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DEPLOYMENT OF NEW OBSERVING SYSTEMS WITHIN THE JERICO-RI

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Abstract

A key message of the JERICO-RI consortium (2014): "The complexity of the coastal ocean cannot be well understood if interconnection between physics, biogeochemistry and biology is not guaranteed. Such integration requires new technological developments allowing continuous monitoring of a larger set of parameters". In agreement with this consideration, several new observing systems are developed, tested and deployed in the framework of the JERICO-NEXT H2020 project, amongst which a few of them will be presented as well as some preliminary results after the first deployments. Focus will be given on coastal transports and hydrology and on benthic biodiversity. In the first case, we will present a low cost 2D moored system dedicated to acquire vertical temperature profiles in shallow waters and its application to study the high frequency hydrodynamics. In addition, during one of the campaigns foreseen for testing these new systems in an area covered by HF radar, hydrographic and current measurements in the water column, together with phytoplankton and plastic sampling, were conducted. In the second case, attention will be drawn on a new floating pulled system dedicated to observe benthic habitat without disturbing it.

Keywords: JERICO, JERICO-NEXT, Coastal, Ocean Observing System (OOS), Harmonization

1. JERICO-RI: A European Research Infrastructure for coastal observation

1.1 Context and objectives

The past developments of various coastal observation systems in European countries are difficult to sustain on long term in the context of economic restriction and despite the growing need for coastal integrated monitoring. Indeed, most of the existing observation systems were developed and deployed to answer specific purposes according to the scientific interest of the involved institutions or research teams, often leading to the implementation of systems and actions in reduced places and times without efficient enough concertation. Moreover, wishing to sustain observations on long term for monitoring and observations purposes, institutes and states face difficulties to engage means without a clear enough vision on the science and socio-economy strategy behind the observing systems. These considerations drove the coastal community to gather efforts since 2010 towards the harmonization of the existing systems in a European recognised research infrastructure dedicated to the coastal observation: the JERICO-RI (www.jerico-ri.eu). Consequently, was born the first phase JERICO-FP7 project, co-funded by European Commission from 2011 to 2015, as described by Farcy *et al.* (2017).

Although significant progress has been achieved, the way toward an harmonised pan european infrastructure capable to answer science needs and societo-policy requirements is long. The first phase project was dedicated to start with the easiest but important systems, it gathered and harmonised some existing automated and semi-automated systems including the so-called Fixed platforms, Ferryboxes and Gliders. Being aware of the preliminary nature of this work, the FP7 consortium concluded in 2014 *"The complexity of the coastal ocean cannot be well understood if interconnection between physics, biogeochemistry and biology is not guaranteed. Such integration requires new technological developments allowing continuous monitoring of a larger set of parameters"*. This premise was the main idea behind the successful JERICO-NEXT proposal for co-funding in the H2020 programme between 2015 and 2019 under the grant agreement 654410. JERICO-NEXT gathers a consortium of 34 partners under the coordination of Ifremer.

Now, the JERICO-RI is integrating additional platform types such as drifters, HF radars, coastal cabled observatories along with the associated technologies dedicated to observe and monitor coastal European seas. Overall, emphasis is given on a better integration of the physics with the biogeochemistry and the biology and this is reflected in the main objectives of the JERICO-NEXT project:

- Strengthening a solid European network and promoting the infrastructure toward several kinds of users;
- Integrating key observing platforms, and harmonisation from the sensors to the data flow;
- Developing further the collection of biological data;
- Defining scientific strategies based on science integration;
- Proposing legal and economical frames for the sustainability of the infrastructure.

1.2 Scientific priorities and organisation

The will of a better integration has been deeply applied in the project definition thanks to the implementation of six specific scientific priorities, derived along and across the workflows. The ultimate objective behind this objective is to establish a strategy that stems from scientific and societal issues to their technological implementation. Threats and pressure to coastal areas are increasing; would it refer to increase in coastal population, degradation of coastal habitats, increased pollution and greater demand for non-living resources. In response to this, the six scientific priorities are: I) The pelagic biodiversity, II) The benthic biodiversity, III) The chemical contaminant occurrence, and related biological responses, IV) The coastal ocean hydrography and transports, V) The carbon fluxes and carbonate systems, VI) The operational oceanography.
These are specifically addressed with the development of technologies and methods in a technology work package, and also in 6 so-called Joint Research Activity Projects (JRAPs). These JRAPs are dedicated to apply and improve these developments thanks to a feedback after deployment and to support and improve the definition of science strategies according to the 6 priorities. The purpose of this document is to give a short overview on two of them: the here above referred scientific priorities II) and IV).

2. Science and some new observing systems in JERICO-NEXT

Several important achievements have been obtained from the beginning of JERICO-NEXT project. Although most of the work is still in progress, the main preliminary results are presented here in an attempt to illustrate how these research activities will help to identify new and strategic technologies to be implemented in the next generation of European coastal observatories.

2.1 Benthic Biodiversity and habitats

A new towed underwater video system (TUVS), called 'Pagure-2', has been developed by Ifremer in the context of JERICO-NEXT JRAP2, to map habitats, describe biodiversity and monitor ecological changes in benthic ecosystems. The technical objective of this task was to modify an existing system ('Pagure') in order to expand the range of accessible benthic habitats, to get more stable footage on irregular and hard bottoms, and to investigate fragile ecosystems (e.g., marine protected areas) where impact has to be limited. Thus, we proposed the Pagure-2 as a more versatile system that could be deployed either on a classical 'sledge' mode or on a 'flying' mode that reduces contact with the sea floor.

This tool is easily deployable on small (~25 m) coastal vessels as well as large research vessels and was designed to cope with a 10-500m operating depth range and with all kind of sea conditions and currents. It is also simple to use opportunistically on different kind of scientific cruises (benthic survey, fisheries stock assessment, hydrology, etc…) and without any dedicated specialist staff. The Pagure-2 supports a new buoyancy system (10 independent syntactic foam-modules) that significantly reduces its weight in water and two easily removable skates (Fig. 1a). This strategy allows deploying the system on a classical 'sledge' mode (with skates) or a 'flying' mode (without skates, but with 4 weights to adjust the distance to the bottom) (Fig. 1b).

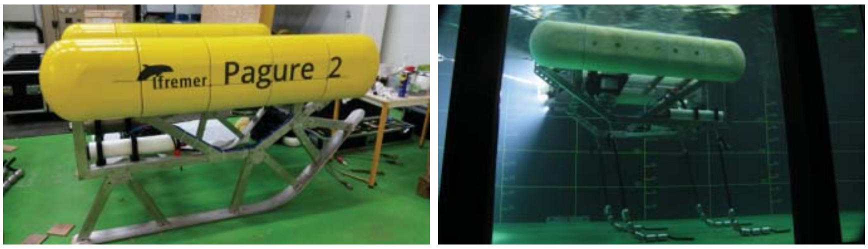
(a)  (b)

Fig. 1. View of the Pagure-2 on 'sledge' mode with its skates (a) and on 'flying' mode with flexible weights (b). (© Ifremer, J.V. Facq).

An HD video camera, positioned in front at angle of 35°, can capture biodiversity data (visible mega- and macro-epibenthic organisms; flora, invertebrates and fish) and information on the physical characteristic of the visited benthic habitat (nature of bottom; anthropogenic footprints). Two laser pointers allow estimating the size of the identified organisms. A vertical still camera offers an even better resolution and is a complementary sensor to assess the density, coverage, size and ecological state (alive vs. dead) of the most frequent encountered taxa. The steel-frame of the TUVS has been designed to integrate 10 kg of additional sensors in order to measure important environmental parameters like bottom temperature and salinity (which can be very different from the surface layer in circumlittoral areas), oxygen, chlorophyll-a and turbidity). This could help to better characterize the ecological status of visited benthic habitats.

The development of the Pagure-2 will allow more comprehensive insights into the integrity of benthic habitats and will be relevant to investigate areas adversely affected by human activities (e.g., bottom-trawling, sand-mining, marine renewable energy development).

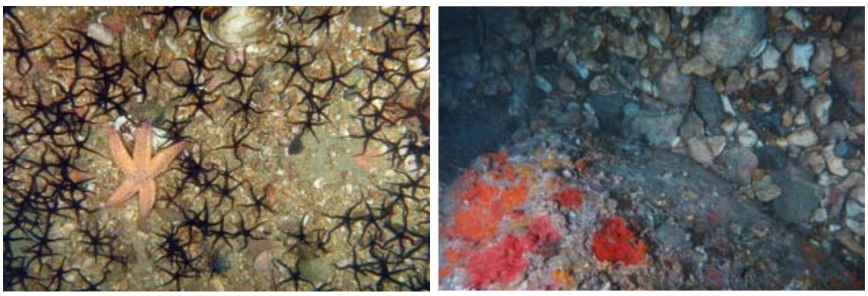
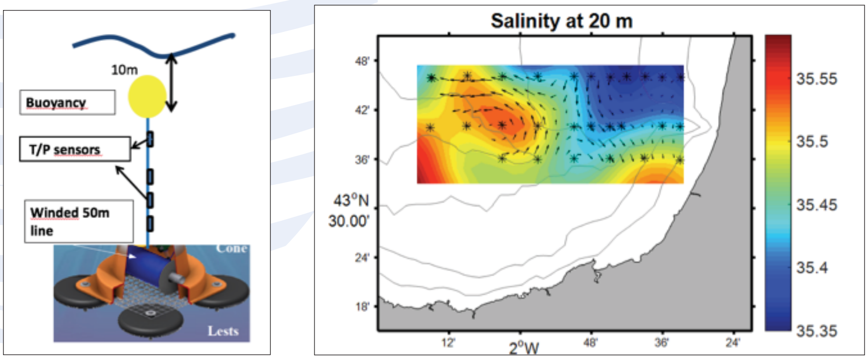
(a)  (b)

Fig. 2. Examples of still images taken with the vertical camera ('sledge' deployment mode) during the Pagure-Next cruise in the Bay of Brest, showing the quality obtained on various benthic habitats: heterogeneous muddy a) and pebbles b) (© Ifremer, 2016). and on 'flying' mode with flexible weights (b). (© Ifremer, J.V. Facq).

2.2 Coastal ocean hydrodynamics and transports

Surface transport at coastal areas is driven by a large variety of processes (tides, current instabilities, coastal jets, eddies, fronts…) acting simultaneously, in response to different forcing and over a broad spectrum of time-space scales. These processes play a key role in the dispersal/retention of pollutants, planktonic species (potentially toxic), and more generally in cross-shelf exchanges. The characterization and better predictability of these processes and the associated transport along the water column is critical to understand the physical/biological coupling in the coastal zone and to ensure the effective management of coastal areas, where the use of the marine space is concentrated.

Two important achievements were driven in this context thanks to JERICO-NEXT: a technological development, the MASTODON-2D, to study higher frequency phenomena such as internal waves, and new research for the integrated study of coastal mesoscale processes and their impact in surface transports. The technology presented here is dedicated to measure the temperature variation in time on several points of the vertical in shallow waters less than 150m deep. The purpose is to study short-term variation of the stratification to assess the influence of strong internal waves in the mixing of the water column. The idea rose after the successful deployments of low-cost moorings in 2014, which were 1D systems, so-called MASTODON, dedicated to register bottom temperature at high frequency with a 0.1°C precision, every ~10min during a few months for a total cost of about €300 per unit (Lazure *et al.* 2015). It consisted in extending the system by using it as a vector with a vertical line where low cost temperature sensors are attached at selected depths (fig. 3a). Ifremer upgraded its system from 1D to 2D measurements. Equipped with a chain of thermistors they allow to build high spatial resolution monitoring arrays, so coastal internal waves can be accurately observed in both cross and alongshore directions.

(a)


(b)

Fig. 3. Two technology and methodology developments in JERICO-NEXT: MASTODON 2D mooring (a) and temperature, salinity and geostrophic velocities at 20m (ETOILE campaign) (b). The positions of the CTD stations are marked using asterisks.

In summer 2017 the deployment of MASTODON-2D moorings in the NW Mediterranean and the SE Bay of Biscay was completed. In the SE Bay of Biscay the deployment of 9 MASTODON-2D moorings was carried out during the ETOILE campaign (July-August 2017). In addition a multidisciplinary experiment was conducted, with CTD, MVP, ADPC, surface drifters, real time monitoring of phytoplankton and plastic sampling in collaboration with the LIFE LEMA project (LIFE15 ENV/ES/000252). Moreover, the ETOILE campaign was conducted in an area covered by HF radar which provides continuous monitoring of surfaces currents and allows the quantitative estimation of surface transports (e.g. Solabarrieta *et al*. 2017). Preliminary results from the CTD data suggest that a well-defined front was sampled, with colder fresher shelf waters closer to the coast (fig. 3b). The integrated analysis of the data from the campaign with remote sensing observations (satellite and HF radar) will help to understand how the observed mesoscale front conditioned the distribution of biodiversity and marine litter (analysis of data still in progress).

The integration of multiplatform data and, namely, data for HF radars is the main driver also for the other two study areas: the NW Mediterranean and the German Bight, where similar experiments are in progress, with CNR, CNRS, and HZG partners. The researches based on the integration of HF radar and multiplatform data are focusing on methodological improvements for data processing and analysis to improve the quality of surface current estimates from HF radars and for the integration of radar surface information with vertical information from other components of the observing system.

2.3 Some other scientific focuses

With focus on the pelagic biodiversity in phytoplankton and HAB (priority i)), the difficulty stands in capturing the bloom events that vary a lot according to the season, the region and the environmental conditions. In that case, JERICO-NEXT methodology development deals with phytoplankton automated measurement methods: comparison and deployment according to the trophic and environmental water characteristics thanks to several platform types (http://www.jerico-ri.eu/2017/07/31/phytoplankton-biodiversity-investigated-with-novel-methods/).

In the framework of the scientific priority iii), by combining the unique sampling facilities and logistic offered by JERICO-RI with the power of state of the art mass spectrometers, some artificial sweeteners were identified as possibly the most abundant micro-pollutant of emerging concern so far identified in marine waters (http://www.jerico-ri.eu/2017/07/24/case-study-on-marine-contaminants-artificial-sweeteners/).

Progress is still on the way and results for other scientific priorities are to come soon.

3. And After…

These dynamic activities going beyond a project's lifetime include continuous efforts towards harmonization in terms of design, operation, and maintenance, and in terms of evolution and extension of the current systems as well as the delivery of data and products to the users. To reach this main target an important work needs to be coordinated farther from FP7-JERICO to JERICO-NEXT, and after, at both hardware and software levels. More specifically, the existing network and its possible evolution are continuously assessed taking into account the harmonization effort to be driven, the existing sensors and technologies, their upgrades for integration on dedicated platforms, also the accompanying of the development of low TRL sensors and/or systems with involvement of providers and stakeholders when possible. Nevertheless, the main issue deals with the sustainability of the infrastructure by considering its economics and it governance framework on long term, in addition to the scientific and technological one. This is reflected by the key message acknowledged by the JERICO-NEXT consortium in 2017: *"Coastal focus uniquely positions the JERICO-RI Coastal Observing network to respond to the pressing societal questions, and by doing so, to engage with key maritime stakeholders, both government and commercial - including flooding and coastal erosion, sustainable marine resources, MPAs and CZM, aquaculture, shipping, climate change adaptation."* Consequently, our next steps are not so much led by the development of technologies and methodologies, but more by the need to engage several stakeholder types on a sustainable model.

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