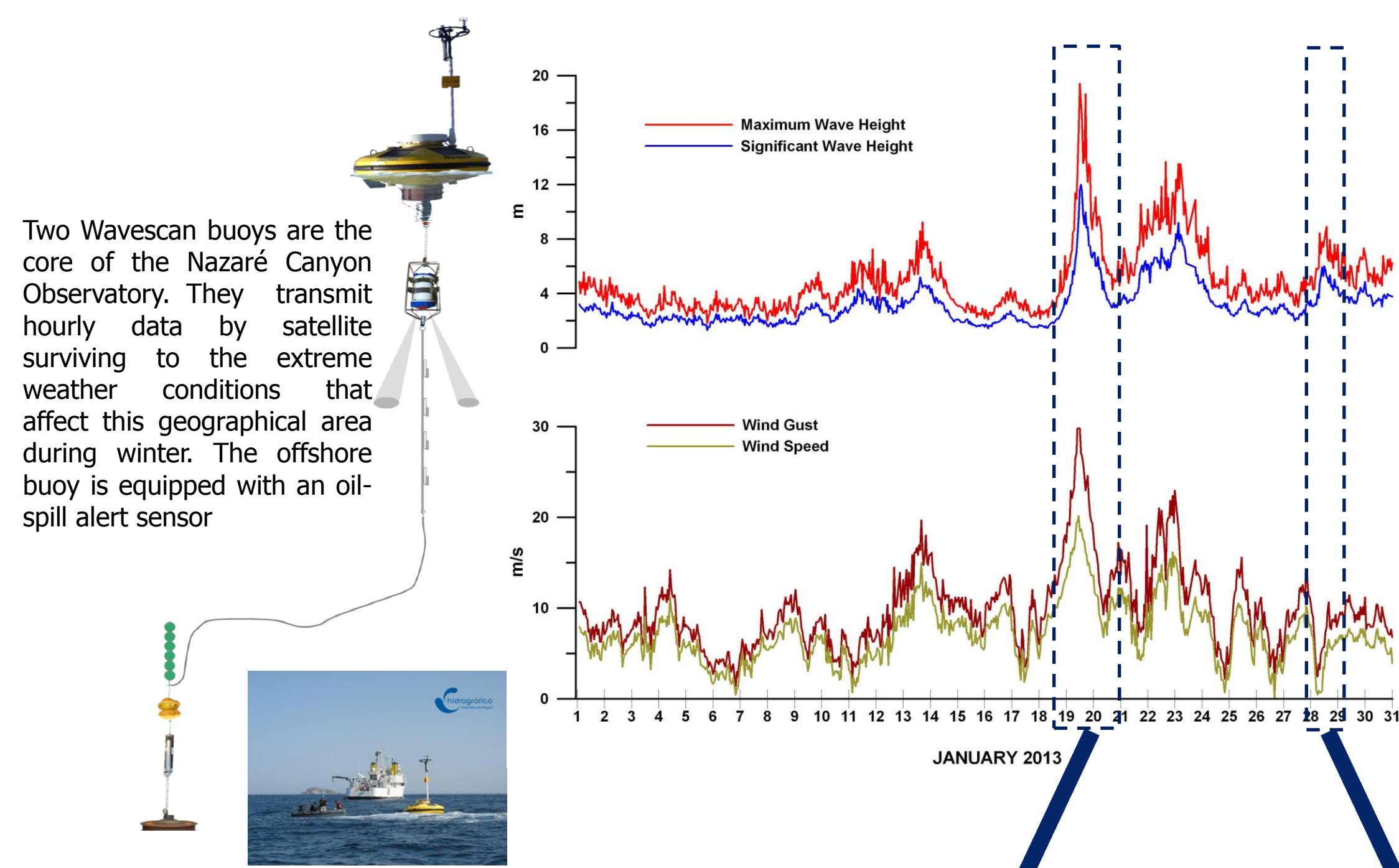




Support during crisis at sea

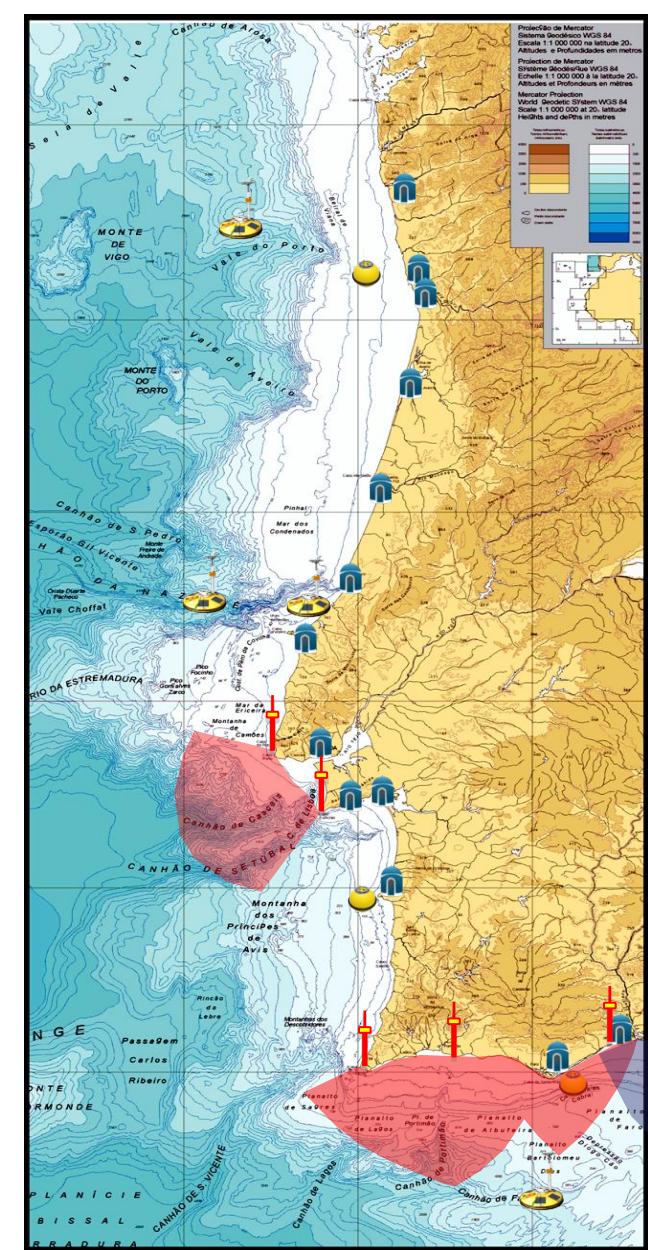
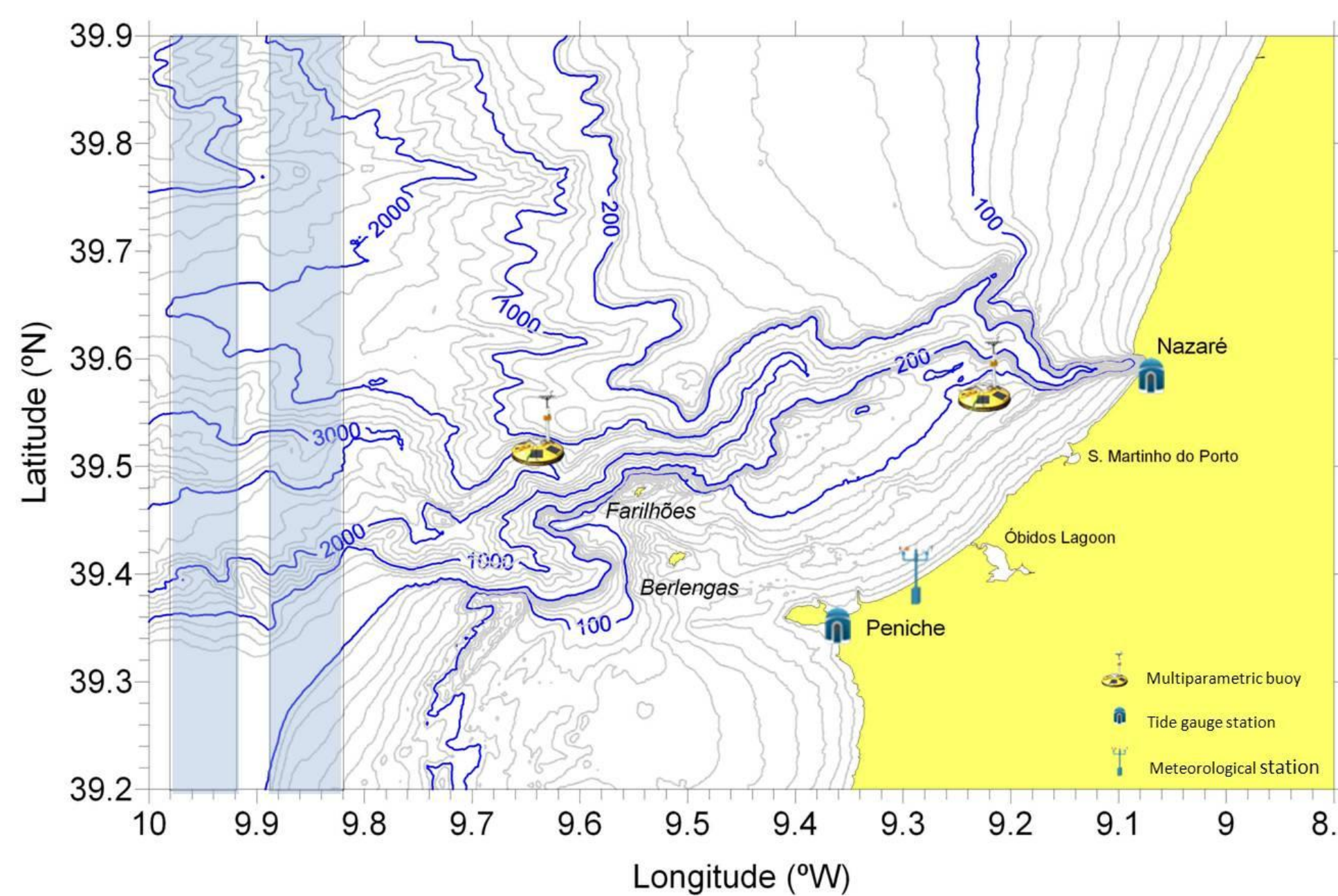
During the evolution of extreme storms that affect the Nazare coast the MONICAN real-time measurements support both the nautical community and the national and local authorities by revealing how the real conditions are evolving. On the photo the effects of the storm of the 19 January 2013 that caused flood conditions and damages on the entrance of the Nazaré port.



The Nazaré Canyon is one of the largest submarine canyons of the European Margin. The area it affects, offshore the Western Portuguese coast, is marked by the presence of the Protected Area of the Berlengas Islands and by important navigation corridors located offshore.

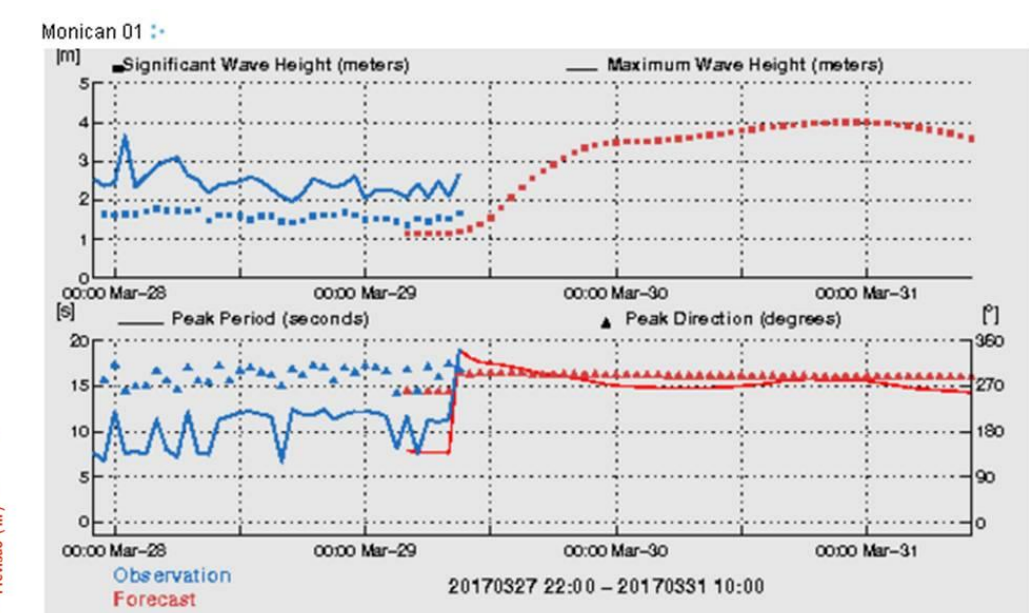
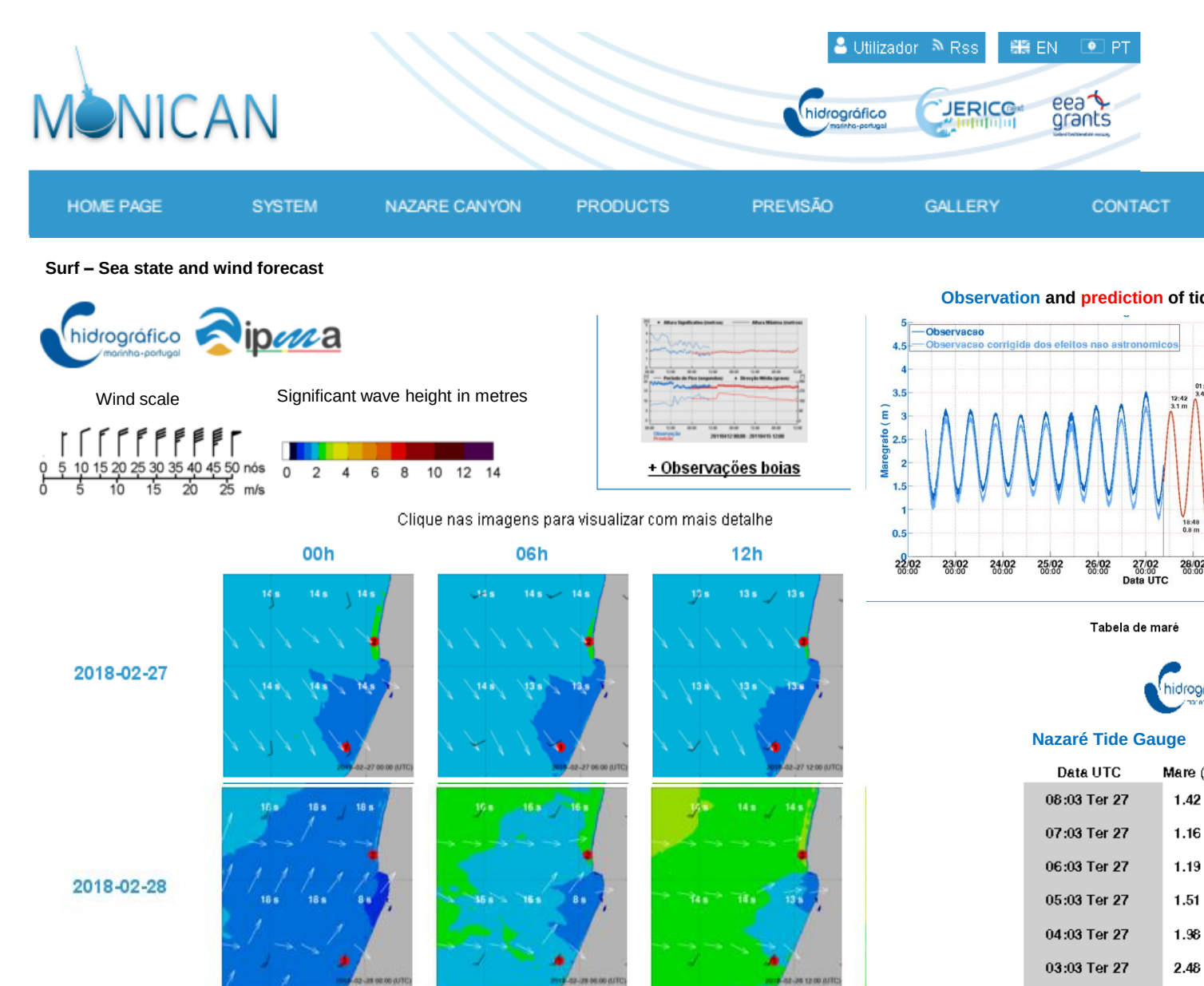
A real-time monitoring system is maintained in this area since 2009 by Instituto Hidrográfico (Portuguese Hydrographic Office). The Nazaré Canyon Observatory MONICAN provides in quasi real-time hourly measurements of waves, meteorological parameters, currents, water temperature and costal sea level.

Installed with the financial support of the EEA Grants 2004-2009 program, through project MONICAN, the Nazaré Canyon Observatory MONICAN is presently contributing to the network of coastal ocean observatories gathered under H2020 project JERICO-NEXT



The Nazaré Canyon Observatory is part of the real-time monitoring system (MONIZEE system) installed by Instituto Hidrográfico and covering the complete Portuguese continental margin, from the Gulf of Cadiz area to the NW Portuguese coast. The system includes a network of tide gauge stations (▲), a network of directional wave buoys (▲), a network of multiparametric buoys (▲) and a network of HF radar station (▲), the area covered by measurements of surface currents is indicated in the figure). The geographical area covered is key for several oceanographic processes that affect the European continental margin (such as the Iberian Poleward Slope Current or the Mediterranean Water flow) or the North Atlantic basin (such as the interaction between the Azores Current and the Mediterranean Water outflow that occurs in the Gulf of Cadiz area).

Support to the new motors of local economy



Real-time observations from MONICAN systems and forecasts up to 5 days are disseminated through the web page <http://monican.hidrografico.pt>

These products are being used by the surfers and organizations of the surf events as well as by general public wishing to know when to be in Nazaré to see the big waves.

A particularly important information for the surfing community is the comparison of last measurements of waves and winds on the MONICAN buoys with the previously disseminated model forecasts for those conditions. This provides an assessment of how well models are capturing the real evolution and brings confidence in trusting in the forecasts for the following days.

Peaks of visualization of the web page occur from October to March, the time window for the occurrence of the Nazaré giant waves.

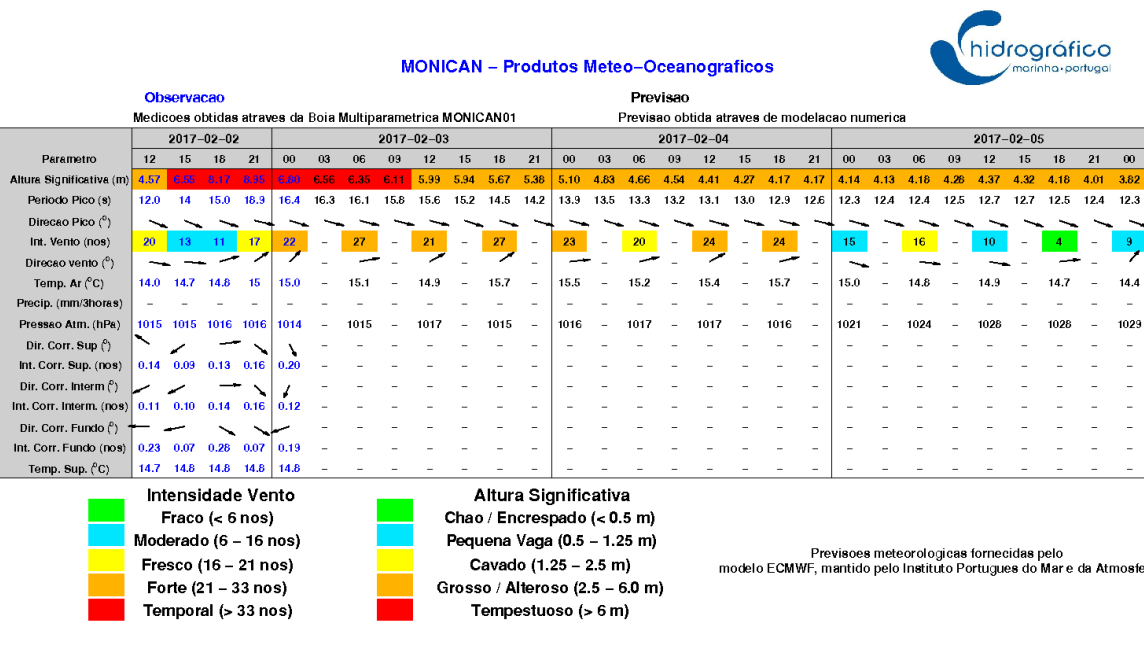
Support to traditional sectors of local economy



Direct contacts with the local nautical community (fishermen, divers, touristic operators, others) where developed in collaboration with the Nazaré Town Hall and proven to be one key for the success of the monitoring system.

Showing to the different groups of the local nautical community that they contribute to the monitoring system and they benefit for it is crucial.

These contacts allowed to identify user tailored products such as the MONICAN tables disseminated daily by email with the last 12 hours of measurements (in blue) and the next 3 days of forecasts (in black).



They also provide the users perspective regarding the developments to be made in the system, for example the introduction of new sensors that are specifically important to support local fishing activities.

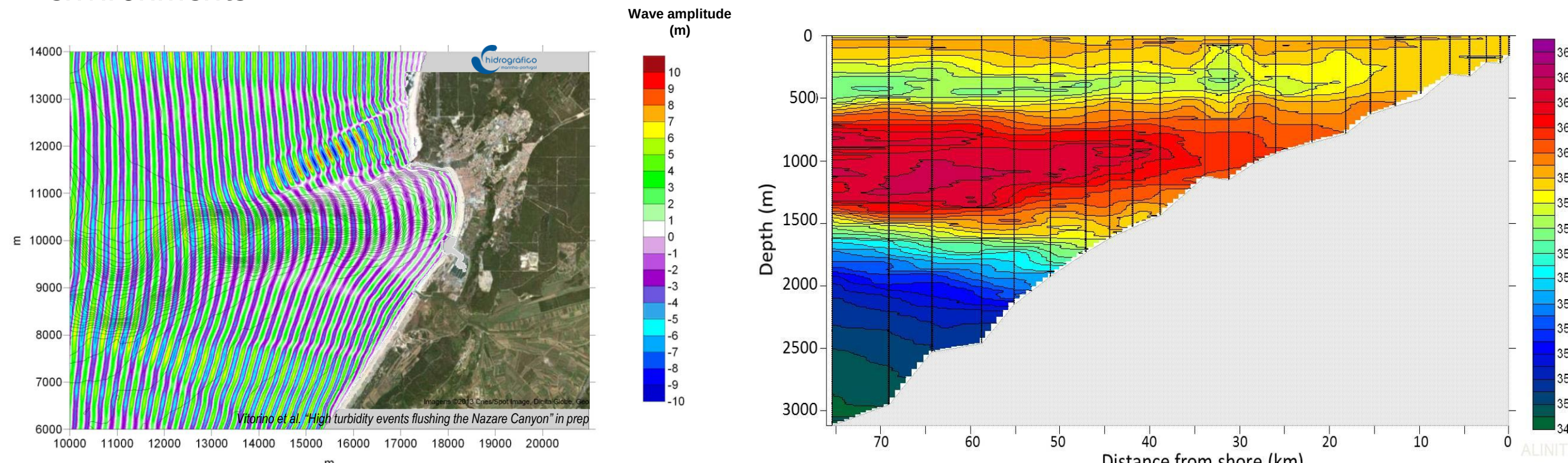
Evaluating new possible directions.

The MONICAN buoys are also providing an opportunity to test new areas of the sea economy. The photo on the right shows an experience of seaweed growing off Nazaré conducted by Seaweed Energy Solutions and Porto University with the installation of seeds and sensors on the buoys cables

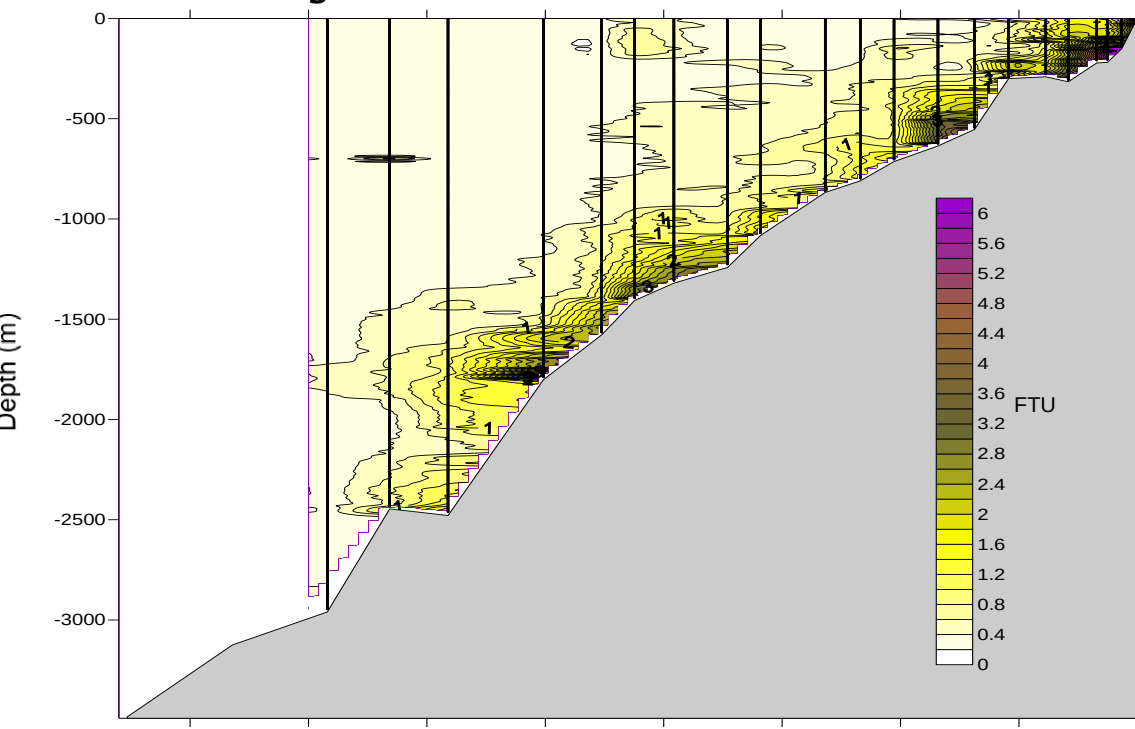


A complex and challenging environment

A extreme topography such as the one of Nazaré Canyon hosts a broad range of energetic processes and promotes important impacts in the surrounding continental shelf, slope and deep sea environments.

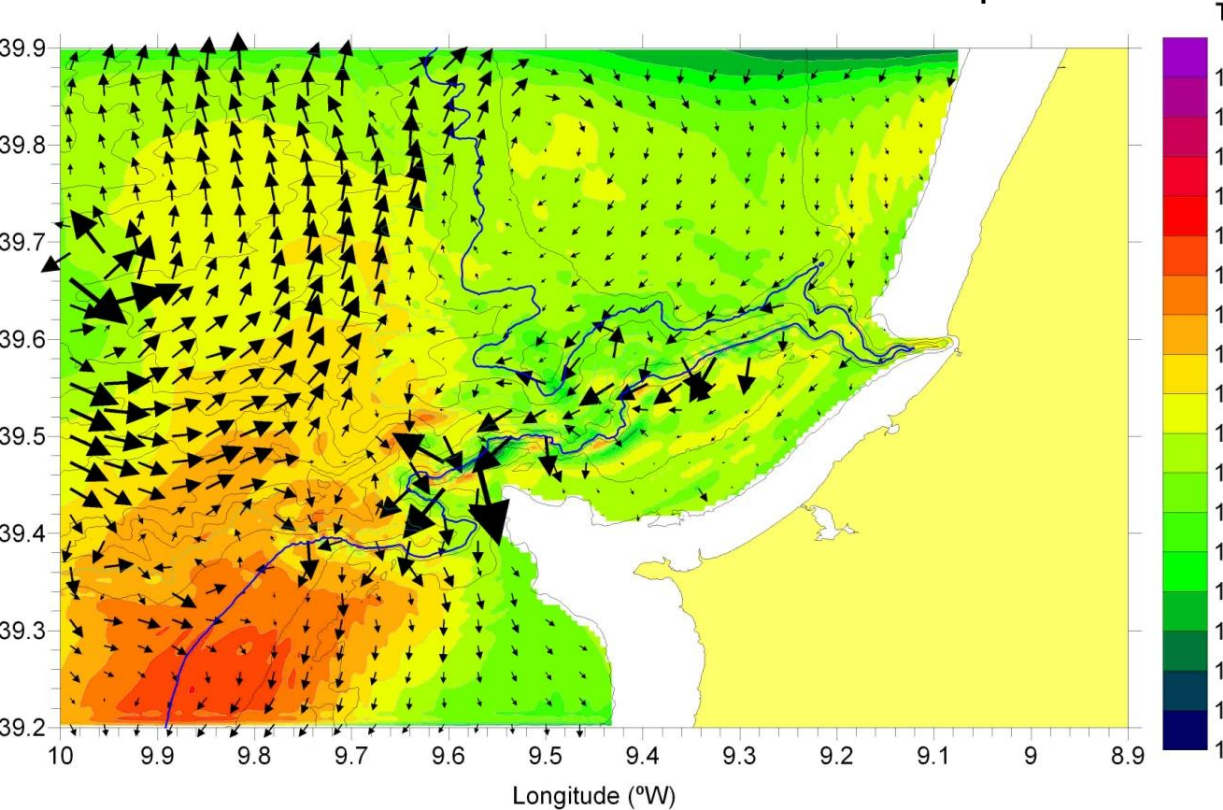


Nearshore amplification of incident swells off Praia do Norte (North Beach) due to the wave refraction associated with the canyon topography are here simulated using the REF2DIF numerical model.



The development of high turbidity events flushing the Nazaré Canyon and triggered by several of the storms that affect the Portuguese margin in winter were observed during the program of measurements conducted in the framework of European projects EUROSTRATAFORM, HERMES and HERMIONE.

Intense mixing between the saline Mediterranean Water and North Atlantic Deep Water is promoted inside the canyon by bottom intensified internal tides at 1500-2000m depth.



A high resolution numerical model with data assimilation is being used in the framework of JERICO-NEXT project to characterize the circulation in the canyon's area of influence and to get insight on the impacts of the canyon on slope currents that influence the complete Iberian margin such as the Iberian Poleward (Slope) Current.



Society Awareness

The public interest in Nazaré waves is opening a powerful window of opportunity to raise the society interest in questions related to the ocean. Those who arrive to Nazaré want to know why the big waves form there. And when they understand this is a consequence of a large submarine canyon they want to know how the canyon was formed and how it is impacting other aspects of the coastal ocean.

The Nazaré Town Hall, in collaboration with Instituto Hidrográfico, has installed in the Fort of S.Miguel (just in front of the big waves) an interpretation center of the Nazaré Canyon. In 2017 more than 200.000 visitors from everywhere in the World found here answers to their questions. Many of them were young scholars eager to learn about ocean sciences and technologies.

The MONICAN real-time monitoring systems play here a huge role in providing the eyes to the conditions offshore, allowing the public to directly link what they are seeing nearshore to what is happening tens of kilometers offshore.

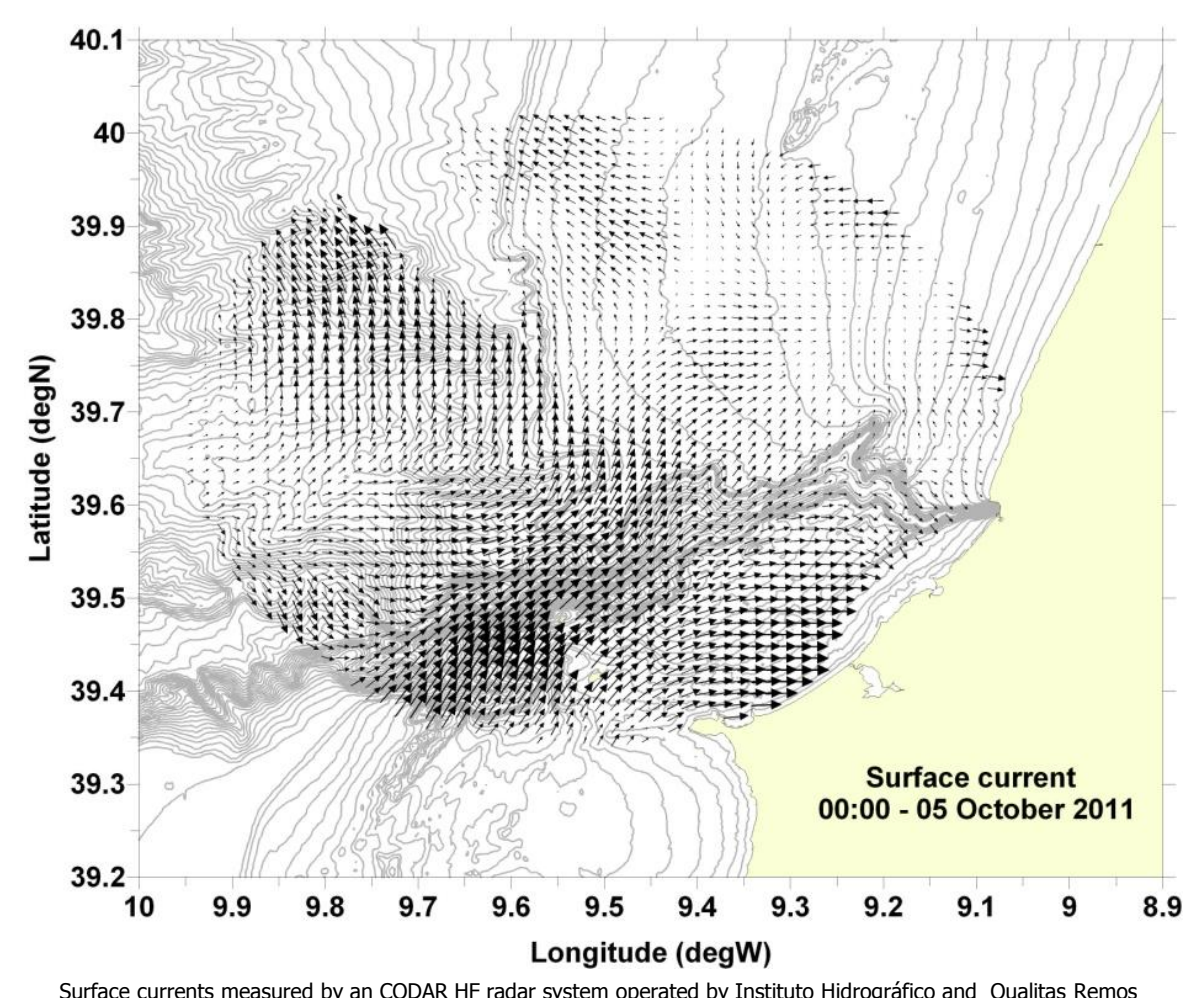


Future Developments

The introduction of new operational capacities for the waves monitoring by MONICAN buoys is presently being evaluated in reply to the demands of the surfing community.

The MONICAN buoys are being used to test several new monitoring systems such as low cost passive sensors for contaminants or larva traps for colonization experiments. These are now evolving to become long-term monitoring programs.

A first test of operation of a HF radar facility (CODAR) covering the area of influence of Nazaré Canyon was conducted in 2011. This type of monitoring capacities are planned to be installed permanently in the future.



Acknowledgements:

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The MONICAN system was implemented with financial support from the EEA Grants 2004-2009 Program through project "MONItoring the nazare CANYon area" – MONICAN (2008-2011) PT0042.