments

This work was partially supported by ESF COST Action (ES 0906) Seagrass Productivity: From Genes to Ecosystem Management and FCT projects PEst-OE/EEI/LA0009/2013 and SENSOCEAN (PTDC/EEA-ELC/104561/2008) through national funds.