

In-situ testing of innovative marine instrumentation for nutrients, heavy metals and pH in Kongsfjorden, Svalbard Islands

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Abstract

Marine ecosystems are integral part of fundamental environmental functions that support life on Earth like climate control, erosion prevention and absorption of carbon dioxide. Oceans contribute to economical activities too with the following prosperity, social welfare, and increase in life quality. Nevertheless, several marine environments also in the European framework show increasing challenges to tackle like the loss of biodiversity and habitats, pollution and impacts due to climate change. For Italy and for Europe a growing environmental interest and awareness in both the public and private sectors is combined with a common strategic goal to ensure sustainable development and the continuity of economic activities. In order to achieve this goal and to improve the competitiveness of Italy and the EU, new technologies and methods for monitoring the marine environment are required.

In the framework of the COMMON SENSE project (Cleary et al., 2014; Ribotti et al., 2015), funded by the VII EU F.P. (2013–2017; <http://www.commonsenseproject.eu/>), the activities planned at the CNR Arctic base in Ny-Ålesund were intended to support the implementation of the Marine Strategy Framework Directive (MSFD) and other European policies such as the Common Fisheries Policy (CFP), providing innovative sensors, low price, multi-functional, easy to use through various platforms for measures in-situ reliable key parameters. This was realized thanks to a multidisciplinary European consortium, well balanced between industry and research. This proposal focuses on some descriptors of the MSFD, using sensors for the monitoring of nutrients, pH, contaminants, microplastic and underwater noise. The developed sensors are tested on different platforms, fixed or floating, surface or underwater, in all European seas including the Arctic.

In the framework of the Common Sense testing activities four daily cruises have been realized in the second half of June 2016 in the Kongsfjorden. Then the cruises were also the opportunities to update hydrological data at stations acquired in the previous month (May) and planned again for the end of July 2016 but just for hydrology.



Figure 1: The nutrient sensor by DCU

One of sensors tested at the Arctic base has been that for nutrients developed at Dublin City University (Ireland; in figure 1). The nutrient sensor is based on a combination of microfluidic analytical systems, chemical colorimetric reagents and optical detection using a low-cost LED. The precompetitive prototype nutrient sensor has been previously and successfully tested on board the R/V Minerva Uno in November 2015 for the detection of nutrients such as phosphate, nitrate and nitrite. During system testing in Svalbard over 180 water samples were collected using Niskin bottles in different stations from the boat along the Kongsfjorden, at different depths from the surface to the bottom (usually surface, mid depth and bottom).



Figure 2: The pH sensor by Ddropsens

A second sensor used in Ny-Ålesund has been tested to measure the pH (see figure 2) developed by the Spanish Ddropsens S.L.. A simple and direct control of pH in sea water samples can be done using Zero Current Potential technique combined with screen printing antimony electrodes. Measuring the difference of potential between reference and working electrode, the calibration of the pH vs. E(V) remains linear over the range 2 – 10.9 (Britton- Robinson 0.1 M solution, $r^2 > 0.99$) with a reproducibility between same pH values $\leq 4\%$. The sensor has been recently positively tested in Oristano. Over 29 water samples have been acquired along the fjord and subsequently analyzed in the laboratory in the CNR "Dirigibile Italia" base in Ny-Alesund. At the same stations CTD profiles with commercial pH sensor has acquired data for intercomparison. This has permitted to make a good evaluation on the quality of the sensor.

Finally, the third sensor was an autonomous system for "in situ" analysis of heavy metals Pb, Cd, Cu and Hg, which was also tested a first time in November 2015 aboard the R/V Minerva Uno. The system includes a microfluidic chip for complete mixing of the buffer and sample, a potentiostat to perform electrochemical measurement, two peristaltic pumps to control the fluidic pathway through the system, a wall-jet flow cell which incorporates the screen printed electrode (carbon-bismuth; see Niu et al., 2016; Barton et al., 2016). Testing onboard the Minerva Uno tests showed some issues with the pre-competitive prototype that were addressed prior final sensor testing in the Arctic. Over 50 water samples were taken in the fjord for the measurement of lead, mercury, cadmium and copper.

The expected results, that should be soon available, are to obtain a series of data able primarily to provide valid information on the quality of manufactured sensors and then on the state of the Arctic environment specifically in the fjord of the base of Ny-Ålesund.

Acknowledgments We gratefully acknowledge funding received from the European Union's Seventh Framework Programme (FP7) for research, technological development and demonstration (OCEAN 2013.2) under grant agreement No. 614155.

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