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OCEAN SCIENCE CENTRE MINDELO

Vito Ramos, Albertino Martins (INDP), Dr. Björn Fiedler, Cordula Zenk (GEOMAR)

**The Ocean Science Centre Mindelo (OSCM) opened its doors in November 2017 with the "International Workshop on Marine & Atmospheric Sciences in West Africa" in collaboration with the "4th International Conference
AWA - ICAWA", where approximately 150 researchers from Africa, Europe and America were present.**

THE OFFICIAL INAUGURATION FOR SCIENTIFIC-TECHNICAL OPERATION

One overarching aim of the workshop was to present and discuss ongoing marine and atmospheric research activities and future perspectives on research and academic education in the West African region. The workshop was used to promote and strengthen a network of researchers focusing their work on West Africa and working towards a research and education hub for marine and atmospheric sciences in West Africa.

The event featured a number of thematic sessions in which results and perspectives of many projects were presented and analyzed, including Atlantic Ocean and Atmospheric Observatories, West African Fisheries Ecosystem Management approaches, Macaronesian research and sessions dedicated to Blue Economy. Side workshops were carried out to promote the POGO network of international research institutions (Partnership for the Observation of the Global Ocean) and to develop a WASCAL master research program about Climate Change and Marine Sciences at the University of Cabo Verde (WASCAL - West African Science Service Center on Climate Change and Adapted Land Use).

The workshop also hosted the traveling exhibition "Future Ocean Dialogue" consisting of various modules dealing with research on the global oceans and challenges such as marine litter or ocean acidification, which many societies are facing.

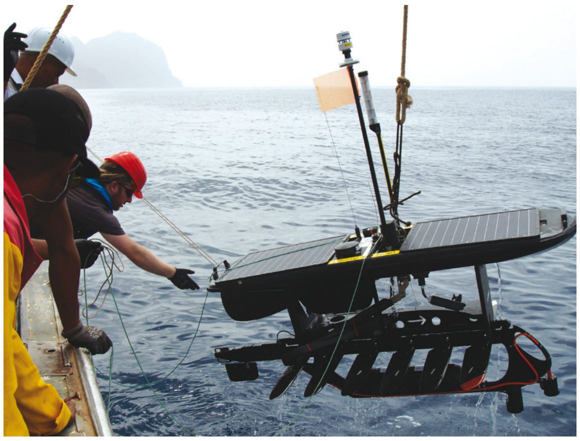
The workshop served as an official starting point for OSCM's scientific-technical operation. The political inauguration is planned to take place in November 2018.

THE BEGINNING OF THE COOPERATION BETWEEN INDP AND GEOMAR

The OSCM was born out of a cooperation between the INDP (National Institute for Fisheries Development) of Cabo Verde and GEOMAR (Helmholtz Centre for Ocean Research Kiel) of Germany, which started in 2004 with the workshop "Towards the West African Science Logistics Center in Cabo Verde" and the participation of scientists from various parts of the world, namely from Africa, Europe and America, having 9 nations represented altogether.

Given the importance of this tropical zone as a natural laboratory for oceanographic and atmospheric research, there was a scientific consensus that there was a need to create a scientific-logistical base in Cabo Verde to support and conduct oceanographic and atmospheric research expeditions.

A cornerstone for the OSCM was the EU-funded (FP6)



project TENATSO (Tropical Eastern North Atlantic Time-Series Observatory), born in 2006. This project formed the basis for a successful long-term collaboration between different institutions and projects, led by GEOMAR and INDP for the oceanic part and the University of York in England, the German Max-Planck Institute for Biogeochemistry in Jena and the Leibniz Institute of Tropospheric Research in Jena and the INMG (National Institute of Meteorology and Geophysics) in Cabo Verde for the atmospheric part.

The objective was to establish two observatories for the collection of time-series data, one oceanic (CVOO - Cabo Verde Ocean Observatory) and one atmospheric observatory (CVAO - Cabo Verde Atmospheric Observatory). This setting allowed to investigate not only the ocean and the atmosphere separately, but also to obtain a closer look on the interaction between them.

THE IMPORTANCE OF THE EASTERN TROPICAL NORTH ATLANTIC

Cape Verde is located in an area of the world that plays a key role in atmosphere-ocean interactions of climate-related parameters as well as of key biogeochemical parameters such as greenhouse gases. The site is also located in an area of massive dust transport from land to the ocean, and where aerosol impacts on climate, atmospheric chemistry and marine processes are large. Such processes are potentially subject to future change as a result of direct or indirect human intervention.

The coastal upwelling region off the Mauritanian coast fuels biological production in the entire region by transporting dissolved nutrients into the sunlit layer followed by offshore advection. A pronounced oxygen minimum zone (OMZ) does not only alter biogeochemical processes in the region but also has implications for the ecosystem as a whole. The existence of several seamounts in that region is important for local fisheries, as they are known to create their own ecosystems and can be seen as an oasis in the deserted ocean.

It is crucial to study these phenomena in order to understand their functioning, their interconnectivity and to learn about their vulnerability with regard to a changing climate. This is not only important from a scientific perspective but even more important for local societies which rely on a healthy ocean.

In the last decade several scientific expeditions have been carried out in this area, as well as the establishment of several cooperations. In 2015, the first International Marine & Atmospheric Science Symposium was held in Mindelo with the participation of approximately 100 guests. This symposium as well as the most recent one demonstrated a very active and growing scientific network in West Africa.

WHAT'S NEXT?

As a logistics and service centre the OSCM will be open to the national, regional and international scientific community to support their field work or networking activities and academic education in West Africa. Therefore, the centre is equipped with modern facilities such as laboratories, workshops, conference rooms, freezing capabilities (-20/-40/-80 °C, liquid nitrogen generator) and guest offices. The INDP vessel "Islândia" is a 22 m research vessel which is equipped with state-of-the-art oceanographic instrumentation and can operate in the West African region. The vessel is also being used for monthly sampling at the CVOO site 60 nm northeast of Mindelo.

OSCM is connected to various research networks (AtlantOS, FixO3, TAOS, ICOS, OCEANSITES, GOA-ON, GAME, VOICE, WASCAL, etc.) at the regional/national (West Africa and Macaronesia) but also at the international level. One goal is to intensify communication and coordination across Atlantic observatories such as CVOO, PLOCAN (Ocean Platform of Canaries), BATS (Bermuda Atlantic Time-series Study) and FNEO (Fernando de Noronha Experimental Observatory) in the future.

Education and training of West African students will also play an important role in the future for OSCM. The establishment of the WASCAL[1] master program at the University of Cabo Verde and at the OSCM in close collaboration with GEOMAR and the University of Kiel will help to better train the next generations of West African researchers, stakeholders and policymakers in the field of climate change and marine sciences.

GOVERNO DE CABO VERDE | INDP | OSCM Ocean Science Centre Mindelo | GEOMAR | Federal Ministry of Education and Research

1. WASCAL West African Science Service Centre on Climate Change and Adapted Land Use, financed by the German Federal Ministry of Education and Research

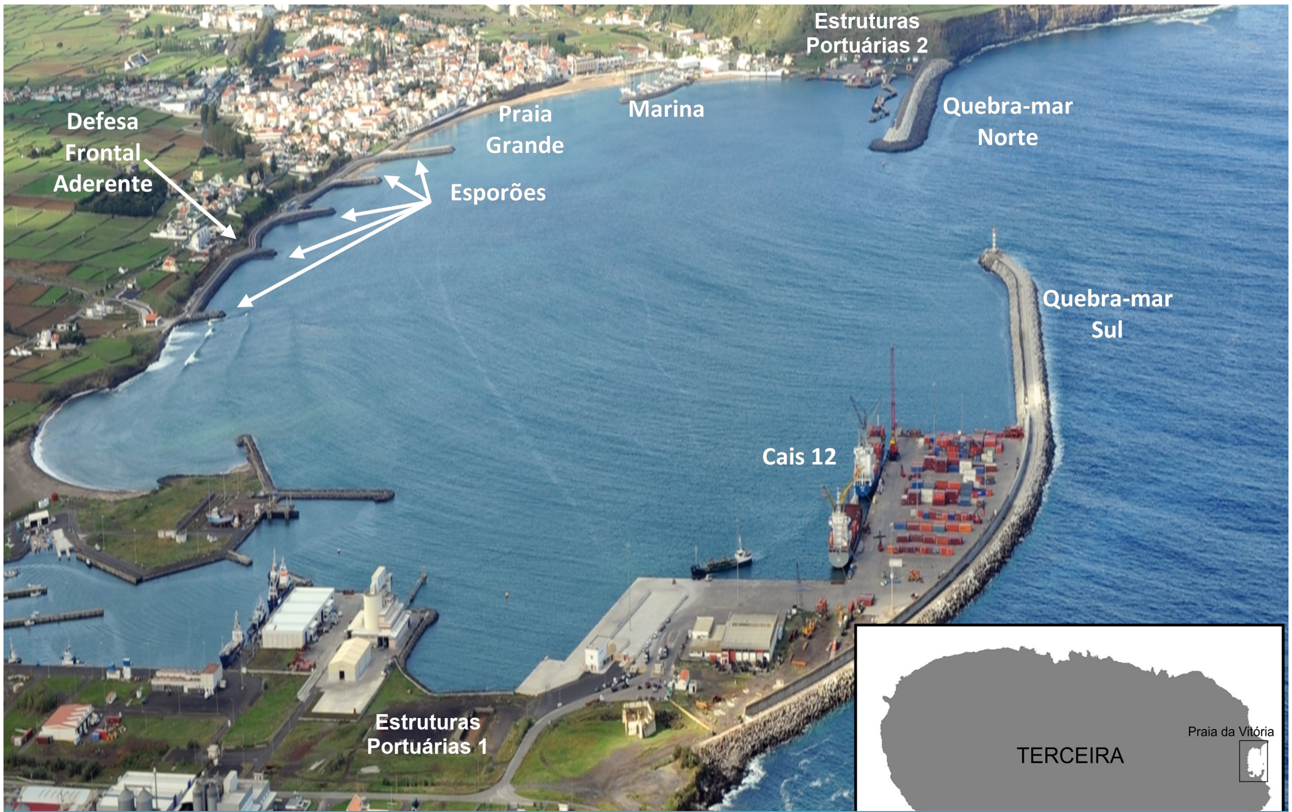


Figure 1 - Porto da Praia da Vitória, Ilha da Terceira, Portugal

SISTEMA HIDRALERTA NO ÂMBITO DO PROJETO ECOMARPORT

Conceição J. E. M. FORTES, Pedro POSEIRO, Maria Teresa REIS (Laboratório Nacional de Engenharia Civil).
Eduardo B. de Azevedo (Universidade dos Açores).

O sistema HIDRALERTA (Poseiro *et al.*, 2014; Fortes *et al.*, 2015, Sabino *et al.* 2018) é um sistema de previsão e alerta de situações de emergência e de avaliação de risco associado ao galgamento e inundação em zonas costeiras e portuárias.

Foi desenvolvido no âmbito de um projeto financiado pela Fundação para a ciência e Tecnologia com a participação do Laboratório Nacional de Engenharia Civil, da Universidade dos Açores e da Universidade Nova de Lisboa. O protótipo do sistema encontra-se em funcionamento para a zona da Praia da Vitória na ilha Terceira do Arquipélago dos Açores.

No âmbito do projeto *"ECOMARPORT - (Transferência tecnológica e inovação para a gestão ambiental e marinha em zonas portuárias da Macaronésia (MAC/1.1b/081) – INTERREG MAC 2014-2020")* pretende-se estender o sistema HIDRALERTA a mais portos das ilhas dos Açores, nomeadamente aos portos de São Roque do Pico e da Madalena do Pico.

DESCRIÇÃO GERAL

O sistema HIDRALERTA utiliza as previsões de agitação marítima ao largo para a determinação dos seus efeitos em termos de caudal de galgamento e/ou de cotas de inundação em áreas específicas, recorrendo a modelos numéricos, redes neuronais e fórmulas empíricas. A comparação desses valores com limites admissíveis pré-estabelecidos permite:

i) a avaliação, em tempo real, de situações de emergência e a emissão de alertas às entidades competentes sempre que se preveja estar em causa a segurança de pessoas, bens ou atividades desenvolvidas;

ii) a construção de mapas de risco, considerando longas séries temporais de previsões da agitação marítima ou cenários pré-definidos associados a mudanças climáticas e/ou a eventos extremos.

Uma vez que permite a identificação de situações de emergência, possibilita a adoção de medidas, pelas entidades responsáveis, para evitar perdas de vidas e minimizar prejuízos económicos e ambientais.

O protótipo do sistema HIDRALERTA foi desenvolvido para o porto e a baía da Praia da Vitória, Terceira, Açores, Figura 1, e encontra-se em funcionamento deste 2015.

MÓDULOS DO SISTEMA HIDRALERTA

O sistema é constituído por quatro módulos (Figura 2) nomeadamente:

Módulo I – Características de agitação marítima
Módulo II - Galgamento e Inundação
Módulo III – Avaliação do Risco
Módulo IV – Sistema de alerta

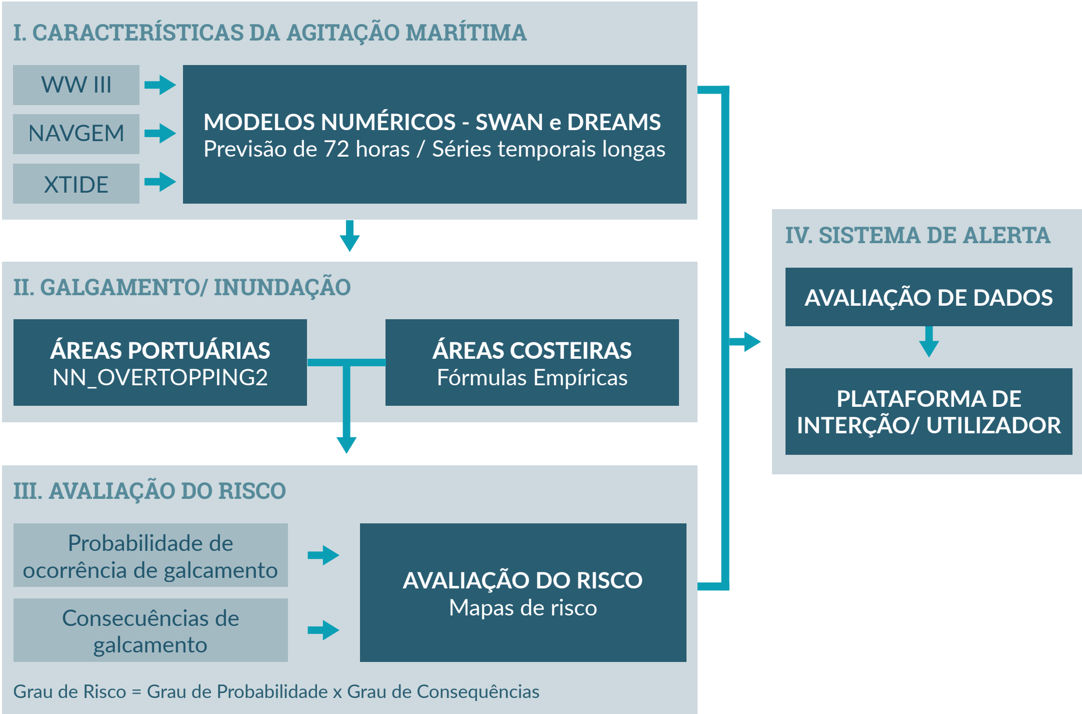


Figure 1 - Esquema do sistema HIDRALERTA

O módulo I, **Características da agitação marítima**, permite a determinação das características da agitação marítima em zonas costeiras e portuárias em termos de altura de onda significativa (*Hs*), período de onda (médio, *Tm*, ou de pico, *Tp*) e direção média (Θ). Essas características de agitação marítima podem ser obtidas tanto no âmbito da realização de previsões, que estão disponíveis com 72 horas de antecedência (com resultados de 3 em 3 horas), como no âmbito do estabelecimento dos regimes de agitação marítima necessários à avaliação do risco de galgamento/inundação, que estão disponíveis para vários anos anteriores. Tal envolve os seguintes passos, utilizando modelo numéricos:

- Estimativa da agitação marítima a uma escala oceânica (WAM, WAMDI Group, 1988);
- Propagação da agitação marítima para uma escala mais regional da zona costeira (SWAN, Booij et al., 1999);
- Transformação da agitação marítima até às estruturas de proteção costeira e portuária (DREAMS, Fortes, 2002).

O módulo II, **Galgamento e inundação**, efetua a estimação dos galgamentos/inundações em áreas costeiras e infraestruturas portuárias. Mais concretamente determina os valores do caudal médio galgado ou da cota de inundação correspondentes a uma dada condição de agitação marítima/nível de mar verificada em cada secção das estruturas analisadas na zona de estudo. Neste projeto, para estimar o galgamento de estruturas marítimas utilizou-se a ferramenta neuronal NN_OVERTOPPING2 (Coeveld et al., 2005), desenvolvida no âmbito do projeto europeu CLASH (Coeveld et al., 2005; Van der Meer *et al.*, 2005; Van Gent *et al.*, 2005). Esta ferramenta processa os resultados produzidos por 700 redes neuronais artificiais, cujos parâmetros de entrada incluem informação sobre a agitação marítima/nível de mar e a geometria da estrutura. A ferramenta fornece o valor do caudal médio galgado por unidade de comprimento do coroamento da estrutura, q, entre outros parâmetros estatísticos.

O módulo III, **Avaliação do Risco**, consiste na avaliação do risco de galgamento/inundação de zonas costeiras e portuárias, com a subsequente construção de mapas de risco. Para a avaliação do risco de galgamento/inundação numa dada zona costeira ou portuária, é utilizado o seguinte procedimento:

- Avaliar a natureza das atividades desenvolvidas na zona abrigada por cada secção das estruturas analisadas e qual o impacto do galgamento/inundação/ na segurança de pessoas e infraestruturas;
- Estabelecer os caudais críticos de galgamento associados a cada secção de estrutura analisada. Estes limiares devem ser estabelecidos com base nas recomendações de Pullen *et al.* (2007) e em informação local;
- Avaliar o grau de consequências de ocorrência de um caudal acima dos limites definidos para cada secção de estrutura. A avaliação deste grau pode ser efetuada de forma simplista, como proposto por Raposeiro *et al.* (2010), ou de forma mais elaborada, com base no trabalho desenvolvido em Poseiro *et al.* (2013);
- Determinar o grau de probabilidade de ocorrência desses caudais associados a cada secção de estrutura. Estes graus foram estabelecidos em Raposeiro et al. (2010);
- Avaliar o grau de risco (Raposeiro *et al.*, 2010).

O módulo IV, **Sistema de Alerta**, Sabino *et al.* (2018) efetua a previsão, em tempo real, das situações de emergência para uma determinada área de interesse e envio automático de mensagens de alerta para as autoridades responsáveis.

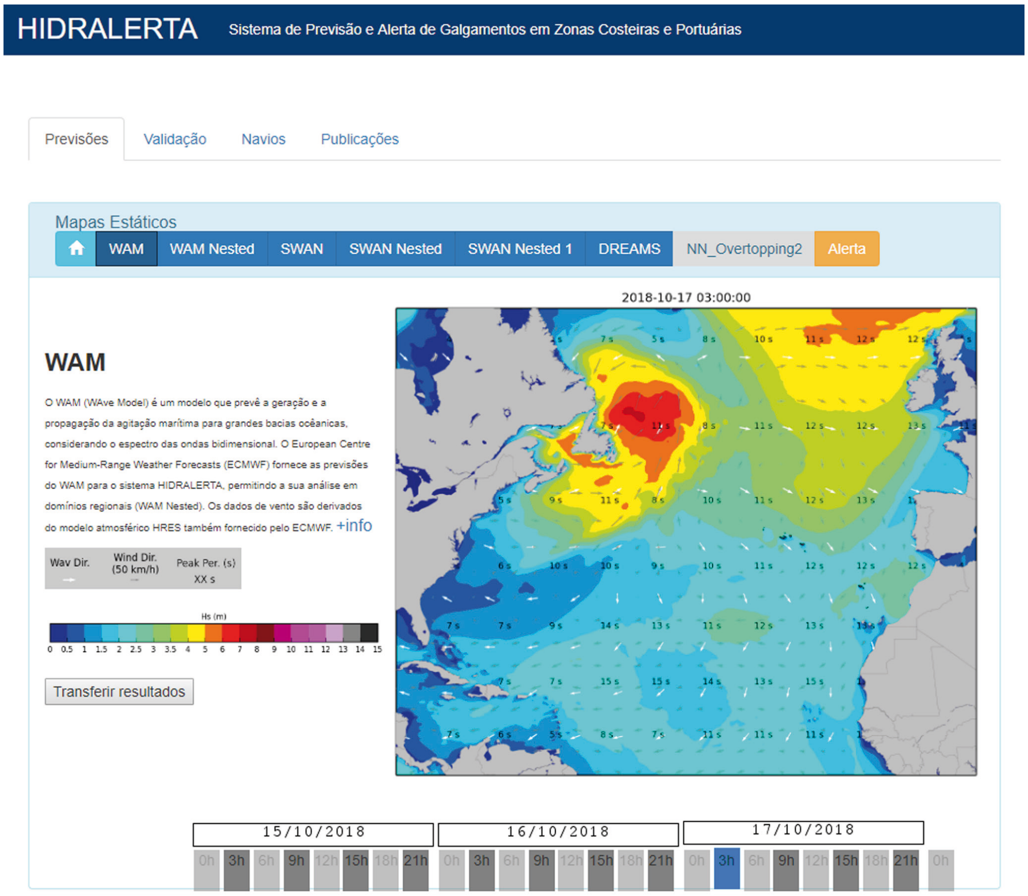


Figura 3 - Plataforma Web do sistema HIDRALERTA

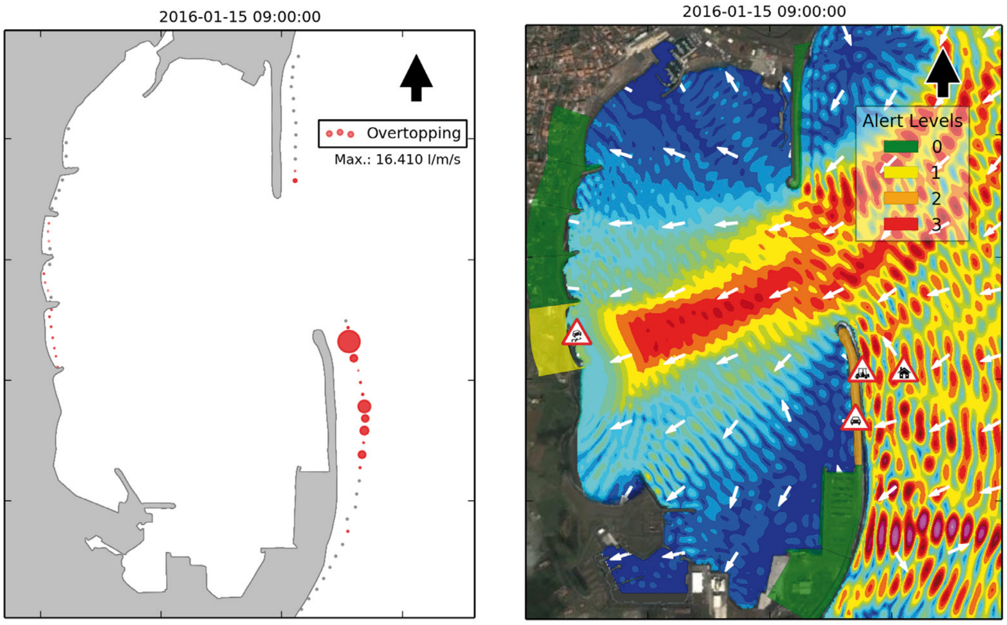


Figura 4 - Layouts do sistema HIDRALERTA (Galgamento e Alerta)

O sistema de alerta é constituído por dois componentes: o componente de avaliação de dados; e o componente de interação com o utilizador.

No componente de avaliação de dados, o sistema parte do princípio que o nível de alerta associado à área de interesse é determinado de acordo com os limiares de galgamento/inundação alcançados em cada secção das estruturas analisadas. Desta forma, é atribuído um nível de alerta a cada secção considerada homogénea. Para o funcionamento do sistema de alerta têm de estar definidos, com base no estudo de avaliação do risco realizado na componente III do sistema, os limites para os caudais admissíveis. Esses limites já têm em conta as consequências dos galgamentos em cada zona, pelo que, em caso de estes limites serem excedidos, é acionado o sinal de alerta, bem como a sua localização num mapa. Torna-se, portanto, particularmente relevante conseguir a melhor caracterização possível de cada zona tendo em conta as suas características e as atividades que nela acontecem, bem como uma análise profunda dos galgamentos registados anteriormente. Os resultados gerados pelo componente de avaliação assumem diversas formas, nomeadamente, gráficos, mapas e relatórios.

Estes são depois transmitidos ao componente de interação com o utilizador para permitir a avaliação da situação pelo mesmo.

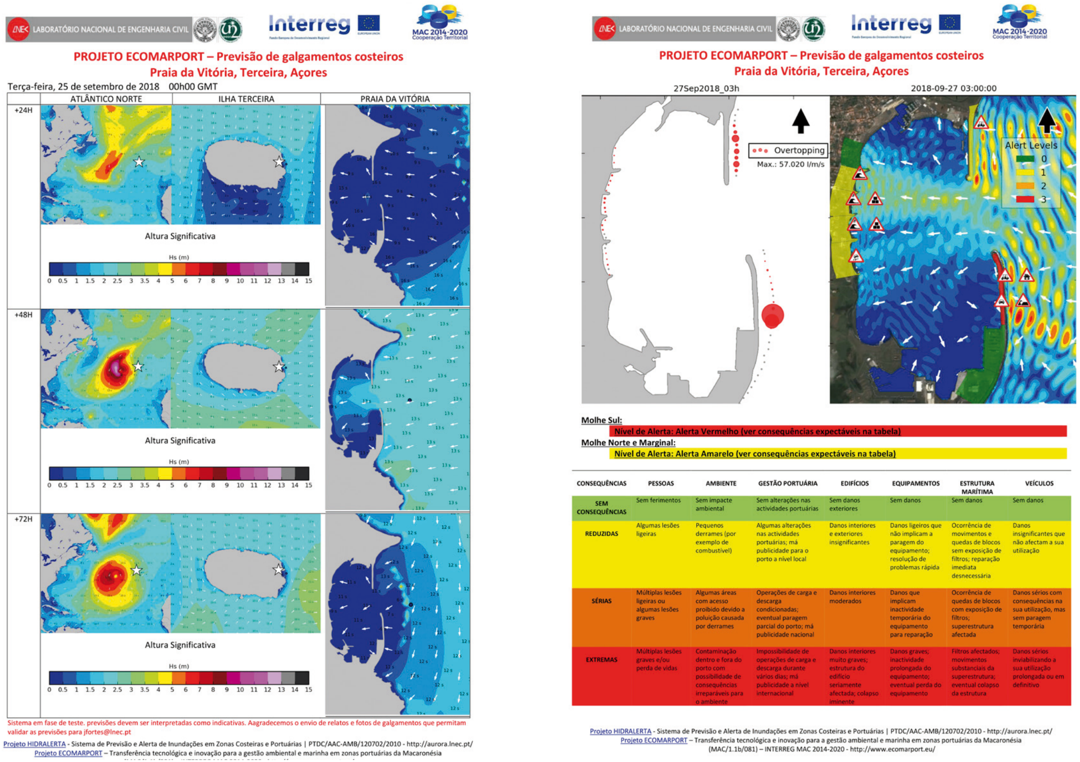


Figura 5 - Boletim diário do sistema HIDRALERTA enviado às autoridades responsáveis

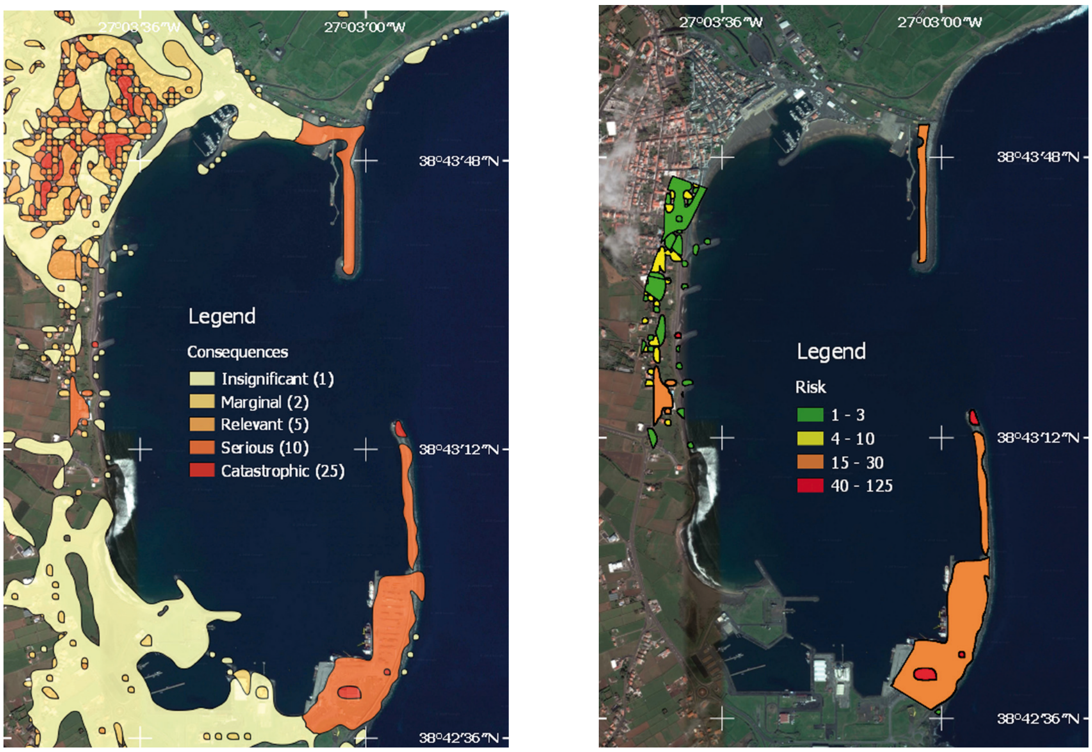


Figura 6 - Mapa de Consequências e Mapa de Risco

O componente de interação com o utilizador é materializado numa aplicação web, na qual todo o sistema de alerta é parametrizado. A plataforma Web foi criada com o intuito de permitir ao utilizador a visualização e a análise de resultados de forma interativa. Esta plataforma dispõe de um conjunto de funcionalidades que passam pela visualização das previsões obtidas pelo sistema para cada um dos modelos numéricos, redes neuronais e/ou formulas empíricas utilizados, bem como, e principalmente, dos mapas de alerta, que destacam os diferentes níveis de alerta e o conjunto de atividades que se podem encontrar em perigo.

Na plataforma são também disponibilizados os dados de agitação marítima registados pela boia ondógrafo da Praia da Vitória (Barrera et al. 2008) em articulação com os resultados obtidos pelo sistema para o mesmo local. Desde junho de 2015, a plataforma está em funcionamento para o porto da Praia da Vitória e as entidades responsáveis que solicitaram acesso, visualizam as previsões a 3 dias.

Alguns dos resultados do sistema são: a plataforma Web, Figura 3, os layouts diários dessa plataforma, Figura 4, os boletins diários que são enviados às entidades responsáveis, Figura 5, e os mapas de consequências e de risco no porto da Praia da Vitória.

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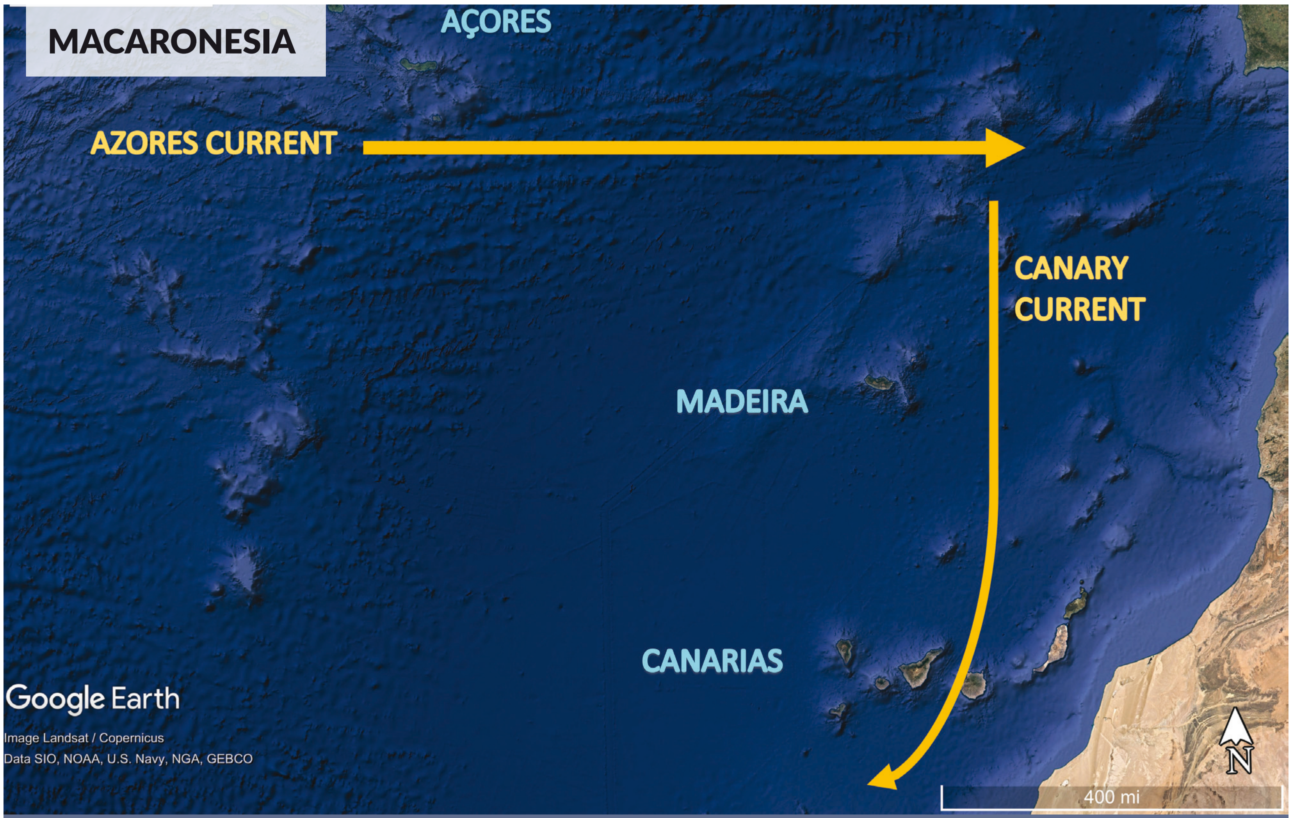


Figure 1: Detail of the Eastern Subtropical North Atlantic, with the Açores (PT), Madeira (PT) and Islas Canarias (ES) archipelagos the three of them belonging to the Macaronesia. Yellow arrows indicate the most relevant surface currents of the area with its directions. Positions of the currents are approximative.

ANOMALOUS WARMING OF SEA SURFACE TEMPERATURE IN THE EASTERN SUBTROPICAL NORTH ATLANTIC. CAUSES AND CONSEQUENCES

Djemila Tassin (Universidad de Cádiz)

Due to the correlation that exist in the oceans between the sea surface temperatures and the surface currents, it was though that an anomaly in the upper currents could be in part responsible for the anomalous increase in sea surface temperature.

To discover what was happening with the surface currents during 2017, we used in situ measurements and then we compared them to a climatological reference. The in situ measurements were taken at the European Station for Time series in the Ocean Canary Islands (ESTOC) which is found 100 km north Gran Canaria (29.2° N, 15.5° W) (see Figures 3 & 4).

ESTOC is one of the eight multidisciplinary observational programs started during Joint Global Ocean Flux Study (JGOFS), which was established to enhanced and better the knowledge of our oceans. ESTOC has been used since 1994 intermittently to study several oceanographic processes in the Canary Basin. Scientists use this location as a reference point to measure chemical, biological, and physical parameters during extended periods. Due to its geographic location, the ESTOC exhibits open ocean and oligotrophic gyre characteristics, however it is sometime under the influence of upwelling filaments and eddies.

The instrument used to measure the current was an Acoustic Doppler Current Profiler. This instrument is placed at 100m depth and attached by a highly resistant rope to a heavy anchor laying over the ocean's floor (see Figure 2). The instrument is able to measure the speed and direction of the current at different levels, from 100 m to the surface. The instrument was left to take measurements continuously from mid-April to late September 2017. Once the results were analyzed, there were compared to a climatology of the currents based on the Simple Ocean Data Assimilation (SODA) reanalysis. The anomaly of the current is calculated by obtaining the difference between the actual value and the mean for that annual day.

What the current-meter recorded was a strong northeastward flow during April and May, an eastward flow during June, a southeastward flow during July and a northeastward flow during August and September. For most of the time range, the current was found to be quite opposed to the usual southwestward Canary Current dominating the open ocean around the Canary Islands.

Figure 3 shows the climatological current direction in yellow (i.e. the mean state of the current in the area), while Figure 4 shows in red the direction of the flow measured during 2017. When the anomaly was calculated, it resulted in an anomalous NE-E flow shown in figure 5. The current rose indicates the direction where the current is going to with the spikes, and its speed (m·s-1) with the color. It is easy to see that most frequently, the current was measured moving/flowing towards the northeast.

Regarding the sea surface temperature anomaly, it was found that the first pulse of anomalous current coincides in time with the sea surface temperature anomaly (April-May). As we know, higher temperatures are found south and southwest of the Canary Islands, principally due to the solar radiation and lack of upwelling

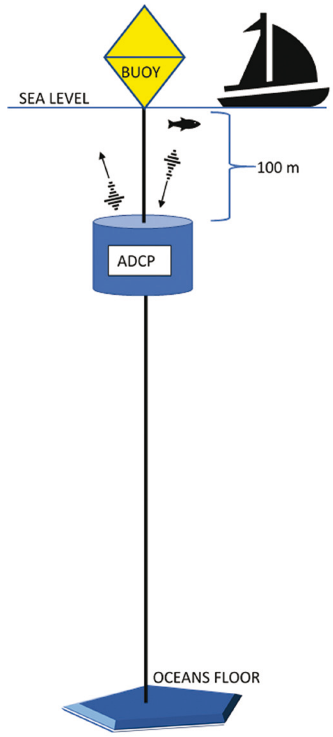


Figure 2 - Schematic representation of the instrument used mooring. The Acoustic Doppler Current Profiler (ADCP) is set at 100 m under the sea surface. It is attached to the bottom of the ocean with a heavy anchor through a highly resistant cable. A buoy lays at the surface to ensure the finding of the mooring once the instrument is retrieved back to the boat. The upward faced ADCP works by sending a pulse of very high-pitched sound at a constant frequency into the water above it. When the pulse hits a particle, it bounces back to the instrument with a different frequency. The instrument can then measure the difference in frequency between the sent and the received pulse (called the Doppler shift) and use it to calculate the velocity of the water. Distances are not at scale.

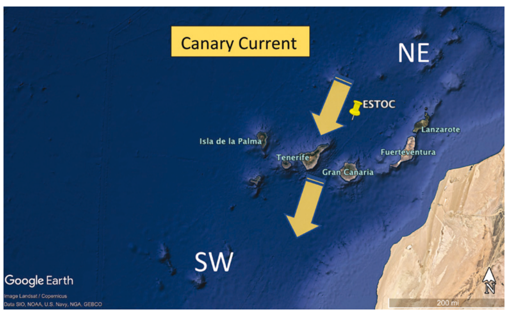


Figure 3 - The Canary Islands archipelago and the general direction of the surface current called the Canary Current which flows throughout the islands. The NE-SW axis represents the mean direction of the current. The yellow mark indicates the position of the European Station for Time Series in the Ocean, Canary Islands (ESTOC). The ESTOC is where the in situ measurements were taken for this research.

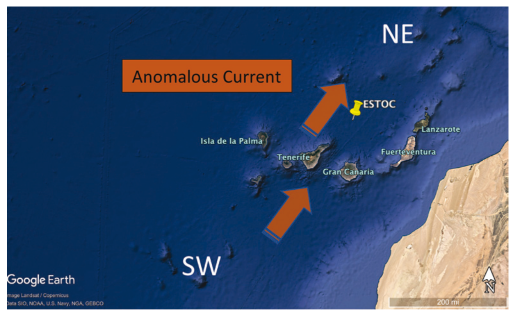


Figure 4 - Same area as Figure 2. Red arrows indicate the direction recorded of the anomalous current during Spring and Summer 2017. The current was measured most of the days flowing towards the northeast.

influences. When the northeast anomalous current transports water, it displaces warmer waters towards cooler areas.

Therefore, the anomalous current seems to be a reasonable cause to the unusually high sea surface temperature. Even more, it may also have been responsible for maintaining high water temperatures during the entire summer around the Canary Islands.

We have also questioned the possible repercussions of this anomalous surface current over the canarian fauna and flora. During summer 2017, the Canary Islands suffered its strongest and longest bloom of the cyanobacteria Trichodesmium spp. It appears to be that the conditions necessary for the bloom to happen were enhanced by the anomalous current. For example, Trichodesmium spp. ability to bloom is facilitated by higher water temperatures, which we presume were consequences of the anomalous current. In a more hypothetical way/vision/, there is also a possibility that the *Trichodesmium* spp. cells, which are usually found west and southwest of the Islands, were themselves displaced closer to the islands by the anomalous current. In conclusion, an anomalous NE surface current is exposed as the immediate cause of a high sea surface temperature increase around the Canary Islands during spring 2017. The anomalous current is also shown to have enhanced the conditions for the unprecedented bloom of Trichodesmium in the island's waters during summer 2017.

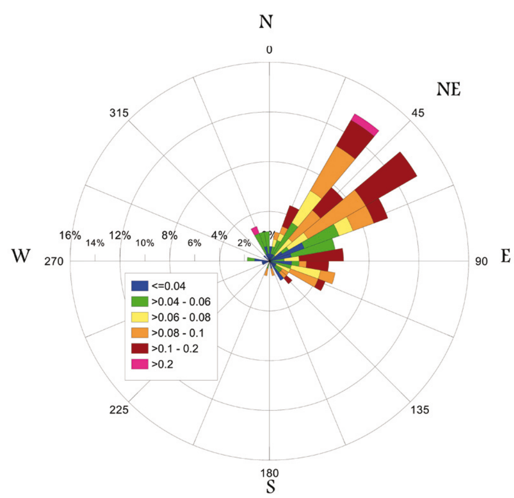


Figure 5 - Current rose of the daily anomaly in current direction. The anomaly is calculated as the observed value minus the climatological value for that day. The spikes indicate the directing where the current is flowing to. Percentages state for frequencies of days. Color state for speed ($m \cdot s^{-1}$) of current. Most frequently, the anomaly in current direction resulted in a northeastward flow, with an average value of 0.07 $m \cdot s^{-1}$.

ANNUAL VARIABILITY AND ANOMALIES OF AIR TEMPERATURE, PRESSURE AND RELATIVE HUMIDITY AT THREE SITES OF THE MACARONESIA

Andrés Cianca. Técnico Proyecto Ecomarport (Plataforma Oceánica de Canarias).

Three meteorological devices were settled on two locations of Gran Canaria (Canary Islands) and one in Sao Vicente (Cabo Verde) island; they were acquired through the ESTRAMAR project "R&D&I Marine-Maritime Strategy in the Macaronesia", which was funded by the transnational cooperation program Madeira-Azores-Canary-Cape Verde (MAC 2007-2013).

The devices were mainly composed by a Weather transmitter model WXT520 (Vaisala), along with two sensors to measure Photosynthetically Active Radiation-PAR (Apogee, SQ215) and Ultraviolet Radiation-UV (SGLUX, UV-cosine), see Figure 1.

The Canteras Beach in Las Palmas de Gran Canaria, and the PLOCAN building nearby the Taliarte harbor in Telde, were the locations where the devices of reference 501 and 502 were settled, both in Gran Canaria Island. The Instituto Nacional de Desenvolvimento das Pescas (INDP) building located in the

Figure 1 - Images of weather transmitter WXT520, PAR sensor (SQ215) and UV sensor (UV-cosine), respectively.

Figure 2 - Las Canteras beach, PLOCAN- Taliarte harbor and INDP- Mindelo bay, respectively.

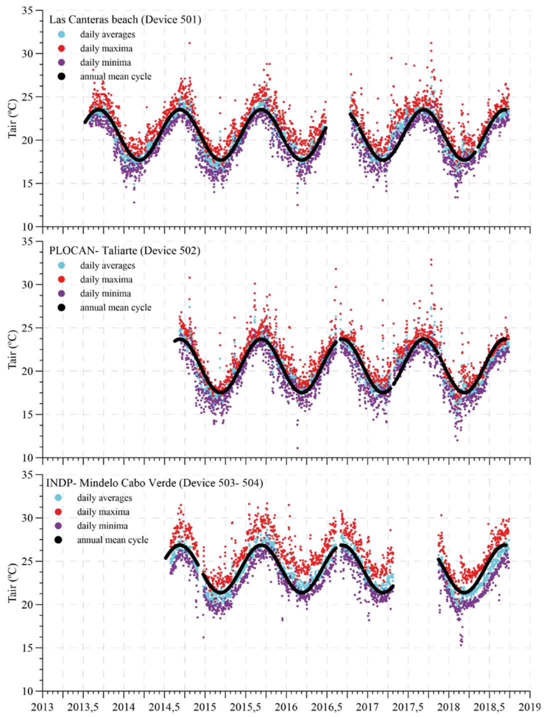


Figure 3 - From up to down.

Daily averages (light blue), maxima (red) and minima (purple) of air temperature at sea level from the devices settled in Gran Canaria and Sao Vicente, respectively. Black line represents the annual mean cycle in each site (years in X axis).

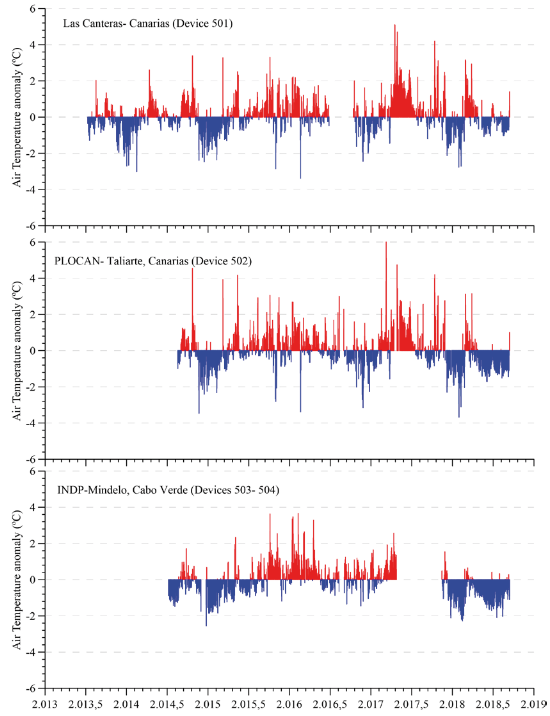


Figure 4 - From up to down.

Daily anomalies of air temperature calculated from the difference between the daily averages and the daily value from the annual cycles. Red shows the positive anomalies and blue the negatives (years in X axis).

Mindelo Bay, Sao Vicente Island (Cabo Verde archipelago) was the location to settle the device 503 (Figure 2).

The device 501 started the observation in July 2013, whereas the devices 503 and 502 were initialized in May and August 2014 respectively. The three devices have worked regularly, although with some gaps related to maintenance or small problems due to malfunctions. The frequency of data acquisition was fifteen minutes (900 seconds) and the data transmission occurred each hour, via a GPRS communication network. From the beginning of the operations until August, 31th 2018, the device 501 (Las Canteras) sampled 89.34% of the daily observations, the device 502 (PLOCAN) took 94.84% and the percentage amount for the device 503 (INDP) was 80.6%. Most of the existing gaps were caused by power cuts, communication errors or data-logger malfunctions.

Both Gran Canaria sites (Canteras and PLOCAN) presented same mean values (20.65±2.27°C and 20.65±2.41°C respectively) with maxima around 32°C and minima 11.5°C (Figure 3, first 2 graphs). A higher mean temperature was observed at the Sao Vicente site (23.89±2.13°C), with maxima around 37.1°C and minima 15.3°C (Figure 3, last graph). The three sites showed annual cycle ranges between 5.5°C and 6.2°C and coincided on time, finding the minima at the beginning of March and the maxima around middle of September.

A similar behavior is observed in the daily air temperatures anomalies (Figure 4) at the three sites (Canteras, PLOCAN and INDP). Spring 2017 appears to be the warmer period with temperature anomalies around two degrees Celsius, whereas the Winter 2015 and the year 2018 seem to be the coldest. The highest positive anomalies are observed with the PLOCAN device in Spring 2017 when values rose more than 4°C above average, being this period also highlighted at the other sites. Similarly, the extreme negative anomalies were taken with the Gran Canaria devices, with values around -4°C in 2015 and 2018.

The mean values found for Barometric Pressure at the three sites were around 1016±4hPa, being the maxima 1032 at northern sites and 1022 in Sao Vicente (Figure 5). The minima coincided with Low Pressure transits having values around 1000hPa. An annual cycle is visible having a pressure change of 6hPa at the Gran Canaria sites, whereas it is only 3hPa in Sao Vicente. The maxima appear to be in winter and the minima happens at the end of summer, coinciding with the maximum displacement of the Azores High pressure northwards during this season.

The low pressure transits through the Canary archipelago are clearly visible in the daily pressure anomalies (Figure 6). However, only the deeper low pressure rose in the Cabo Verde device. Alternative seasonal changes are observed in the Pressure time series without showing any inter-annual pattern of variability. These anomalies showed a decrease of pressure up to 20hPa, although they were not frequent. During most of the survey period the anomalies varied ±5hPa, showing that both archipelagos present a very stable atmosphere.

Finally, we have processed the relative humidity data from the three locations (Figure 7). The average of the daily mean values was very similar among sites (68±7%), being the maxima around 90% and the minima close to 20%. This difference between maxima and minima is consequence of the dust events coming from the Sahara Desert and the Sahel. These events are not very frequent but they produce a considerable change in the humidity, giving consequently these very low values. We obtained the annual cycles for each time series (Figure 7; black solid line) with values ranging between 60 and 75%, being the lowest values during winter whereas maxima mainly occurred during summer, following the temperature pattern.

The anomalies of relative humidity clearly show the episodes where the dust affects the atmosphere at the three sites (Figure 8). This affection is numerically higher at Gran Canaria locations, with values up to nearly -20% of negative anomaly. An important period in frequency of dust entrances from the Sahara Desert appears to be towards the end of 2017, although the dust events are visible along the entire survey period.

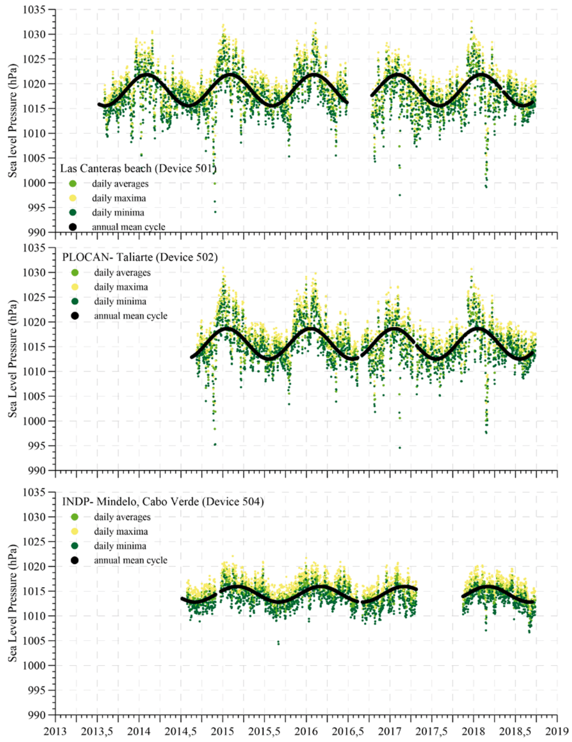


Figure 5 - From up to down.

Daily averages (green), maxima (yellow) and minima (dark green) of Pressure at sea level from the devices settled in Gran Canaria and Sao Vicente, respectively. Black line represents the annual mean cycle in each site (years in X axis).

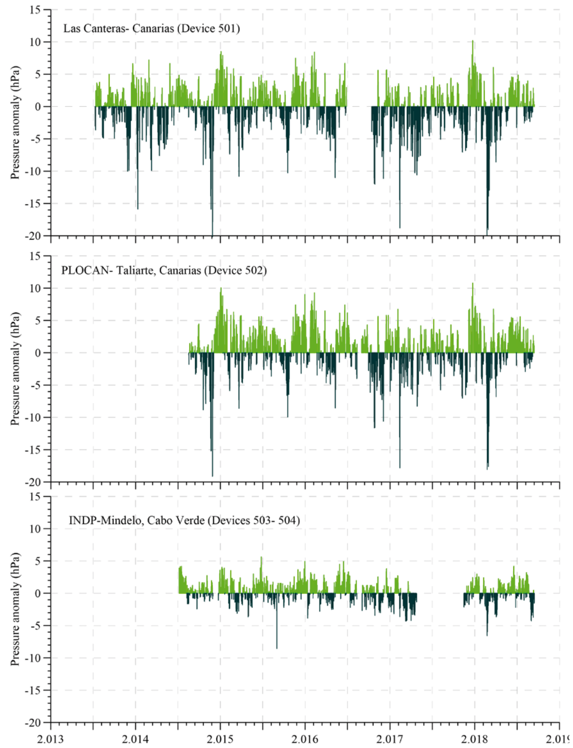


Figure 6 - From up to down.

Daily anomalies of pressure at sea level calculated from the difference between the daily averages and the daily value from the annual cycles. Light green shows the positive anomalies and dark green the negatives (years in X axis).

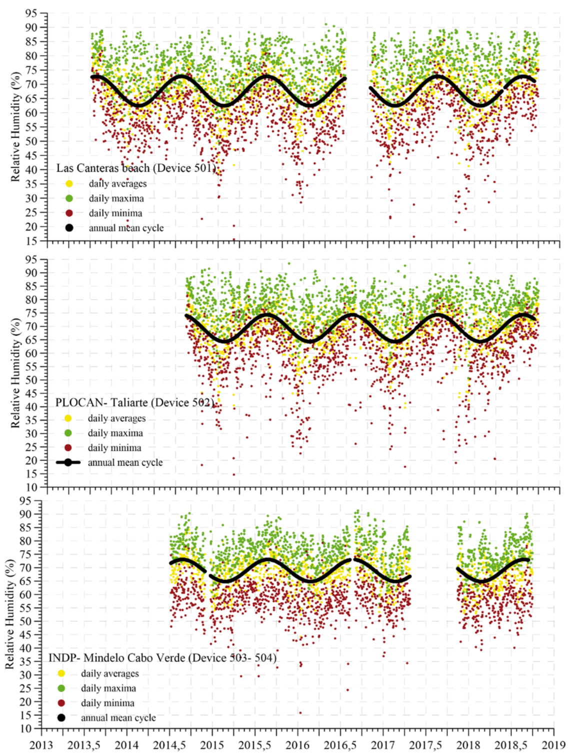


Figure 7 - From up to down.

Daily averages (yellow), maxima (green) and minima (brown) of relative humidity at sea level from the devices settled in Gran Canaria and Sao Vicente, respectively. Black line represents the annual mean cycle in each site (years in X axis).

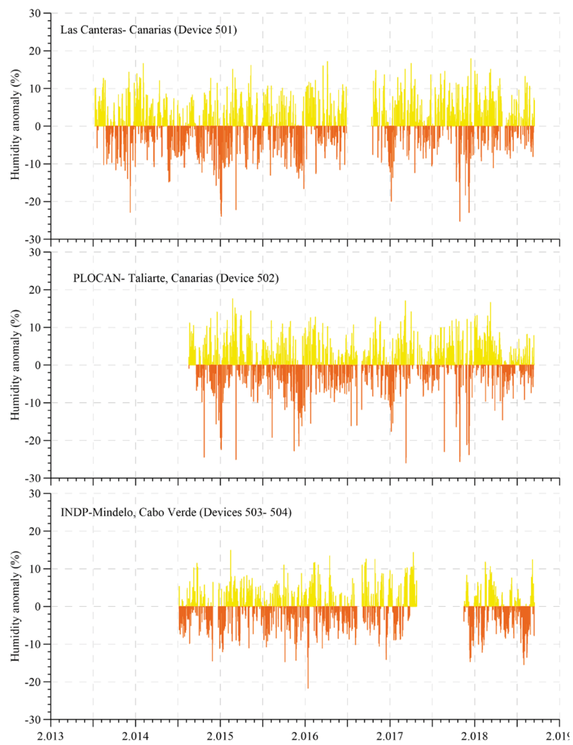


Figure 8 - From up to down.

Daily anomalies of relative humidity calculated from the difference between the daily averages and the daily value from the annual cycle. Yellow shows the positive anomalies and orange the negatives (years in X axis).

THE FIRST MARINE WIND GENERATOR HAS BEEN INSTALLED ON THE PLOCAN TEST BED IN GRAN CANARIA.

Vidina Monagas Machín, Scientific-Technical Co-ordinator of PLOCAN.

Engineering company ESTEYCO installs the first Off-shore Wind sub-structure of the European ELISA/ELICAN Project on the PLOCAN test bed located to the east of the island of Gran Canaria.

Installation of the ELISA prototype in the PLOCAN Test Bed. June 2018

This is the first off-shore wind generator installed in Spain, revolutionising the technological concept of off-shore energy, as the tower is built completely of pre-fabricated concrete with gravity foundations and telescopic installation, which includes a 5MW turbine.

This was the first off-shore wind sub-structure to be installed without the need for major installation equipment, thanks to the telescopic tower and the floating structure, which contributes significantly to bringing the cost of off-shore wind power down. The technological development of ELISA has taken 7 years of research to reach the stage of a life-size prototype.

THE PROTOTYPE, DEVELOPED AND MANUFACTURED BY ESTEYCO, WAS CONSTRUCTED IN THE PORT OF ARINAGA IN GRAN CANARIA, AND LATER TRANSPORTED AND MOORED AT ITS FINAL CO-ORDINATES ON THE PLOCAN TEST BED IN JUNE 2018

The prototype, developed and manufactured by ESTEYCO, was constructed in the Port of Arinaga in Gran Canaria, and later transported and moored at its final co-ordinates on the PLOCAN Test Bed in June 2018. It was fully built and had the turbine already installed when it was floated out to its mooring site. Once at its co-ordinates, the telescopic tower was raised. Together with the rotor blades, it reaches a height of 160 metres.

ESTEYCO technology constitutes the first off-shore wind generator installed in Spain, the first in the south of Europe to use fixed foundations and the first in the world that has not required large vessels or heavy lifting equipment, thus reducing installation costs significantly.

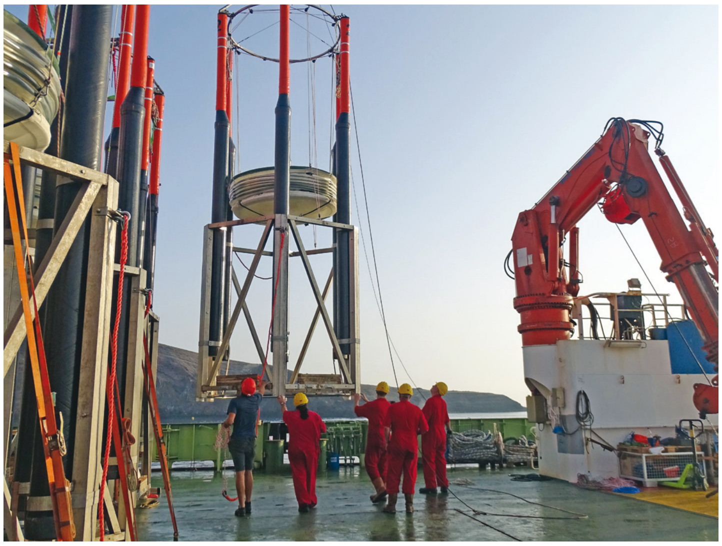
The European Project is being carried out by a consortium led by ESTEYCO, with the participation of SIEMENS-GAMESA, ALE HEAVYLIFT, DEWI GmbH and the PLOCAN consortium.

ESTEYCO TECHNOLOGY CONSTITUTES THE FIRST OFF-SHORE WIND GENERATOR INSTALLED IN SPAIN, THE FIRST IN THE SOUTH OF EUROPE TO USE FIXED FOUNDATIONS AND THE FIRST IN THE WORLD THAT HAS NOT REQUIRED LARGE VESSELS OR HEAVY LIFTING EQUIPMENT

PLOCAN HOSTS THE KOSMOS 2018 GC PROJECT AS PART OF THE OCEAN ARTUP PROJECT

Patricia López. 'Project support technician for the KOSMOS project at PLOCAN'

An international team of 50 marine scientists are participating in a study to investigate the feasibility, effectiveness, associated risks and potential side effects of using artificial ocean upwelling to fertilize ocean productivity and enhance energy transfer to higher trophic levels in order to increase fish production.



A group of biologists, chemists, biogeochemists and physical oceanographers led by Professor Ulf Riebesel, will cooperate closely in the field experiment with KOSMOS mesocosms, which will be conducted in Gran Canaria between October and December 2018.

Within the framework of the Ocean artUp project (ERC-AdG project, https://ocean-artup.eu/), the researchers plan to organize a mesocosm study in Gando Bay. Ocean artUp will further investigate the impacts of artificial upwelling on biogeochemical cycling, including carbon export potential, and air-sea gas exchange of climate relevant gases. This will be addressed through a combination of small-scale batch experiments, long-term in-situ mesocosm experiments, field observations in cyclonic eddies, ecosystem biogeochemical modelling of the relevant processes, and the technical development, construction and testing of a free-drifting pump system, and its application in an artificial upwelling pilot study.

For this experiment, nine mesocosm bags will be deployed in Gando Bay and artificial upwelling of varying intensity will be simulated (by varying the volume of deep water added). For a period of around 10 weeks, the plankton community inside the mesocosms and the biogeochemically relevant pools and fluxes of carbon, nitrogen, phosphorus and silica will be monitored daily.

'Deplyment of the mesocosms in Gando Bay' (general)

PREVIOUS AND FUTURE EXPERIMENTS:

The KOSMOS facility has been successfully employed in long-term experiments in various climate zones, ranging from the high Arctic to temperate waters in the Baltic and North Sea and the oligotrophic waters off Gran Canaria and Hawaii. These studies have focussed on the effects of ocean acidification plankton dynamics and biogeochemical cycling.

As part of SOPRAN (Surface Ocean Processes in the Anthropocene) and BIOACID (Biological Impacts of Ocean Acidification), three KOSMOS experiments have been carried out in Gran Canaria: two in 2014 in Melenara Bay and in Gando Bay and one in 2016 in Taliarte Harbour. The last experiment consisted of a small-scale experiment for practicals for Masters students of Biological Oceanography (BIOC) at the Christian-Albrechts-Universität zu Kiel.

Within the framework of Ocean ArtUp, a small-scale experiment has been conducted in Taliarte Harbour in 2017, and more experiments are planned for the coming years in Gran Canaria and Peru.

Sketch of a single mesocosm unit, with the floating frame at the top, which supports the 17 m long enclosure bag.

PLOCAN Glider School

Carlos Barrera. Jefe de Grupo - Area VIMAS. Plataforma Oceanica de Canarias".

The "PLOCAN Glider School" is a highly specialized certified training initiative, unique in its field, with international dimension and under the coordination of PLOCAN, which takes place yearly in Gran Canaria since 2011, related to applied marine robotics.

Session on ocean-glider applications

PLOCAN Glider School provides the ideal training framework in which converge for six days a selection of fifteen students from the academic and business sector together with the main global manufacturers of ocean gliders and an experienced group of international users in technical and scientific disciplines.

The educational contents of the Glider School are structured in dedicated theoretical-practical sessions in the classroom, laboratory and open water, with the main objective of offering respectively the most complete and wide vision of the technical aspects and operational capabilities that the current state-of-the-art of this cutting-edge autonomous devices provides to the users aiming for a better, more efficient and sustainable ocean observation. Main topics includes ocean glider technology general features at hardware and software level, payload sensor configuration, mission planning, applications, telemetry options, deployment and recovery procedures, piloting, maintenance, among others.

The nine editions carried out up to date have had the support and direct participation of more than twenty-five international leading companies in the sector of robotics and marine sensors (Teledyne Marine, Kongsberg Maritime, Liquid Robotics, Alseamar, Excetus, Seabird Scientific, CLS , Aanderaa, Turner, Idronaut, OceanSonics, Offshore Sensing, Contros, Nortek AS, Ocean Aero, Rockland Scientific, SA Instruments, SensorLab, Wetlabs, RBR, etc.), the main international institutions of scientific-technical base users of this type of technologies (NOCS, MARUM, GEOMAR,

Practicing in real operational scenarios with different glider technologies

Different technologies of ocean glider showcased and tested by students

CNRS / DT-INSU, WHOI, Memorial University, PROOCEAN, SAMS, ANFOG, NOAA / IOOS, BODC, Rutgers University, SOCIB, SCRIPPS, Cyprus University, UEA, among others) and allowed to train more than a hundred students from countries around the world like France, Italy, Tunisia, Greece, Germany, Sweden, Canada, USA, Brazil, Ecuador, Nigeria, Australia, Cyprus, Cape Verde, Colombia, Turkey, Chile, Israel, Portugal, Ireland, United Kingdom, Mexico, Finland, Korea, Poland and Spain. Specifically, 130 students from 26 countries, highlighting that 90% of them come from Europe and USA.

PLOCAN is a member of the EGO-gliderports (https://www.ego-network.org/dokuwiki/doku.php) international network, made up by highly specialized infrastructures, with technical capabilities and service provider of both operational and training related to ocean glider technology. EGO promotes in a coordinated way the use and technological improvements of the gliders destined to ocean observation through missions and experiments, tutorials, schools, technical notes, thematic forums, workshops, as well as data availability, communication protocols, calls for transnational access (TNA), etc. all from the field of dissemination and applied use of the information generated by these devices in a wide range of socioeconomic sectors of the marine-maritime field worldwide.

After just ten days since the end of the 2018 edition, PLOCAN is already working on the special edition of 2019 being the tenth.

Fig. 1 – PLOCAN's Wave Glider SV2 (Liquid Robitics©) ready to be deployed

MARCET

Collaboration between PLOCAN and whale watching companies in a pilot study using autonomous vehicles: efforts towards a more sustainable commercial activity.

Carlos Barrera, Eric Delory and Silvana Neves (Plataforma Oceánica de Canarias).

The MARCET project transfers and disseminates cutting-edge science and technology in order to promote growth and sustainable development of tourism directly and indirectly related to Whale Watching, through the creation of new eco-innovative products and services. In particular, centres specialised in the monitoring and tracking of cetacean health and in operational oceanography will be brought together from across the region in order to integrate, harmonise and optimise knowledge, infrastructures and best practices in the region.

Interreg
Fondo Europeo de Desarrollo Regional
EUROPEAN UNION
MAC 2014-2020
Cooperación Territorial

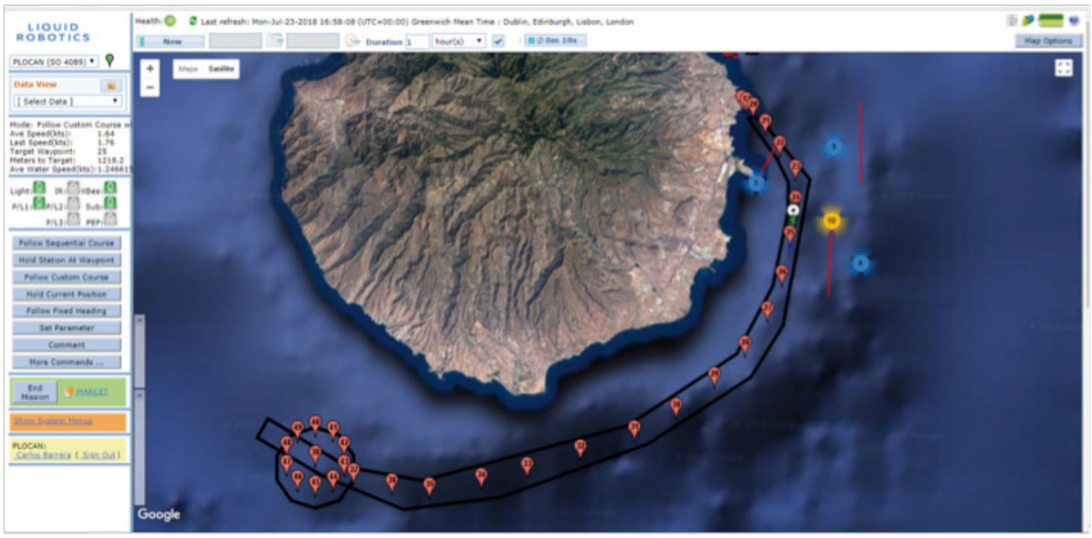


Fig. 2 - Screenshot of the WGMS graphic interface displaying the path for the WG mission plan.

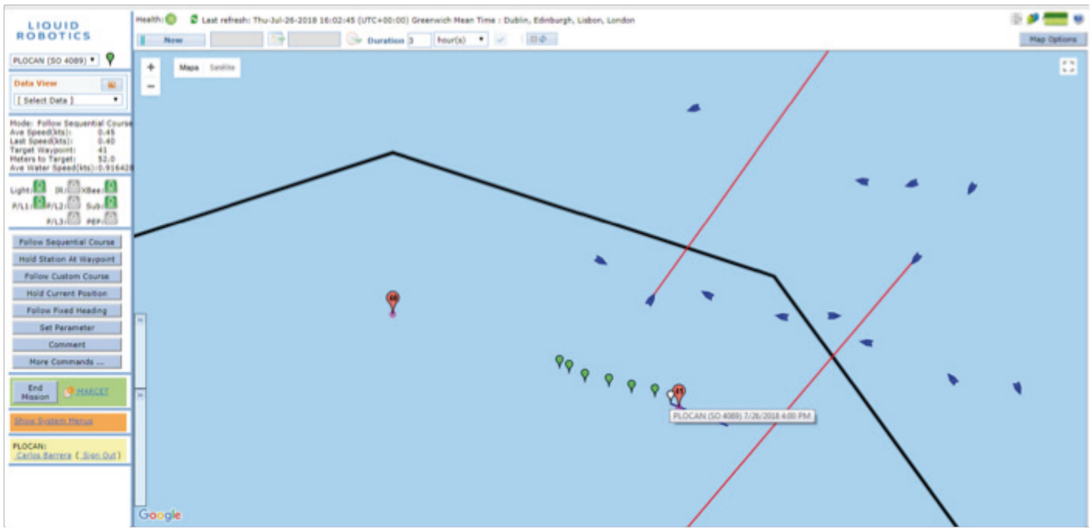


Fig. 3: Detail of the WGMS piloting graphic interface displaying the Wave Glider position and Whale-watching vessels located in the surroundings.

Moreover, involving marine science and technologies directly with the whale watching companies contributes to the improvement of the business competition and diversification of the specialized tourism in all three regions. This is achieved by the appreciation and protection of its biodiversity through sustainable development. Additionally, the integration of advanced knowledge and expertise in cutting-edge information and communication technologies (ICTs) will lead to the increasing of the digital knowledge of the marine sciences and the specialized tourism in the three regions of the Macaronesian area.

PLOCAN IS RESPONSIBLE FOR THE OPERATIONAL OCEANOGRAPHY ASPECT OF THE PROJECT WITH SEVERAL PLANNED MISSIONS WITH AUTONOMOUS VEHICLES THROUGHOUT REAL OPERATIONAL SCENARIOS ACROSS THE MACARONESIA WATERS.

PLOCAN is responsible for the operational oceanography aspect of the project with several planned missions with autonomous vehicles throughout real operational scenarios across the Macaronesia waters. The latest was performed in Gran Canaria from PLOCAN headquarters to the South of Gran Canaria where whale watching companies mostly operate. The mission was carried out by a Wave Glider SV2 (Liquid Robotics©) (Fig. 1). The Wave Glider is an unmanned ocean mobile platform able to harvest the ocean-wave power as source of energy for sailing, suited in this case with a dedicated payload sensor configuration that includes a conductivity, temperature and pressure (CTD) unit, dissolved oxygen sensor, a meteorological station for wind speed and direction, air temperature, air pressure and relative humidity, as well as a passive acoustics module (PAM) for marine mammal and noise monitoring on a towbody platform. The PAM unit (Saint Andrews Instrumentation ©) is equipped with a broadband Teledyne Reson TC4014-5 hydrophone and DECIMUS© main board electronics and software tools for embedded data processing before sending only useful data to the end-users by the bi-directional satellite telemetry unit of the Wave Glider SV2.

The mission started in Melenara bay (Telde) with the launching and preliminary verifications of the Wave Glider performance regarding navigation and science data gathering, in order to cover the mission path as shown in Fig. 2

Piloting 24/7 was conducted by PLOCAN technical staff through the Wave Glider Management System (WGMS©), a graphic interface as well as a software tool able to keep control in real time from land over the Wave Glider during the mission, consisting in two main areas: transect between Melenara Bay and the Southwest coast of Gran Canaria, and a dedicated "stand-by" monitoring area (circle) overlapped with the area where the whale watching activity usually takes place, as a result of the cooperation between MARCET partners involved in the mission as shown in Fig. 3.

The Wave Glider was successfully recovered in coastal waters of the Southwest of Gran Canaria (Mogán) after nine days of continuous mission (Fig.4).

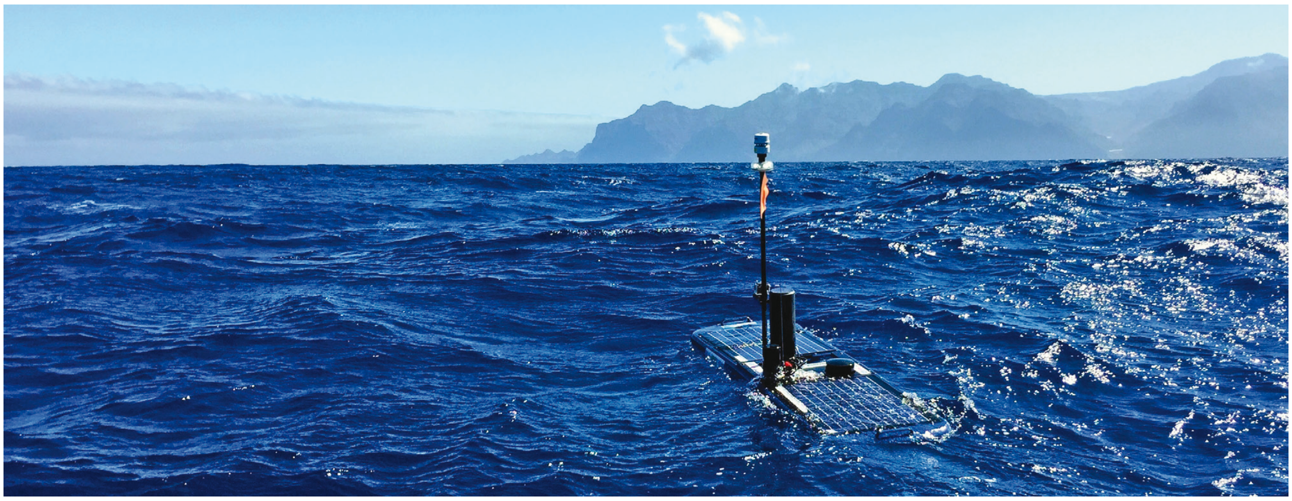


Fig. 4: Wave Glider sailing in waters of the Southwest of Gran Canaria.

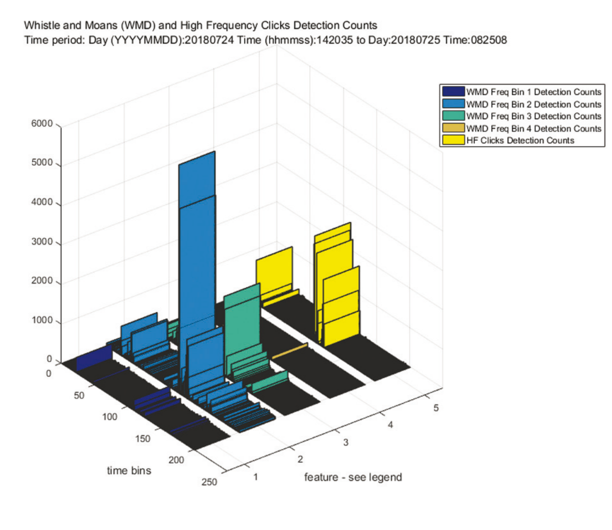


Fig. 5: Whistles and click detections. Results of the real time processing of the towed acoustic system installed on the wave glider during the MARCET mission.

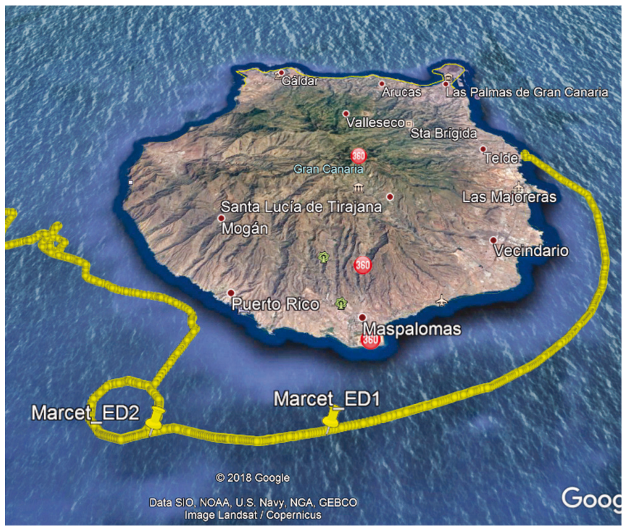


Fig.6: The acoustic detections in Fig.5 correspond to the path between Marcet_ ED1 and Marcet_ED2 waypoints

This operation was a collaborative effort between the partners of the project, namely the Dolphins and Whales S.L. Their boat, Spirit of the Sea coordinated with the other companies that operate in the area, and during the time period while the Wave glider was in the whale-watching area, the whale watching boat skippers established a communication channel where the species, date and time and geographical position of the species sighted were reported to the autonomous vehicle pilots. This way the vehicle could be directed to a position closer to the marine mammals being watched. This cooperation will help the validation of the dolphins and whales identified through the towed acoustic sensor. Preliminary results are illustrated in (Fig. 5).

The acoustic detections shown in figure 5 were obtained between Marcet_ED1 and Marcet_ED2 geographical points (Fig. 6).

These are promising results and a good example of the collaborative effort between the partners of the project. Further investigation on the vocalizations detected is currently being pursued towards the validation and identification of the species detected by the system.