PRELIMINARY EXPERIMENTS TOWARDS CONTROLLING BIOFOULING EFFECTS ON THE M3A ARRAY'S OPTICAL INSTRUMENTS

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Abstract

For the needs of the EU MFSTEP project, and based on the experience gathered during its previous phase, various experiments have been planned to prevent biofouling of the optical instruments on the Mediterranean Moored Multi-sensor Array (M3A). Although the system, when operational, is deployed in oligotrophic open sea waters 22 N.M. north of the port of Iraklion Crete, severe fouling prevented the proper functioning of the optical sensors and sources after 30 days of deployment. These experiments are still underway, however, emerging initial results from a 50 day deployment in coastal waters, indicate that the introduction of a bromine canister and copper tubing in the flow system can result in almost fouling free instruments.

Keywords: marine optics, marine growth, operational oceanography, optical oceanography

Introduction

New trends in ocean observation approaches demand the deployment of moored instruments for large periods of time. Important processes such as ecological can be monitored by sensing various properties of the visible light field within the water column (both inherent and apparent). This is accomplished by means of optical sensors and sources, which however, tend to be severely affected by marine biofouling [1]. Such problem was encountered during the first stage of the Mediterranean Forecasting System project (MFS-PP) [2], and in particular for the optical instruments attached on the M3A array [3]. Thus, for the second phase of MFS, the MFSTEP, a special task was introduced in order to assess and mitigate this negative aspect.

Data and methods

The location of the experimental deployment was the protected surroundings of a fish-farm situated off the islet of Patroklos in Saronikos Gulf, Greece. It was chosen so having in mind the minimization of the deployment period since the waste of the farm results in relatively eutrophic waters.

The instruments deployed were four SBE-16s having the following optical sensors attached:

1. PAR sensors (model 193SA manufactured by LI-COR).
2. Fluorometers (WETSTAR by Wetlabs)
3. Transmissometers (C-star by Wetlabs) at 660 nm with a 25 cm path length.

In the current configuration, the PAR sensors are open (to the surrounding water column) while the fluorometers and transmissometers are closed by means of tubing and pump.

The experiment was set as follows: For the open instruments no particular action to prevent biofouling was taken. For the rest of the sensors four different configurations were deployed (no protection, copper, bromine, combination of both). The copper configuration simply included replacement of 10 cm of plastic tubing adjacent to the fluorometer and transmissometer with copper tubing (∅ 10 mm) of similar length. The bromine system included a vented canister, [4], with bromine tablets attached between the fluorometer and the transmissometer and above them, in order to slowly and constantly release bromine solution through diffusion towards both sensors. To avoid erroneous readings all sensors were flushed for 15 seconds prior to taking a measurement. The sampling interval was set to 1 h.

For the fluorometers, both pre-deployment and post-deployment calibration was performed. It was based on five samples of local phytoplankton populations which were nutrient-enriched and cultured for about 10 days to attain discrete chl-a concentration values. After a 15 minute sampling by the fluorescence sensors, a reference value was estimated by extracting phytoplankton by means of filtering and measuring its chl-α concentration with a TURNER AU-10 laboratory fluorometer.

Transmissometers were post deployment calibrated by obtaining several voltage readings after blocking the receiver to obtain (v_{dark}) and in de-ionized water to obtain a clean water offset (v_{ref}).

Results and discussion

The instruments were recovered after 50 days of deployment when scuba divers observed excessive external biofouling build up.

Inter comparison of PAR and incoming solar radiation time series after the removal of the daily cycle, showed a decrease of sensitivity in the order of 40% in 50 days with an accelerating trend towards the end of the deployment period.

The fluormeters recorded no obvious increase in chlorophyll-α concentration despite there external build up of organisms. Only the one with no antifoulant protection showed an increasing trend towards the end of the deployment. It should be noted here that the concentration as measured from bottle data was low and ranged from 0.06 to 0.09 μg/lt.

The transmissometers' records exhibited an exponential increase in all configurations with no bromine canister, indicative of optical window contamination. The one with the least bio-fouling was that which incorporated both copper tubing and bromine solution (see Figure 1). This was in contrast to the results reported elsewhere [1], where copper alone was sufficient.

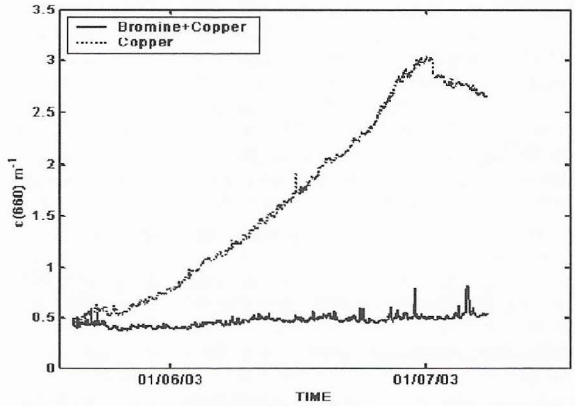

Fig. 1. Time series of c(660) (m^{-1}) beam attenuation coefficients for two characteristic configurations. Solid line corresponds to the one with bromine canister and copper tubing and the dashed line to that with only copper tubing.

A follow up experiment is planned either with a longer deployment period or during the spring bloom, so a better assessment of the fouling conditions on the fluorometers is achieved. Moreover additional steps will be taken towards protecting the open PAR instruments (i.e. copper collars).

References

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