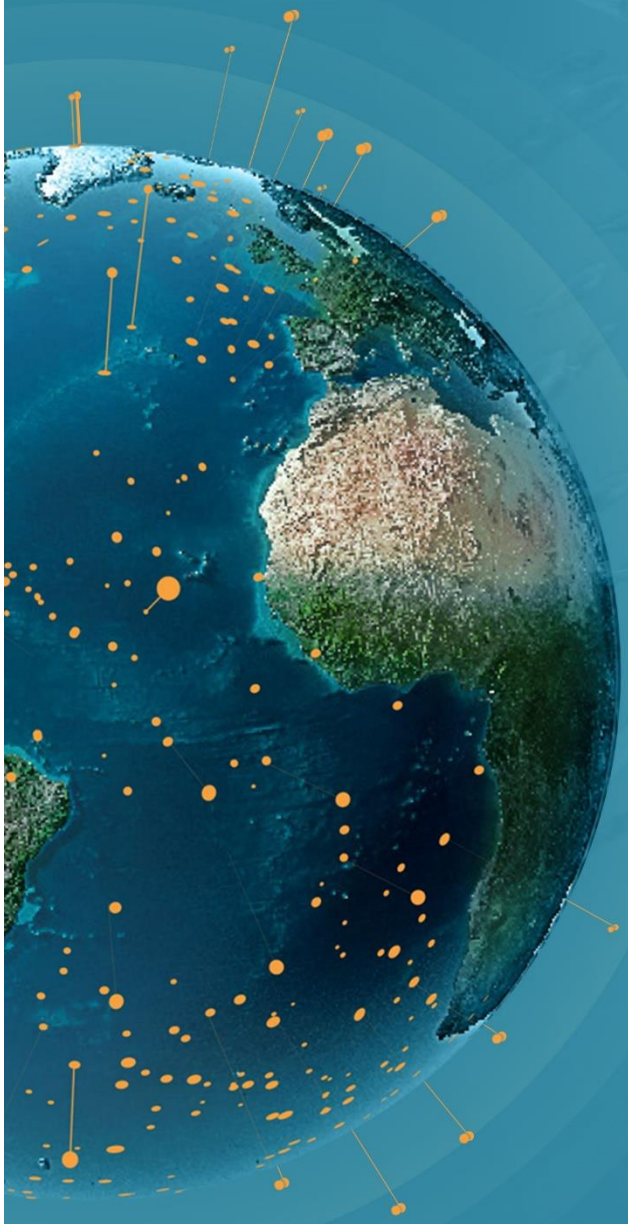

ALL-ATLANTIC OCEAN RESEARCH ALLIANCE

Creating an Atlantic Ocean Community by Implementing the Galway and Belém Statements

AA-MARINET Report:

Case study ship-time sharing and cooperation opportunities

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

Report Identifier

Report name	**AA-MARINET Report:Case study ship-time sharing and cooperation opportunities**
Related Project title	All AtlaNtic Cooperation for Ocean Research and innovation
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ALL-ATLANTIC JOINT PILOT ACTIONS

Following a year-long collaborative process among more than 70 stakeholders at the Atlantic level, the All-Atlantic Ocean Research Alliance Multi-Stakeholder Platform, divided into 5 sub-multi-stakeholders platforms, identified more than 1000 initiatives towards strengthening marine research and innovation collaboration at the Atlantic level, 56 gaps and 79 needs/recommendations to achieve the All-Atlantic Ocean Research Alliance ambition, guided by a total of 20 Strategic Objectives, 20 Operational Objectives, and 10 Key Performance Indicators.

Based on these findings and on the idea of collaboration, alignment, and use of existing resources, they have developed six ambitious and long-term collaborative Joint Pilot Actions:

- All-Atlantic Training Platform (AA-TP)
- All-Atlantic Aquaculture Technology and Innovation Platform (AA-ATiP)
- All-Atlantic Marine Biotechnology Initiative (AA-BIOTECMAR)
- All-Atlantic Data Enterprise 2030 (AA-DATA2030)
- All-Atlantic Blue Schools Network (AA-BSN)
- All-Atlantic Marine Research Infrastructure Network (AA-MARINET)

This report is developed by the All-Atlantic Marine Research Infrastructure Network (AA-MARINET) Joint Pilot Action, that provides tools to support a transatlantic network of Research Infrastructures initiatives, promoting Trans-National Access and other methods for sharing infrastructures in the Atlantic area. It will work as a platform where stakeholders can share information about planned observation activities and available spare capacities, creating a forum where thematic networking and synergies will bring a better articulation of infrastructure-related activities in the Atlantic basin, improving the support of multidisciplinary science to address global societal challenges.

This report is a deliverable in scope of AA-MARINET task 3 “Case study ship-time sharing and cooperation opportunities” that aimed at providing background knowledge to potentially expand the ship-time sharing mechanism to other areas and communities.

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AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

SUMMARY

During the seed-funding period of AA-MARINET Joint Pilot Action a case study of cooperation and sharing of observation infrastructures was conducted in the eastern part of the All-Atlantic basin. The case-study developed in the framework of Task 3 of AA-MARINET and profited from the opportunity offered by a mission conducted by a hydro-oceanographic vessel of the Portuguese Navy that, between October 2021 and January 2022, covered the area between the continental coast of Portugal, Cabo Verde Archipelago, Angola and São Tomé e Príncipe. Three potential scenarios for cooperation and sharing of infrastructures in the Atlantic were explored. Scenario 1 corresponded to cooperative actions during a dedicated multidisciplinary survey and was developed in the Cabo Verde Archipelago, between 30 of October and 15 November 2021. It included the involvement of elements from partner institutions in the All-Atlantic area, particularly local partners, and the use of a ship as an opportunity to deploy a Waveglider, among other aspects. Scenario 2 was conducted in the global area covered during the mission and corresponded to the opportunistic use of a research ship visiting those areas to deploy surface floats and to conduct observations of the presence of invasive biological species. Scenario3 started during the mission conducted by the ship but extend long after the end of this mission. This scenario explored the sharing of observing systems and the joint operation of fixed platforms installed in the coastal ocean areas of Cabo Verde, Angola and São Tomé e Príncipe. The present report will describe the activities developed in association with the development of these three scenarios.

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1. Introduction

The "All-Atlantic Marine Research Infrastructure Network" Joint Action (AA-MARINET) was developed under AANChOR WP7 (Alignment and Convergence of Research and Innovation Infrastructure Initiatives) with the aim at creating a long-term collaboration framework to promote and facilitate the convergence and the alignment of Research and Innovation infrastructure initiatives in the All-Atlantic domain. AA-MARINET was aimed to provide a forum and tools to support the development of a transatlantic network of RI initiatives and promote Trans-National Access (TNA) and other methods for sharing infrastructures in the Atlantic area, thus supporting the implementation of the Belém Statement.

AA-MARINET activities will address in the long-term the 5 different types of marine research infrastructures that were identified by the sub-Multi Stakeholders Platform (sMsP) "convergence and alignment of R&I infrastructures initiatives" to tackle the Belém Statement thematic areas. These are research vessels, in-situ data acquisition systems, marine data centres, marine land-based / offshore facilities for engineering, experimental facilities for biology and ecosystem studies. During the seed funding period the focus was on infrastructures for observation.

AA-MARINET strategy comprised three levels of approach and engagement between partners. The first level is based on the implementation of a web portal to unlock the potential for articulation of the observation activities conducted in the Atlantic basin and was developed by Task2. In the second level approach of cooperation, AA-MARINET will facilitate thematic areas networking, addressing specific needs of RI communities, such as plankton imaging (I/ITAPINA), coastal observation (AA-COASTNET) and polar research (NMRI-PR).

The third level of alignment of RI was showcased trough a case-study which would focus on the possibility to exchange ship-time, fixed platforms and autonomous systems for monitoring and/or cooperation opportunities during planned cruises between research vessel operators from different Atlantic countries, following the OFEG and Eurofleets+ examples (http://www.ofeg.org/, https://www.eurofleets.eu/). This will provide the background knowledge to potentially expand this sharing mechanism to other areas and communities after the end of the joint action. This case study was developed in AA-MARINET Task 3 and the present report provides an account of the main activities developed in this task, the main achievements that it produced and the main difficulties that were identified.

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2. A Case Study in the Eastern Atlantic

The opportunity for developing a case study that could focus different axis of the sharing of observation infrastructures was presented in 2021. The Mar Aberto Initiative is one of the missions conducted by the Portuguese Navy with the aim of strengthen cooperation and know-how exchange in several areas with countries along the Atlantic African coast. Instituto Hidrográfico (Portugal), a state laboratory of the Portuguese Navy, is involved in the Mar Aberto Initiative missions that are more focussed on technical and scientific cooperation and that are developed with the involvement of an hydro-oceanographic vessel of the Portuguese Navy. Typically, the action of Instituto Hidrográfico on these missions comprise activities such as hydrographic surveying in close cooperation with the national authorities of visited countries.

The fall-winter 2021 Mar Aberto Initiative mission was planned to be conducted by the hydro-oceanographic vessel NRP "D. Carlos I" of the Portuguese Navy, with activities to be developed in Cabo Verde, Angola and São Tomé e Príncipe (figure 1). The large area of the Eastern Atlantic that was planned to be covered during this mission and the broad diversity of partners in each country that could be engaged, opened the opportunity for planning a scientific and technical program to be developed during this mission that could explore different perspectives of sharing of observation infrastructures. This program was started to be prepared in the summer 2020 and had its beginning in October 2021, when NRP "D. Carlos I" left Lisbon and head to Cabo Verde Archipelago. Some of the components of the program are still ongoing as it will be described in the following subsections.

The case study comprised three main scenarios for cooperation and sharing of infrastructures for observation of the All-Atlantic domain. These scenarios were developed and assessed in association with the scientific and technical activities conducted during the Mar Aberto Initiative fall-winter 2021 and area described in detail in the following subsections.

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Figure 1 Ship track covered during Mar Aberto Initiatite fall-winter 2021 mission, including area of dedicated multidisciplinary survey in Cabo Verde Archipelago

Figure 2 The hydro-oceanographic vessel NRP D.Carlos I from the Portuguese Navy.

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2.1 Cooperation during Dedicated Multidisciplinary Surveys

The first scenario that was explored during the Mar Aberto Initiative fall-winter 2021 corresponded to the cooperation of different research partners, from different countries, in association with a dedicated observational effort developed in a given geographical area of the All-Atlantic domain. This scenario was explored through the conduction of a multidisciplinary research survey on the waters of Cabo Verde, profiting from the presence of NRP "D. Carlos I" in those waters between October and November 2021.

The preparation of this mission started in August-September 2020, with the establishment of the first contacts between elements from Instituto Hidrográfico (IH, Portugal) and colleagues from Instituto do Mar I.P. (IMAR, Cabo Verde), to evaluate the feasibility of profiting the presence of the ship in Cabo Verde waters in 2021 to develop a program of observations of that area. These contacts were rapidly extended to include colleagues from Instituto de Engenharias e Ciências do Mar – Universidade Técnica do Atlântico (ISECMAR UTA, Cape Verde) and from the Helmoltz Centre for Ocean Research Kiel (GEOMAR, Germany). IMAR and GEOMAR jointly operate the Oceanographic Science Centre of Mindelo (OSCM) and the Cabo Verde Ocean Observatory (CVOO), the last one a permanent fixed platform equipped with measuring instruments from near surface to near bottom, which is located in the abyssal plain area north of Cabo Verde Archipelago.

The COVID 19 crisis rendered particularly difficult to have a clear view of the planning for the operations for the fall 2021. Despite these difficulties, the interaction with the colleagues from IMAR, UTA and GEOMAR allowed to define a planning for a two-week survey onboard NRP "D. Carlos I", to be held from end of October2021 to mid November 2021.

The initial observations plan was aimed to collect data that could improve our understanding of the dynamics in the global area of the Cabo Verde Archipelago. A particular emphasis was given to the potential influence that oceanographic features that develop along the western African coast (the Cape Blanco upwelling filament) may have on the transport of continental influenced to the waters of the archipelago. To accomplish these goals an observation program that extended over the complete Cabo Verde Archipelago, and that detailed some particular areas, was planned. The interactions with the colleagues from IMAR and UTA were particularly important to articulate and fine-tune this strategy of the observations. In this regard, they were key to include in the program the coverage of areas of particular interest, such as the João Valente Submarine Bank, between the Islands of Santiago, Maio and Boavista. This is an important and poorly know area, marked by extreme processes and important conservation issues and in which IMAR and UTA, together with other international partners, are developing an intense research work.

One of the areas in which the preparatory discussions held during 2021 were focused was on the potential participation of researchers from IMAR or UTA onboard during the cruise, particularly it was evaluated the possibility that this participation onboard could allow to integrate a number of biological measurements that were not contemplated by IH program. This possibility was, however, discarded due to the significant

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participation of elements from IMAR and UTA in another cruise that was planned to be conducted onboard a Norwegian research vessel, starting from the Canary Islands. It was however possible to articulate the presence onboard of two students from UTA which were integrated in the scientific team and were involved in the different aspects of the work, with particular focus on the water sampling and laboratory analysis for evaluation of nutrients, contaminants and chlorophyll on the water column.

The program of observations onboard NRP "D. Carlos I" also opened the opportunity to articulate with the colleagues from GEOMAR the deployment of a Waveglider, a surface vehicle propelled by the movements associated with the surface waves, which uses satellite communications both to transmit the data collected and to be navigated remotely. This type of vehicles can operate for long periods and cover a large geographical area, collecting a broad range of surface measurements. GEOMAR conducts regularly observations missions in the Cabo Verde area using this type of systems. The NRP "D. Carlos I" mission to Cabo Verde, in the framework of Mar Aberto Initiative fall-winter 2021, opened an excellent opportunity to develop one of such missions, allowed to embark the wave glider in Lisbon, in early October 2021, and to deployed it during the observations program. An additional point of interest was the fact that the observations conducted onboard the ship would be used to compare and complement the Wave glider observations in the same area.

NRP "D.Carlos I" arrived at Mindelo (São Vicente Island, Cabo Verde) on the 28 October 2021. The scientific team from IH, GEOMAR and UTA entered onboard on that same day and started the preparation of equipment's and laboratories. The multidisciplinary survey started on the 30 October 2021, and developed until the 15 November 2021. During the two weeks period a number of technical problems and bad weather conditions affected the conduction of the works and required to proceed to adjustments to the initially planned program of work. The mission allowed to collect a number of vertical profiles of temperature, salinity, DO2, turbidity and pH to water depths up to 1500m, using a CTD probe from IH. These profiles were complemented with current profiles collected with an Acoustic Doppler Current Profiler (ADCP) installed in the CTD frame and operating as a Lowered ADCP in downward looking configuration and by water samples collected by a Rosette sampler with 12 Niskin bottles that was associated with the CTD probe. In addition, during the transits of the ship and in station, a Vessel Mounted ADCP system provided current profiles up to 1000m depth and systems installed onboard provided continuous sampling of microplastics (IH) and biogeochemical parameters (GEOMAR).

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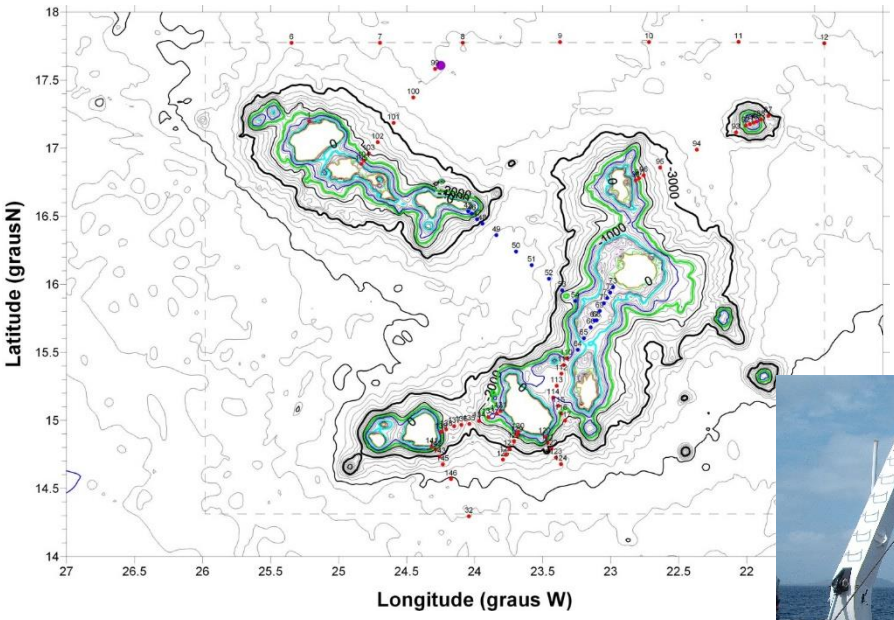

Figure 3 Map of CTD stations covered during the October-November 2021 mission in Cape Verde waters (on the left) and recovery of the CTD system at the end of one of these stations (below)

During this period of two weeks a total of 4 surface floats were deployed in different location in the global area covered by the survey. The majority of these floats were part of the collaboration with the NOAA Surface Drifter Program, which will be discussed in the following subsection. These floats provided location and sea surface temperature (figure 7) and complemented very well the observations conducted onboard or with the Waveglider from GEOMAR. One of the floats was a prototype (Wavy Ocean) developed in the framework of the European project MELOA, and the deployment in the waters of Cabo Verde provided the opportunity to test this floats in this geographical region and to compare its performance regarding the NOAA surface drifters.

As indicated before, the mission in Cabo Verde waters provided the opportunity to deploy a Waveglider from GEOMAR (figure 4). This equipment was deployed on the 8 November, in the northern part of the area covered, in a position to the north of the Cabo Verde Ocean Observatory. The program of observations continued and one day after the deployment of the Waveglider the ship was close to the Cabo Verde Ocean Observatory at the same time of the Waveglider that has moved to the same area. This allowed the collection of measurements in a close position, which may be used for future intercomparisons and integrated analysis. After the depart of the ship from the area, the GEOMAR Waveglider continue its own program of observations, remaining in Cabo Verde Archipelago waters from several months.

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In addition, the program of observations conducted during the cruise also allowed to articulate with the Cabo Verde Ocean Observatory (CVOO). Some of the CTD profiles collected by the team onboard NRP "D. Carlos I" were conducted in the vicinity of this permanent observatory, providing independent measurements that can be used in inter-comparisons and integrated analysis. In the CTD station that was closer to CVOO, water samples were collected by GEOMAR at the standard depths used for assessment and calibration of the measurements collected by the instruments that are part of the observatory (figure 5).

Figure 4 Deployment of the GEOMAR Waveglider

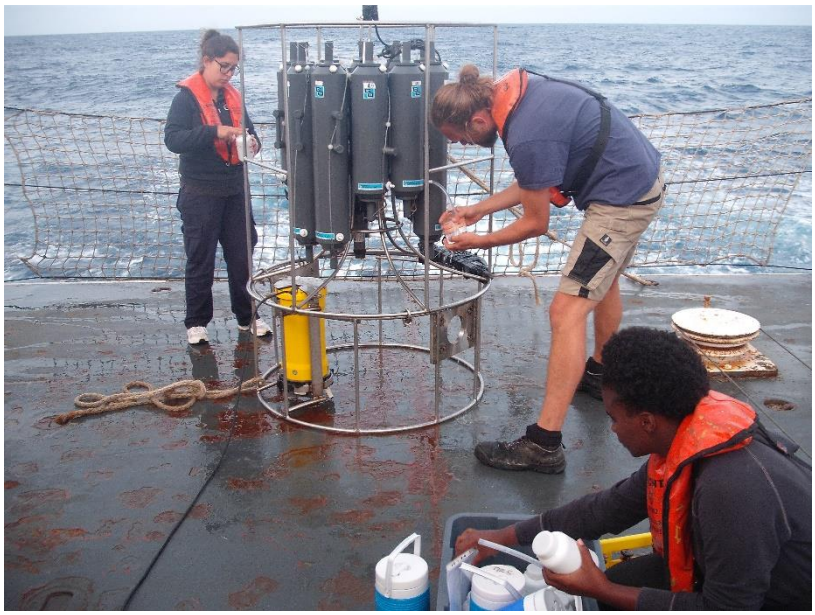

Figure 5. Water Samples collected in the vicinity of the Cabo Verde Ocean Observatory (CVOO) are taken from the Roset Sampler that equiped IH CTD system.

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Finally, the survey in Cabo Verde waters also allowed to start the program of observations for the presence of Sargasso in the Atlantic, which will be discussed in detail in the next subsection. The detection of Sargasso in the surface waters south of Cabo Verde Archipelago initiated this program, the presence of the scientific team still onboard during this phase allowing to train the ship crew in the activities involved to this program.

COMMUNICATION ACTIVITIES

The mission of NRP "D. Carlos I" in Cabo Verde waters also proportionate an opportunity for interaction between IH team and different local entities, namely to present the main objective and achievements of the observational activity that was developed in that Atlantic area. On the 29 October 2021, before the start of the mission, the scientific team visited the installations of the Oceanographic Science Centre of Mindelo (OSCM) and had the opportunity to give a brief presentation of the mission to a group of students from UTA and to researchers from IMAR and UTA. Later, during a scale at the capital of Cabo Verde, the city of Praia in the Island of Santiago, two elements from IH (João Vitorino and Carla Palma) were invited to be present in a session held at the Portuguese Embassy in Cabo Verde, dedicated to the presentation of the overall Mar Aberto Initiative mission. Here, the two members of the scientific team were asked to give a brief presentation about the objectives and achievements of the scientific mission, the collaborations that were developed with different partners and the All-Atlantic framework in which this work was being developed.

STUDENTS TRAINNING ACTIVITIES

The Cabo Verde multidisciplinary cruise also opened and opportunity to develop a program of training of students in the areas of Marine Sciences. Two students from UTA participated in the mission and were involved in the diverse set of activities developed, with emphasis from the program of water sampling for evaluation of nutrients, contaminants and chlorophyll in the water column. One of the students continued the work at the installations of Instituto Hidrográfico, in Lisbon, between February and April 2022. The training period for this student was supported by a NF-POGO Shipboard Training Fellowship associated with the mission at sea and consisted in the laboratory analysis of the samples collected during the cruise and integrations with other complementary data. This work contributed to the Degree Thesis that the student presented at UTA.

Figure 6. Students from UTA (Cape Verde) preparing water samples onboard NRP D. Carlos I laboratories.

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EVALUATION OF THIS SCENARIO FOR COLLABORATION AND SHARING INFRASTRUCTURES

The experience provided by the conduction of the fall-winter 2021 dedicated observation program in Cabo Verde, inserted in a larger mission that extended over a broad area of the All-Atlantic domain, can be translated in a number of lessons-learned.

Some of the lessons-learned acquired during the preparation and conduction of the dedicated survey in Cabo Verde in October-November 2021 allow a SWOT (Strength, Weaknesses, Opportunities and Threats) analysis of this type of cooperative efforts.

STRENGTHS: A broad articulation of efforts between different partners of the All-Atlantic community was easily developed and implemented following the confirmation that a research vessel was planned to conduct dedicated scientific observations in an area of the All-Atlantic domain.

This type of articulation lead to a significant improvement of the observational effort and, consequently, of our ability of characterize and understand main aspects of the All-Atlantic space. They introduce the possibility of measure new variables and, in this way, to extend the initially planned program of observations to marine sciences that were not contemplated by the leading institutions in their initial cruise planning. They also allow the sharing of different type of observing infrastructures besides the ones initially planned, allowing the collection of a broad range of complementary observations.

The collaborative action with teams operating gliders or autonomous vehicles is particularly fruitful. For the objectives of a research survey such as the one we have conducted in October-November 2021, which was focused on a specific geographical area. Systems such as gliders or AUVs can either be deployed at the start of the mission and recovered at the end or, in alternative, can be launched at intermediates period, to explore in detail smaller domains while the ship is covering a large area. These systems provide a set of measurements that complement the ones conducted onboard, allowing for example the coverage of complementary geographical domains or the repetition of the domains already covered by the ship to characterize time evolution. On a broader perspective, this articulation efforts also leads to the possibility of transporting these vehicles to geographical areas from which they can start a broader and more extended program of observations. This opportunity can be particularly relevant if these type of systems are to explore large remote areas of the All-Atlantic.

WEAKNESSES: The extend and effectiveness of the articulations that can be developed in association with a particular multidisciplinary survey depends on the knowledge about the observation action that will be held. This requires a permanent information not only in the phase of preparation of the survey but also during the conducting of the work since opportunities can manifest during this period.

For example, during the mission in Cabo Verde waters, in 2021, a Norwegian research vessels arrived to the Cabo Verde Archipelago area to conduct research work already when NRP “D.Carlos I” was conducting our program of observations. A higher level of articulation and complementarity could have been achieved if we had been able to establish contacts and try to collaborate but in fact both teams had deficient

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knowledge about each other plans and, on addition, the scientific team onboard NRP "D. Carlos I" had some difficulties in communicate. A mechanism such as the collaboration portal that was implemented during 2022 under AA-MARINET Task 2 could have been an important support here, allowing an alert of convergent planning and easing the interactions.

OPPORTUNITIES: The easy implementation of the program of collaborative dedicated observations during the multidisciplinary cruise in Cabo Verde waters opens the possibility of furthers and more intensive cooperations. The possibility of articulating the presence of a hydro-oceanographic ship of the Portuguese Navy with research vessels from IMAR or from GEOMAR, during the same time windows and to conduct articulate programs of observations was discussed in the preparatory phase for the mission in 2021 but was not feasible in time. But it certainly is one of the possibilities that open in the near future.

THREATS: A real problem faced by research institutions or individual researchers that want to profit from collaborations associated with the presence of research vessel in a given area of the All-Atlantic is the heavy bureaucracy that, with more or less degree depending on the countries, is associated with the transport of scientific equipment's to and from the ships. These difficulties are, in some way, less sensible in the cases when the equipment enters onboard (at the start of the mission) and leaves (at the end) on the national ports of origin of the ships. But if a mission at sea extends for several months, and the equipment is to be involved only in a small part of the mission (say a few weeks) there is the need to disembark it in another port/country and to transport it back to the researcher lab or institution. This can be a very difficult enterprise, implying an administrative process that can extends for several weeks if not months until the equipment is returned to the owner. The anticipation of these difficulties can kill the interest and availability for an institution or an individual researcher to share a particular equipment (a sensor, a laboratory package, a glider or a AUV, among others) to be used during a mission at sea profiting from the opportunity.

In our case study, for example, once the Cabo Verde survey was finished and since the ship continued the mission to Angola and São Tomé e Príncipe during the following two months, it was decided to disembark some equipment (one CTD probe and other sensors) that were needed at IH. We hoped that this equipment could be to back in Lisbon well in advance of the arrival of the ship. In reality, and due to different bureaucratic delays, it was finally delivered at IH only in February 2022, about two weeks after the return of the ship to Lisbon.

This is an area were, perhaps, the All-Atlantic community can play an important role in putting together a mechanism of support that could help to make more agile the process of transporting scientific equipment from institutions to the ships and back to institutions, capable of operating at different countries of the Atlantic area. This could guarantee that opportunities for sharing observation infrastructures be fully profited in the All-Atlantic domain.

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2.2 Observations of Opportunity

The second scenario that Mar Aberto Initiative fall-winter 2021 mission allowed to explore was the potential use of the presence of a research vessel in areas of the All-Atlantic domain to conduct opportunistic observations that are crucial for the understanding of key processes in this region. Two examples of this type of scenario were explored during the mission.

This first example corresponded to the conduction of a program of deployment of surface drifters that integrated the NOAA Surface Drifter Program, during the complete extension of the Mar Aberto Initiative fall-winter 2021. This program was integrated in a collaborated between IH, E-SURFMAR and NOAA, which was initiated in 2019 and, since then, allowed to profit the missions from different ships of the Portuguese Navy to proceed to regular deployments of surface floats in several areas of the Atlantic. As part of this collaboration, IH received several surface floats during 2021 and these were available to be deployed during the Mar Aberto Initiative fall-winter 2021 mission.

The deployment of the floats occurred in the global domain covered by of the mission (figure 7), from the area offshore the Portuguese mainland, in October 2021, (figure 1, upper panel), to the areas offshore Angola and São Tomé and Príncipe, in December 2021 positions for deployment of these surface floats were selected having in mind boat the scientific interest that these observations could have to contribute to the characterization of the surface circulation of the Atlantic basin as well as to optimize the survival period of the floats and, consequently, extend the most as possible the period of observations in the basin of the North and South Atlantic. Three floats were selected to be deployed in the Cabo Verde Archipelago, during the development of the dedicated multidisciplinary survey onboard NRP “D. Carlos I” from the 30 October to the 15 November 2021. These floats, in particular, provide and additional set of observations for those waters, complementing the observations conducted onboard the ship.

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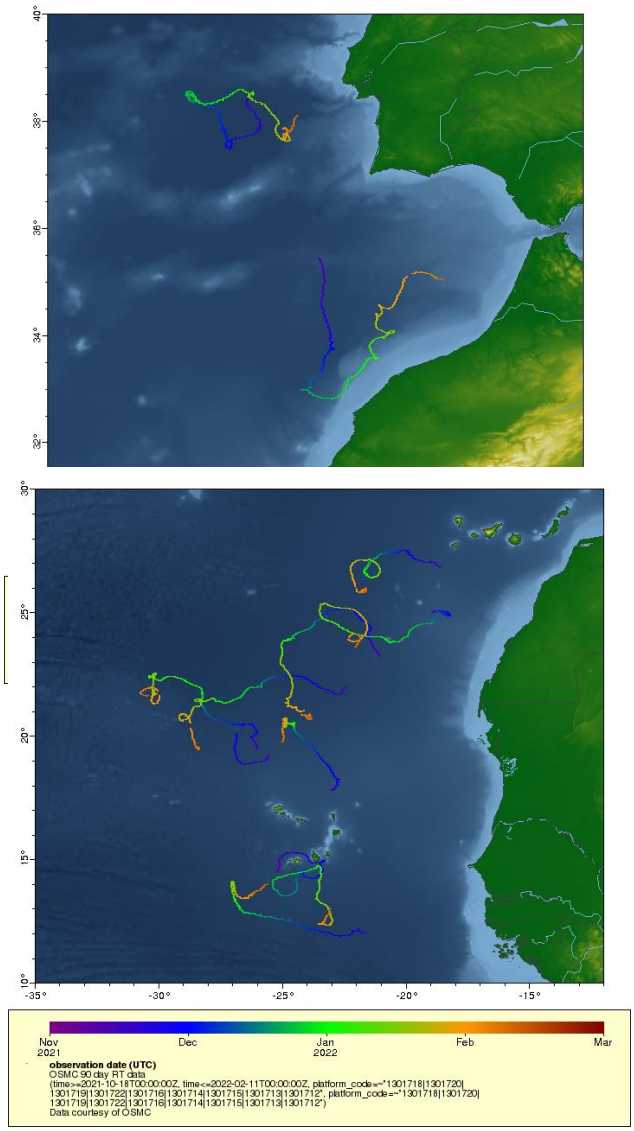

Figure 7. Trajectories and measured sea surface temperature from the different surface drifters contributing to the NOAA Surface Drifter Program that were deployed during the Mar Aberto Initiative fall-winter 2021, from (top left panel) the depart from Lisbon, in October 2021, and transit towards Canary Islands, to (bottom left panel) the transit passing Canary Islands to Cabo Verde and dedicated survey in Cabo Verde Archipelago, to (bottom right panel) the transit to Angola, to Sao Tome and Principe and return to Lisbon. The images were obtained from the web page of NOAA Surface Drifter Program

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The second example that Mar Aberto Initiave fall-winter 2021 allowed to explore regarding the opportunistic sharing of an infrastructure (in this case a research vessel) to expand he observations available in the All-Atlantic domain was focused on an important question, the progressively more important presence of Sargasso in the eastern part of the Atlantic. This question is gaining more and more importance in the last years, with important impacts of huge presence of Sargasso registered along the coasts of Guiné and other African countries of the Atlantic basin.

During 2021, as part of discussions to prepare the dedicated multidisciplinary mission in Cabo Verde, this topic was discussed. Dr. Ajit Subramaniam, from the Lamont-Doherty Earth Observatory at Columbia University (LDEO) was identified as the interlocutor to further discuss the potential development of a program of observations of Sargasso profiting from the presence of NRP "D.Carlos I" in the waters offshore Cabo Verde, Angola, and São Tomé e Príncipe in the fall-winter 2021. The discussions led to the implementation of the program, with the reception at IH of some material to help in the collection of the samples onboard.

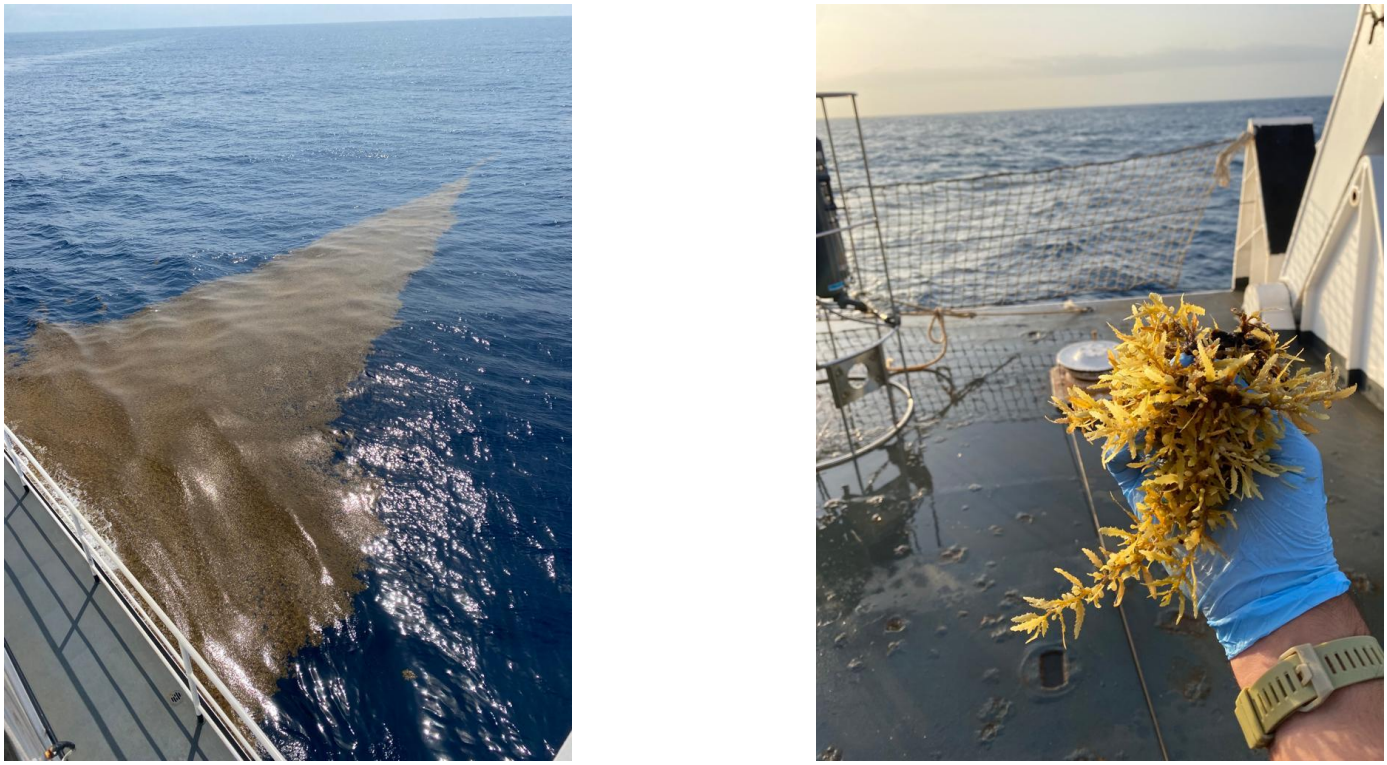

Figure 8. Bands of Sargasso detected at surface on December 2021, offshore Angola (left) and sample collected by the ship crew (right)

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The program incorporated different types of observing actions that, depending on the conditions and opportunities available, could be conducted onboard by the ship crew. The basic action consisted in a simple report (on a log sheet) of the occurrence of Sargasso at the surface, with the indication of the date and geographical position and, if possible, of how the Sargasso manifested (for example if only dispersed patches or in big consistent sheets extending over the ocean surface). A second level action implied to take a photo of the Sargasso at surface, which would complement the report. Finally, a more demanding action, particularly during ship transits, consisted in collecting a sample of the Sargasso at surface and to preserve the sample in the freeze for later analysis.

The program started, in fact, during the dedicated survey conducted in the Cabo Verde Archipelago. Sargasso was detected at surface in the southern part of the covered areas, and relatively close to the port of Praia, in the island of Santiago. This allowed the scientific team onboard to articulate with the ship crew in the different components of the program, testing some of the solutions that were latter used to collect Sargasso samples from the surface. After the depart of the scientific team, on the 18 November 2021, the ship continued the mission, in direction to the water of Angola and São Tomé e Príncipe. During all this period, that extended to January 2022, the ship crew maintained the monitoring for the presence of Sargasso at the surface, reporting the positions at which this species was found and, whenever possible, taking photos and collecting samples.

EVALUATION OF THIS SCENARIO FOR COLLABORATION AND SHARING INFRASTRUCTURES

Following the example of the preceding scenario, we can now synthetize, using a SWOT type analysis, the experience gathered during Mar Aberto Initiative fall-winter 2021 mission in what regards the use of available ships operating in an area of the All-Atlantic domain to conduct additional observations of opportunity.

STRENGTHS: The two examples explored during the mission (deployment of surface floats and monitoring of the presence of Sargasso in surface waters) proven to be very easily implemented, being conducted by the ship crew and articulating very well with the normal ship operation. This facilitates and even stimulates the repetition of this kind of collaborative effort in other missions and with diverse type of ships. Training material, such as leaflets or videos, are easily used to instruct the ship crew on how to conduct the required operations.

WEAKNESSES: Two main points of weakness can be referred. This scenario of sharing infrastructures being typically applied to those cases in which a research ship or other type of vessel is not dedicated to observation work, namely when it is in transit from different locations in the All-Atlantic domain, no much opportunity arise to deal with problems, if these occur. As an example, a ship in transit can probably be used to deploy an autonomous vehicle or glider (if a ready to deploy solution is available) but offers no

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possibility for a recovery and/or intervention in case technical problems are detected a few hours after deployment.

As a second point of weakness we can refer that, by not involving specialized element onboard for the operation of the systems or monitoring programs, it is possible that during periods of more intensive work for the crew some relevant information be missed or that complementary information be not recognized as important. An example of this last point is the identification of particular oceanographic processes that may be correlated with the presence of biological species at the surface. This can easily be overcome with the involvement of a specialist onboard, which coordinates the work with the crew.

OPPORTUNITIES: Being a mechanism easy to implement, this type of sharing of infrastructures can substantially increase the range of available observations in the All-Atlantic domain and contribute to significantly advance in the knowledge of important processes impacting this area. It provides the opportunity to deploy observing systems in remote areas of the Atlantic, by ships in transits, providing observations much needed in poorly know regions. Observation programs such as the one we have conducted for the Sargasso have, despite their simplicity, the potential to reveal key aspects of processes with the potential to significantly impact coastal populations and the coastal ocean environment.

THREATS: The experience in this scenario of sharing infrastructures that was conducted in 2021 was accomplished in the period of a few months, that corresponded to the start and end of the mission in Lisbon. For the Sargasso program, this allowed to take the samples collected to the laboratories of Instituto Hidrográfico where they were preserved until the laboratory analysis could be made. However, in case a similar program is being developed in a ship of opportunity that is not entering in ports were logistical support is easily accessible a mechanism must be found to assure that similar samples can be preserved and sent to the institutions that will conduct the analysis. If no such mechanism if found and implemented, this can compromise the feasibility and success of this type of collaborative effort.

2.3 Long-Term Cooperation and Sharing of Infrastructures

The third scenario explored in association with Mar Aberto Initiative fall-winter 2021 mission corresponded to the establishment of long term cooperation between Instituto Hidrográfico and partner institutions in Cabo Verde, Angola and São Tomé e Príncipe for the sharing and use of low-cost Spotter wave buoys in areas of interest of those partners.

During the last few years, the Spotter buoys (SOFAR) started to be used at IH as fixed platforms for wave measuring. The performance of these buoys is being evaluated by comparison with the standard wave buoys (Waverider Datawell buoys) that integrate the monitoring network that IH operates along the Portuguese coast. The Spotter buoys are relatively low-cost systems, with small dimensions and, for this reason, easy to handle and deploy. These characteristics can be particularly interesting for operation in

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areas where no-dedicated means are available and to use them in areas with less protection. The systems provide quasi real-time measurements of wave parameters and surface temperature, being particularly adequate to provide important information to support port operations or coastal Blue Economy plants and other coastal communities.

Contacts were developed during 2021 with partners in Cabo Verde, Angola and São Tomé e Príncipe to evaluate the possibility of profiting from the presence of NRP "D.Carlos I" in those waters during the Mar Aberto Initiative fall-winter 2021 mission, to deploy this type of systems. Three Spotter buoys from Instituto Hidrográfico were sent to Cabo Verde in early November 2021 and embarked on the ship at the end of the dedicated multidisciplinary survey. One of the buoys was deployed on the 18 November 2021 (figure 9), in the south coast of São Vicente Island (Cabo Verde), in a position selected in articulation with the colleagues from IMAR. The second buoy was deployed offshore the port of Luanda (Angola), early on December 2021, in close articulation with Instituto Hidrográfico e de Signalização Marítima de Angola (IHSMA). Finally the third buoy arrived in São Tomé e Príncipe by the end of December 2021. This buoy was deployed at the Ana Chaves bay in a close collaboration with Instituto Nacional de Meteorologia (INM) of São Tomé e Príncipe.

Figure 9. Spotter buoy after deployment offshore the south coast of Sao Vicente (Cabo Verde).

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EVALUATION OF THIS SCENARIO FOR COLLABORATION AND SHARING INFRASTRUCTURES

The experience gathered from November 2021 until February 2023 in the operation of the three Spotter wave buoys together with the colleagues from IMAR (Cabo Verde), IHSMA (Angola) and INM (São Tomé e Príncipe) can be synthetized in the following analysis.

STRENGTHS: This scenario of sharing of an observation infrastructure asks for a strong articulation between the collaborating All-Atlantic partners, which are asked to joint efforts in the operation and management of the infrastructure. This clearly help to develop a clearer perception among the partners in the local specificities and difficulties, reinforcing the sense of community. The possibility for installation of low-cost sensors and equipment's in areas poorly covered by observations can decisively contribute to expand the understanding of many processes impacting the All-Atlantic domain.

WEAKNESSES: The present scenario of cooperation and sharing of infrastructures involved the operation of permanent fixed platforms installed in areas near the shore. As it is well known, this is a particularly difficult activity, particularly due to the fact that the systems are frequently out of sight, the only monitoring available being the reports of the system position that is available during the regular satellite transmission of data to the land base. For this reason, the systems are vulnerable to vandalism of to the simple curiosity of the passing nautical community. Coping with these situations requires a permanent a permanent monitoring and a well-organized articulation between the partners providing the infrastructures and the local partners in order to respond to urgent situations (e.g. drift away or removal of a buoy). Our collaborations were conducted without the presence of a dedicated element (e.g. from IH) working at the partners institutions to provide the support required. This could be scenario to be develop in the future extend of the collaborations, with the benefit of contribution to a better articulation and to know-how exchange in technical and scientific domains associated with the observation actions.

OPPORTUNITIES: The joint operation opens a window over the local specificities and local difficulties that promote a better understanding of the global environment where the observations are conducted. This should contribute to improve the cooperative work and to open new perspectives for collaboration and possibilities for observation of a given geographical area.

THREATS: The effectiveness of operation of fixed platforms such as the ones that were installed in Cabo Verde, Angola and São Tomé e Príncipe greatly depends on the capacity of maintain these systems in operation in those waters. This asks for a strong sensibilization of the local communities so that they can be engaged and become not only the users of the information collected but also the nodes of the security net that guarantees the observing systems are maintained in operation at sea. This is a difficult task and if not succeeded can render unfeasible the operation of such kink of fixed platforms.

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3. Conclusions

Three scenarios were explored as part of the case study for cooperation and sharing observation infrastructures that was developed in AA-MARINET Task 3. The case study profited from the mission conducted by a hydro-oceanographic vessel of the Portuguese Navy that, between October 2021 and January 2022, covered the area between the continental coast of Portugal, Cabo Verde Archipelago, Angola and São Tomé e Príncipe. A common perception that emerges from the case study is the fact that collaborative actions based on the sharing of infrastructures that can have significant impact in the understanding of the All-Atlantic domain may, in fact, be very simple and require only in-time exchange of information of the opportunities that can be available. This was particularly clear for the scenario of opportunity measurements from a ship in transit in a large Atlantic area, but also for the possibility of articulating ships and glider or autonomous vehicles availability in the first scenario explored. Some difficulties that we faced during the case study could probably be surmounted with a more planned strategy (for example planning the direct involvement of researchers, as discussed in scenario 3). Others, however, revealed to be a major issue that can effectively discourage the individual researchers or the research institutions to actively engage in the sharing of infrastructures or observing systems in the All-Atlantic domain. The difficulties faced in the transport of equipment to or from a research vessel that is operating far in the Atlantic can block any wish to involve equipment that is needed for the other areas of activity of these researchers or institutions. This is certainly an issue that, once improved, can lead to a significant increase of the number of opportunities for sharing infrastructures being fulfilled.

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