CORRELATION BETWEEN THE ACOUSTIC NOISE FIELD MEASURED IN A *Posidonia oceanica* BED AND THE PHOTOSYNTHETIC ACTIVITY

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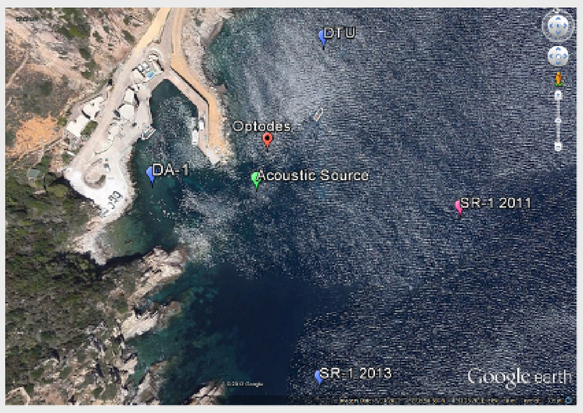
Objectives

Macrophyte ecosystems host high biodiversity and stabilize shore-lines, providing valued ecosystem goods and services. Macrophyte ecosystems are also characterized by intense carbon flows. Yet, little information is available on inter-annual variability of carbon cycling in macrophyte ecosystems that can be driven by climatic forcing, or long-term trends due to various anthropogenic pressures.

This research is a contribution for the development of a low cost passive acoustic system

- to long-term monitor the O_2-based productivity of a seagrass meadow at the ecosystem level with high time resolution
- to estimate the production of O_2 as bubbles, which is difficult to asses by other methods

The experiment

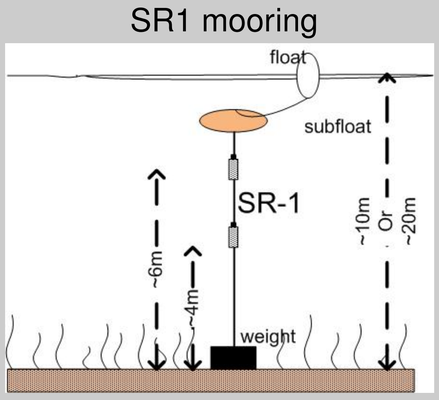


The data were gathered in front of the Station de Recherches Sous-marine et Oceanographiques (STARESO) Calvi, Corsica, over a *Posidonia oceanica* meadow from May 9 to 15, 2013. A sound source (**Acoustic Source**) transmitted 2 min long sequences of low frequency signals followed by a 3 min period of silence. A previous experiment was conducted in the area in October 2011, but the acoustic data was acquired only during transmissions.

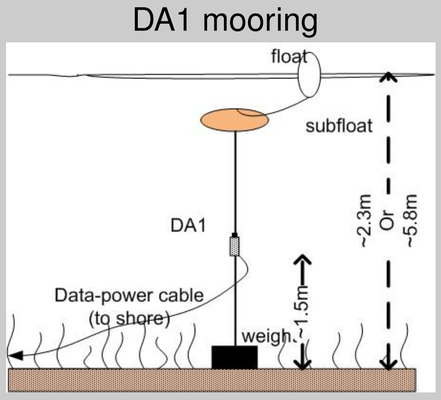
The acoustic signals were recorded by 2 digitalHyd SR1-1 self-recording hydrophones 100 m distant from the source at 10 m water depth location (**SR1-1 2013**) and at a 20 m water depth location (**SR1-1 2011**, same as in October 2011 experiment). Additionally, the acoustic signals were recorded continually (transmissions and environmental noise) by the single-hydrophone (**DA1**) and the 8 hydrophone short array (**DTU**) moored at approximately 50 m from the source.

digitalHyd SR-1 hydrophones

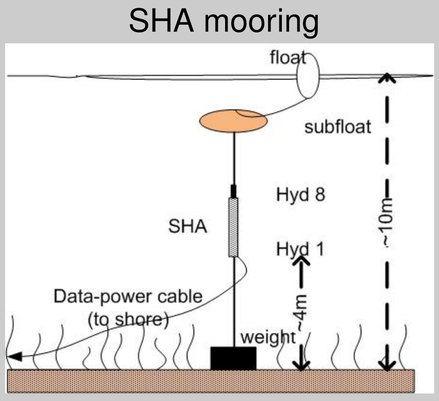
SR1 mooring



DA1 mooring



SHA mooring



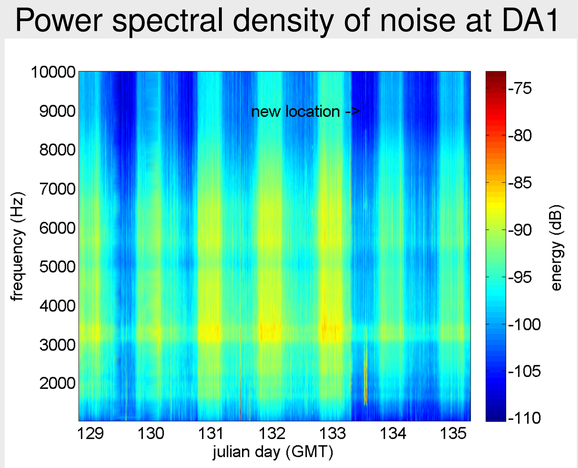
The acoustic data shown herein is environmental noise acquired when the sound was not transmitting.

Dissolved O_2 data was acquired hourly at 4.0 7.0 and 9.5 m depth above the meadow by a 3-optode array (**Optodes**) moored at 10 m depth.

Acknowledgments: This work 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. The authors tank the STARESO team for logistic support.

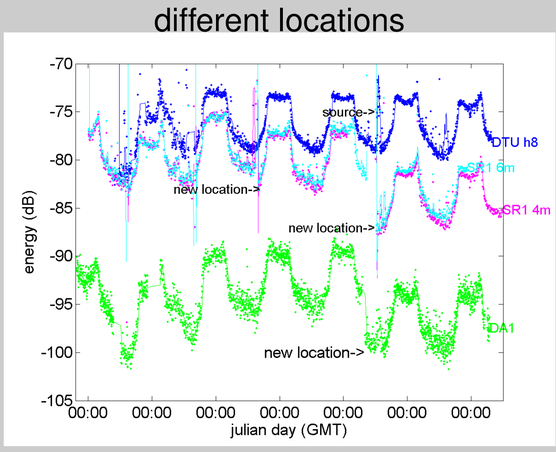
Experimental results

Power spectral density of noise at DA1



Power spectral density analysis of the environmental noise data shows that the noise field in the band 2-7 kHz was dominant at the different locations. The noise in this band is generally associated with wind and surface agitation. However, the noise power was not significantly correlated with wind speed. On the contrary the diel cycle of the noise power was highly correlated with diel cycle of plant's photosynthesis.

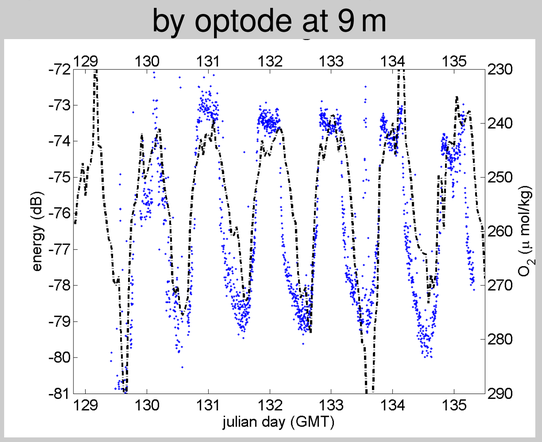
Noise power in the band 2-7 kHz at the different locations



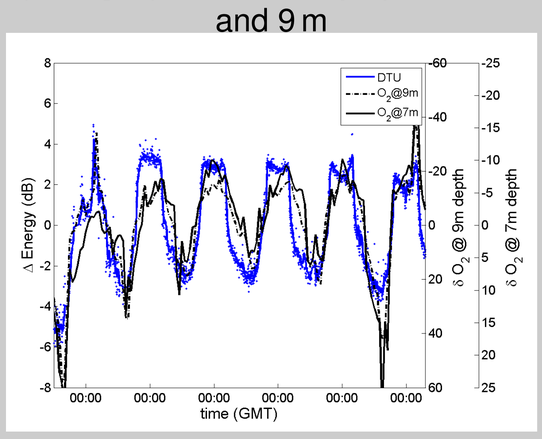
The instantaneous (dots) and half-hour moving average (solid lines) environmental noise power in the band 2-7 kHz show a diurnal pattern, where the energy sudden decreases at sunrise and increases at sunset.

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.

Noise power (changes) at DTU (hyd. 8) vs. O2 (absolute value) measured by optode at 9 m



Noise power (changes) at DTU vs. O2 (changes) measured by optode at 7 and 9 m



The comparison between the changes in dissolved O_2 at 7 and 9 m 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 O2, what could suggest that the air in plant tissues (aerenchymas) plays a major role in the acoustic signature of photosynthetic activity. These measurements of environmental noise have confirmed the correlation between active acoustic signals transmitted through a seagrass meadow and the photosynthetic activity of the plants observed in the October 2011 experiment.

Conclusions

- O_2 production of a seagrasses give rise to a visible acoustic signature in environmental noise
- changes in environmental noise were highly correlated with dissolved O_2 measurements
  - the sudden change of noise power at sunrise occurs earlier than the change of dissolved O_2, what can be ascribed to the formation of O_2 bubbles within plant aerenchymas
- since the amount of O_2 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