Assessing diel cycles of optical properties using high frequency observations from BOUSSOLE: implications for future space missions

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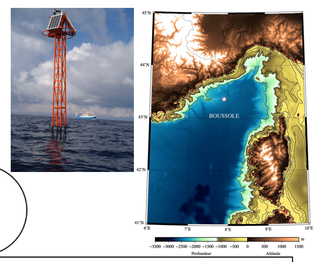
Abstract

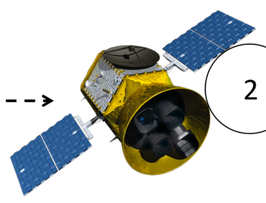
The **study** of the temporal **cycles** of the ocean biomass is one fundamental topic from satellite perspective. It allows to understand its dynamics and to study the ecosystem functioning, and to interconnect specific processes by relating other detectable cycles. Using high frequency observations at Mediterranean BOUSSOLE observation site (collecting ecosystem relevant data from 2011– 2013), a **wavelet analysis** method is used to decompose, describe and estimate the spectral characteristics of optical signals as a function of time. The primary goal of the study is the **identification** of different **period frequencies** (from **diel variability to annual cycle**) and their temporal evolution. Results on fluorescence (Fls) and particulate backscattering (b_{bp}) show three period of high signal of correlation among scales (late autumn, winter and spring), which are interpreted in view of the phytoplankton blooms, of the observed mixing intensity, and of the nutrient and light availability.

Background and objectives



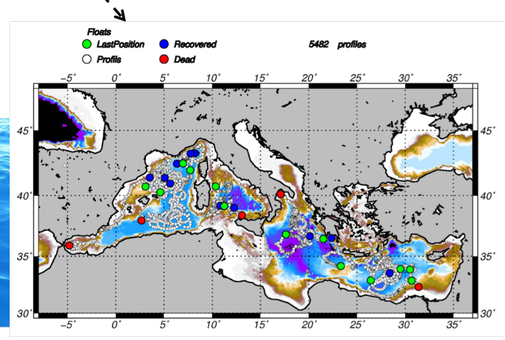
1

A priori wavelet analysis to find the cycle of bio-optical parameters using one or more year of BOUSSOLE data



2

Wavelet analysis using geostationary temporal resolution setting of 1 hour



3

Analysis of the BioArgo vertical profiles in relation to the results found at BOUSSOLE site

4

Comparison of the results found between the different approaches

Data and Method

BOUSSOLE site:

- Since 2003, high frequency observations of **bio-optical parameter** every **15 minutes at 9 meters**

A long term bio-optical time-series

- Hobilabs, HS-IV (442, 488, 555, 620 nm) for particulate backscattering (b_{bp})
- Wetlabs ECOFLNTUs (fluorescence 470ex/695em) for fluorescence (Fls)

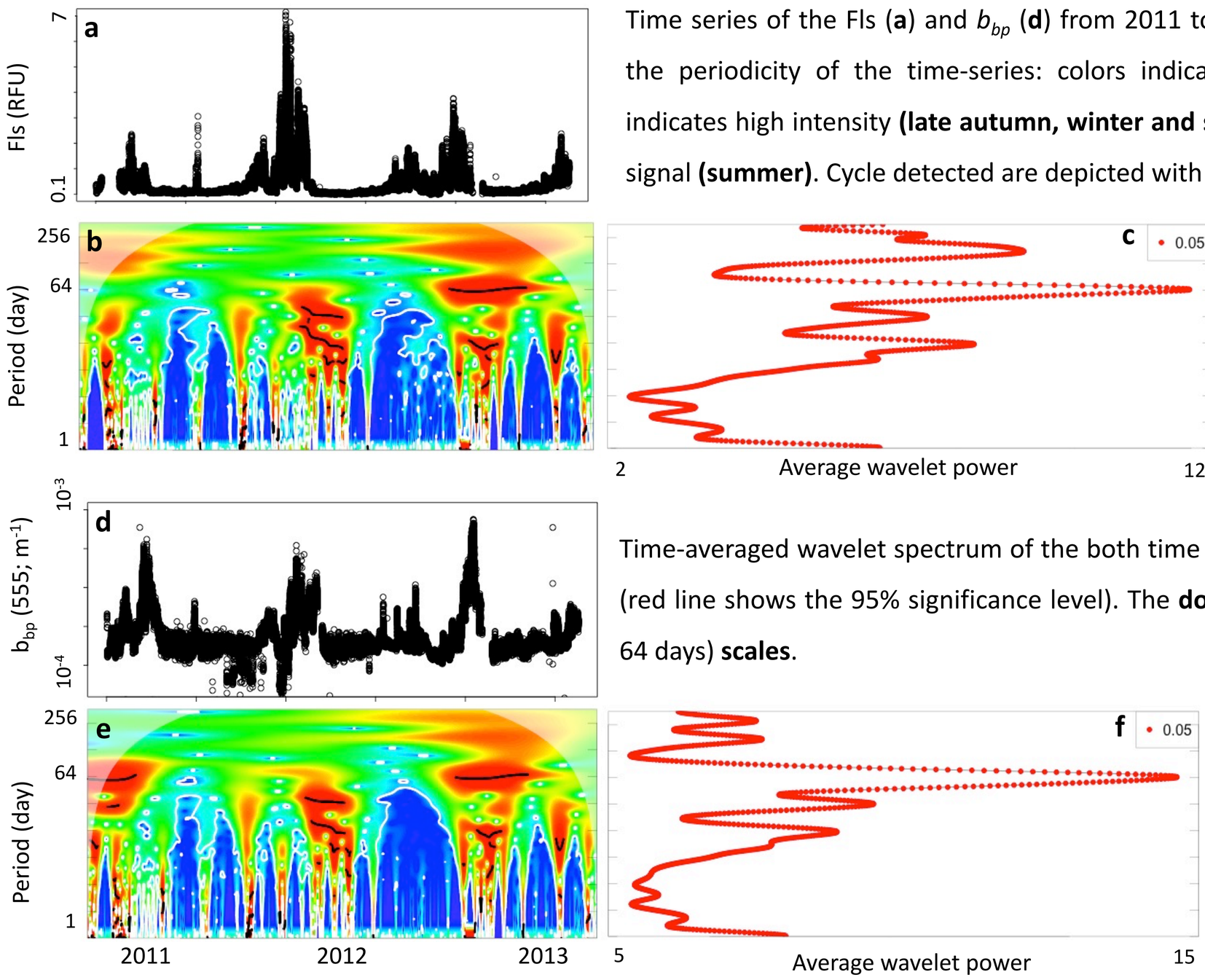
The **wavelet** analysis method performs a time-scale **decomposition of** the **signal** by estimating its spectral characteristics as a function of time

The "Morlet" wavelet:

$$\psi(t) = \pi^{-1/4}\, e^{i\omega t}\, e^{-t^2/2}$$

References: Antoine *et al.* 2008 a,b

Results



Time series of the Fls (**a**) and b_{bp} (**d**) from 2011 to 2013. The wavelet power spectrum (**b, e**) shows the periodicity of the time-series: colors indicate differing degrees of variance. The red color indicates high intensity **(late autumn, winter and spring)** whereas blue indicates low intensity of the signal **(summer)**. Cycle detected are depicted with the black lines.

Shaded area indicates the region of time and frequency affected by the edges of the data and should not be considered; solid white lines are significant (*p*, 0.05) coherent time–frequency regions.

Time-averaged wavelet spectrum of the both time series (**c, f**) showing the dominance of the periods (red line shows the 95% significance level). The **dominant periods are from diel to monthly** (32 and 64 days) **scales**.

The time-averaged spectrum depicts the periods that explain a high proportion of the temporal variance of the series (y-axis) and the recurrence strength of the periods (x-axis).

Future perspectives

Next analysis will be:

- a cross-wavelet analysis to pairs of bio-optical time-series which provides relevant information to identify dependencies in the bio-optical response to environmental impacts on surface water
- a comparison with daily satellite data try to understand which cycles are detected, with the same method, in a geostationary perspective

Acknowledgements

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