The flows of carbon and nutrients in the coastal ocean are disproportionately high in comparison with its surface area; it receives massive inputs of organic matter and nutrients from land, exchanges large amounts of matter and energy with the open ocean across continental slopes and constitutes one of the most biogeochemically active areas of the biosphere. The production, degradation, export and burial of organic matter in coastal waters are generally much higher than in the open ocean. However, the ecosystem metabolic status of the coastal ocean as net autotrophic or net heterotrophic has been the subject of a long lived debate. One of the sources of this debate is the lack of data to fully capture the temporal variability of organic carbon cycling in the highly dynamic coastal ecosystems. Indeed, a recent exhaustive literature review of ecosystem metabolic estimates in European coastal waters did not allow to conclude unambiguously on their trophic status, albeit these are among the more thoroughly studied sites in the world (Gazeau et al. 2004, Estuarine, Coastal and Shelf Science, 66(4): 673-694). Gazeau et al. (2005, Marine Ecology Progress Series, 301, 23-41) reviewed the advantages and caveats of several methods to estimate net ecosystem metabolism (NEP), and recommended the use of integrative mass balance approaches. With the recent development of reliable and accurate oxygen sensors (optodes), NEP can be determined from the temporal O$_2$ change from high temporal resolution moored measurements.

Material and methods

Three Aanderaa Oxygen Optodes (Figures 2 and 4) were deployed on a mooring at 4, 7 and 9 m depth above a Posidonia oceanica seagrass bed (10 m depth) in the Bay of Calvi (red point Figure 1, from Gobert et al. 2001, Hydrobiologia 455, 121-125), outside the Oceanographic Station STARESO. Degree in saturation of oxygen (%O$_2$) and temperature were recorded every 30 mins. An Aanderaa cup anemometer was deployed above the station at 11.8 height, recording wind speed every hours. Wind speed were corrected to 10m height (U$_{10}$) according to Johnson (1999, Coastal Engineering, 39, 263-269). Air-sea O$_2$ fluxes (F$_{O2}$) were computed every hours using the k-wind relationship given by Wanninkhof (1992, Journal of Geophysical Research-Oceans, 97 (C5), 7373-7382). For NEP (with NEP = GPP - R, cf. equations 1 and 2) computations, the water column was divided into 5 boxes (surface-5m, 6m, 7m, 8m and 9 to 10m).

\[
1) \text{GPP} = \sum ([O_{2}]_{n} - [O_{2}]_{d}) + R \times F_{O2}
\]

\[
2) \text{R} = \sum ([O_{2}]_{n} - [O_{2}]_{d}) \times 24 - F_{O2}
\]

With n and d referring to night and day hours (H), w to the whole water column, F$_{O2}$ and F$_{O2}$ to air-sea O$_2$ fluxes over respectively the night and day, R$_{a}$ to respiration during daytime, [O$_2$] is the concentration of oxygen in the whole water column.

Results and Discussion

Figures 3 show results from U$_{10}$, seawater temperature and %O$_2$ at the 3 depths. Water column was generally well-mixed and seawater temperature declined from summer (28°C) to winter (14°C). Over a short period (grey cross), a slight thermal stratification was observed during low wind speed event. Consecutive to North-East wind speeds, offshore waters (characterized by lower temperature) were introduced to the system, as noticed in the drop of the seawater temperature (red crosses) and a transient thermal stratification. Daily %O$_2$ signal, associated to light availability, was well captured in the data sets showing highest %O$_2$ and daily signals (%O$_2$ increase during day and decrease at night) at 9m depth consistent with the biological activities effect of the P. oceanica on the water column. Daily and seasonal signals of %O$_2$ dropped from summer to January, before increasing again in February, related to biological activities of the seagrass meadow.

This is consistent with results from Figure 5 on the NEP computations in the water column averaged over a month. Over the studied period the system was autotrophic with highest values in August (9 mmol O$_2$ m$^{-2}$ d$^{-1}$). The system tends toward heterotrophy (-3 mmol O$_2$ m$^{-2}$ d$^{-1}$) during fall-winter whereas production showed an increase around February (3 mmol O$_2$ m$^{-2}$ d$^{-1}$). The GPP was significantly well correlated with the respiration. Overall NEP values were consistent with the results from Barron et al. (2006, Estuaries and Coasts, 29 (3), 417-426) from O$_2$ measurements in incubation chambers methods in the Magalluf Bay (Mallorca Island, Spain).

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Preliminary results of continuous oxygen measurements above a Posidonia oceanica seagrass bed in the Bay of Calvi (Corsica)

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