DEVELOPMENT OF AN AUTONOMOUS SYSTEM FOR INTEGRATED MARINE MONITORING

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Abstract

Increasing our understanding of the complex exchange among processes throughout ocean basins is severely limited by the paucity of infrastructures able to support sustained and interactive observations of the biological, chemical, physical, atmospheric and geological processes. Because all these processes interact in the ocean in complex ways, promoting a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation. In this work we are developing an autonomous system for integrated marine chemical, physical and biological monitoring – MarinEye. This system combine high-resolution imaging, acoustic, sonar, fraction filtration systems and sensors technologies in a modular, compact system that can be deployed on fixed and mobile platforms.

Keywords: Biodiversity, Chemical analysis, Bacteria, Monitoring, Mediterranean Sea

Marine organisms exert tremendous power over the planet, and linking the organisms to their environments by monitoring biological variables with contextualized environmental data (physical-chemical variables) is essential to evaluate the environmental status of marine ecosystems. While ocean observation technologies and programs have made considerable progress in advancing physical and chemical observing systems, bio-geochemical and biological monitoring is still under-represented and poorly implemented on ocean observatories (Barnes et al. 2007, Moloney et al. 2012). Thus, the present work addresses the urgent needs to provide regular monitoring of oceanic ecosystem function at the biological level, by developing an autonomous system for integrated marine chemical and biological monitoring. This device will provide key data to respond to time sensitive environmental issues. This is fundamental for accurately assess the health of marine ecosystems, necessary to protect more efficiently and promote sustainable management of marine resources. Also, such integrated data will promote the implementation of adaptative management approaches, as the EU Marine Strategy Framework Directive (MSFD, European Commission 2008), allowing the development of marine strategies for the continuous assessment of the environmental status of marine waters and the achievement and maintenance of the good environmental status (GES). The autonomous monitoring system consists of several modules, each particularly conceived to a specific oceanic compartment. One of the modules is a multi-sensor system that composed by different physico-chemical sensors, to measure temperature, salinity, dissolved oxygen and pH. This module also includes a novel optoelectronic sensor platform adapted and validated with dissolved CO_2 sensing layers envisaging further development and a new self-referencing mechanism for external light and biofouling. This modular multi-sensor system allows the collection of essential environmental physical and chemical data. MarinEye also integrates an underwater high-resolution imaging system to record plankton organisms targeting the main groups of phyto- and zooplankton. A third module is equipped with an active sonar system and an hydrophone for hydroacoustic surveys, to provide information about the presence of marine mammals as well as an estimation of fish abundance and schooling behavior. In addition, MarinEye harbours a forth module, an autonomous biological sampling device, specially designed for filtering and preserving two distinct biological size-classes of plankton species (including unicellular Eukaryotes and Prokaryotes). The genomes of these communities will be further examined (at DNA and/or RNA level) generating a multitude of data on species occurrence and function, providing an in deep understanding on the players of fundamental ocean processes responsible for maintenance of the global ocean balance. Thus, the autonomous monitoring system that is being developed combines a range of technologies capable of providing data that gives an integrated view of the different compartments of the ocean (physical, chemical, biological) at different levels of knowledge (from genomics to biogeochemistry and from micro to macro community dynamics) but synchronized in time and space. The capability to simultaneously monitor biological, chemical and physical data provides the ability to answer questions about how organisms interact with their environment and with each other, and how these interactions influence the overall ecosystem stability. MarinEye also includes a centralized data base infra-structure that will aggregate all the diverse data sources (physical, chemical, biological) collected by the different modules. This data base feeds a platform of data visualization and summarization that can provide synthetic summaries of the main events of the system in order to simplify data analysis. Moreover, the platform also implements several modelling tools that have as main goal to uncover unsuspected and useful patterns that may exist on the physico-chemical and biological data sets generated. The development of the proposed autonomous monitoring system capable of acquiring biological, physical and chemical data at the same spatio-temporal resolution will represent a great advance in integrated ocean data generation with an important impact in monitoring and measurements programs, which will certainly contribute to the maintenance of the Long Term Ecological Research (Caroppo et al. 2013), deepen the knowledge of the community response and helping deriving accurate multimetric indicators to assess the environmental status of marine ecosystems (Racault et al. 2014).

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