Atlantic Interactions

A Science and Technology Agenda for an integrative approach to the Atlantic:

Integrating Space, Climate, Oceans and Data Sciences through North-South / South-North Cooperation

Towards the

Atlantic International Research Center (AIR Center)

A science and technology agenda developed by a group of international experts promoted by the Portuguese Foundation for Science and Technology (FCT) with the support of an open international consultation and a series of research workshops and high-level events.

Portuguese Foundation for Science and Technology

(Fundação para a Ciência e a Tecnologia, FCT), Portugal

August 2017

AIR Center Agenda Steering Committee

appointed at the

High-level Industry-Science-Government Dialogue Towards the Atlantic International Research Center (AIR Center)

Terceira, Azores, 20-21 April 2017

Juan Maria Vazquez Rojas, General Secretary of Science and Innovation, Spain;

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Preparatory Research Workshops:

1. Institute of International Education (IIE), New York City – US, June 10th 2016
2. University of Azores, Ponta Delgada, Azores – PT, June 27th 2016
3. "Portugal Science Summit, Ciência 2016", Lisbon – PT, July 4th 2016
4. European Space Agency (ESA), Paris – FR, August 29th 2016
5. Technological Park, São José dos Campos – BR, September 6th 2016
6. Portuguese Permanent Representation to the EC, Brussels – BE, September 19th 2016
7. Maloka, Bogotá – CO, October 5th 2016
8. Cartagena de Indias – CO, October 6th 2016
9. Brazil Space Agency, Brasilia – BR, October, 31st 2016
10. MIT, Cambridge, Mass – US, November, 6th 2016
11. University of Texas at Austin, Texas – US, November, 9th 2016
12. ISRO, Bangalore – IN, January 8th 2017
13. Luanda – AO, January 30th 2017
14. Lagos – NG, February 1st 2017
15. Abuja – NG, February 2nd 2017

Other High-level Events:

16. Terceira Island, Azores – PT, April 20th-21st 2017
17. Postdam – DE, May 22nd 2017
18. Gran Canaria – SP, June 20th2017
19. Lisbon – PT, July 14th 2017

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Preface

A commitment to knowledge through global science and technology cooperation

The preparation of this Scientific and Technological Agenda has been associated with an open and new debate about multilateral cooperation in complex systems engineering and science towards an integrative approach to space, climate-energy and oceans sciences in the Atlantic, together with emerging methods of data science management. The ultimate goal is to help building the future through an effective commitment to knowledge through global and north-south / south-north cooperation.

We are entering critical times that require the creation of conditions for the strengthening of knowledge-based international cooperation. Lessons learned over the last decades with international partnerships in science, technology and higher education, including those established over the last decades between Portuguese and US Universities, among many other Intergovernmental scientific ventures, have clearly shown that the future can only be built based on an exchanged of solid knowledge, skills and ideas.

A new paradigm of structured international research relationships is emerging, which is shaped by a new era of Government and Industry intervention in association with scientific knowledge. Cross-disciplinary new frontier research should be the result of ambitious initiatives yet to be stimulated and developed from the huge potential of Intergovernmental research laboratories and joint ventures. It is under this context that the debate of the potential installation of an *Atlantic International Research Center (AIR Centre)* is focused on. This debate is centered under two main priorities: i) new data collection for innovative research; and ii) space, climate, oceans and data sciences synergies towards new knowledge production and diffusion.

Our ambition is driven by an increased perception by society of the growing evidence for the potential benefits resulting from the human, social and economic appropriation of the results and methods of science. We aim to stimulate the necessary knowledge-driven conditions to build an Intergovernmental research center with strong international cooperation, taking advantage of the strategic positioning of Atlantic islands by establishing a network of research sites in Azores, Madeira, Canary Islands, Fernando Noronha and S. Pedro-S. Paulo, in Brazil, Cape Verde, as well as in others to follow, thus increasing operational efficiencies by optimising the appropriate use and sharing of research infrastructures, and access to and management of data and platforms. By promoting new knowledge on climate change and

related issues in the Atlantic, we are fostering conditions to provide the world with more science, more knowledge and more scientific culture.

The exceptional position of Azores and other Atlantic islands stimulates the access to new frontiers of knowledge, together with the development of new space and marine industries. For example, facilitating the access to Space from the unique position of the Azores, promoting access to new frontiers of knowledge, together with the development of new space industries, should be promoted in coming years to entrepreneurs worldwide. Also, by promoting new research in the deep-sea of Azores and in other Atlantic regions we facilitate the access to a better understanding of living organisms in extreme environments and also of non-living resources.

Moving towards the goal of sustainability requires fundamental changes in human behavior as well as more knowledge and more scientific culture, ensuring the access to science and education as an inalienable right of all. More science and the systematic democratization of access to knowledge mean more equal opportunities, more social mobility and a new stimulus for entrepreneurial activities and well-being.

Manuel Heitor
Minister for Science, Technology and Higher Education, Portugal

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Part I – *Atlantic Interactions*: A vision to better understand the interconnected North and South Atlantic through international cooperation

The imperative of building **knowledge-based societies** demands an investment in our collective institutions to enable them to provide worldwide access to quality science education and scientific practices to everyone, regardless of age, origin or social and economic background. People at large will need to access knowledge and modern learning practices at all ages to build future generations who are becoming increasingly knowledgeable, creative and able to adapt responsibly to the challenges of a rapidly changing world. The future of different people on earth is woven in a single garment. We all gain from the joy and benefits of discovery when all people participate in learning and the productive use of knowledge. This means reaching out and engaging our colleagues, scientists and lay people with young people in all parts of the world.

The impending environmental challenges on the Atlantic Ocean and beyond find us at a historical crossroads, with the opportunities brought by the accelerated pace of data production and sharing, the digital plugging-in of Northern and Southern hemispheres and the coming-of-age of scientific communities all around the Atlantic align to create *intellectual commons* around the *natural commons*. The Atlantic is a mega-regional space, the understanding of which, in all its physical and biogeochemical complexity will be a bold, flagship project for the World. Its sheer size and significance of the challenge will mobilize countries and the private sector, and the success of the initiative will propel other nations to follow globally.

The need to foster and further develop knowledge in Atlantic region in terms of related natural resources, ecosystems dynamics and the interdependences with human activities towards achieving the 2030 United Nations Goals for Sustainable Development, together with the potential exploration of new avenues for knowledge-based economies in south and north Atlantic is the drive of the ***Atlantic Interactions*** initiative.

The ***Atlantic Interactions***, an initiative initiated by Portuguese Government in 2016, builds on the achievements on Atlantic related research over the last five years such as the Galway Statement on Atlantic Ocean Cooperation, signed on 23 May 2013 between the European

Union, the United States and Canada, which enabled the alignment of ocean observation efforts, as well as the priorities and actions outlined in the Atlantic Ocean Research Alliance. It also recognizes the progress achieved by Southern Atlantic nations in discussing and establishing a scientific agenda for the Tropical and South Atlantic and the Southern Ocean.

It builds on the results of the series of scientific workshops on Atlantic Interactions held throughout 2016 in New York, Ponta Delgada, Lisbon, Brussels, Paris, Brasília, Cartagena, Bogotá, Cambridge (Mass) and Austin (Texas), as well as other related meetings in Bangalore (India), Luanda (Angola), Abuja (Nigeria), Berlin (Germany) and Gran Canaria (Canary islands, Spain) hat that have mobilized researchers worldwide towards the development of a new science and technology agenda for an integrative approach to the Atlantic focused on space and ocean sciences and technologies, as well as the implications of climate change and the development of sustainable energy systems.

More recently, it builds on the conclusions of the High-Level Industry-Science-Government Dialogue on *Atlantic Interactions* held in Terceira Island on the 20-21 April 2017 where it was recognized the need of an **integrative approach to space, climate change and energy, earth and ocean sciences in the Atlantic**, together with emerging methods of **data science, data visualization and science communication** to better understand the emerging issues associated to climate change and the sustainable management of common resources affecting our planet and the lives, prosperity and wellbeing of our citizens. A better use of the strategic positioning and uniqueness of **Atlantic islands** and a better use of **existing infrastructures and initiative** would also contribute to the vision of the *Atlantic Interactions* initiative taking advantage of natural commons and empowering those who are already working to tackle global Atlantic issues.

Atlantic Interactions is therefore a new initiative to unleash the potential of the Atlantic for Society. It considers the Atlantic as a "moonshot project" fostering knowledge and technology-driven solutions for Atlantic and Global Societal challenges that require interdisciplinary research and innovation of complex Earth systems through international cooperation targeting the Atlantic.

This document proposes a **Science and Technology Agenda for the Atlantic integrating Space, Atmospheric, Climate-Energy, Ocean and Data thematic areas** in order to reach the *Atlantic Interactions* vision ultimately benefiting decision-makers, public users, universities

and industry, and fostering highly skilled human resources, the exchange of research infrastructures and technology transfer contributing to the sustainable growth of our countries and regions.

1. A holistic and integrative approach to the Atlantic

The Atlantic Region can be considered as stretching from Norway down to the southern shore of South Africa and Brazil, encompassing parts of the American continent, European continent and African continent. The Atlantic Ocean is the body of water that links all of the countries in the Atlantic Region. It is an interconnected system without physical boundaries that, together with all the other Earth Oceans, should be addressed as a whole, as stated in the United Nations Convention on the Law of the Sea[1]. The idea of an interconnected system takes us to a new dimension of science and technology where a **holistic and integrative approach is needed**.

A holistic and integrative approach entails the **alignment of national strategies through international cooperation.** This idea is in line with the 2030 Agenda For Sustainable Development and its Goals[2] which addresses, besides others, the need of international scientific and technological cooperation to achieve a sustainable development of our society.

The Atlantic Ocean comprises about 20% of the Earth´s surface, and is still understudied in terms of its natural resources, ecosystems dynamics and the interdependences with human activities. An alignment of research strategies through international cooperation will allow a better understanding of the Atlantic Ocean dynamics and emerging issues associated to climate change and the sustainable management of common resources affecting our planet and the lives, prosperity and wellbeing of our citizens.

Interdisciplinary research able to face today's challenges and the economic transitions, in particular environmental changes, security conditions, natural hazards, and other human dimensions, calls for the design of an international partnership that aims for resilience and sustainability for the Atlantic and related North-South / South-North cooperation in the five thematic areas represented in Figure 1.

[1] http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf
[2] https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

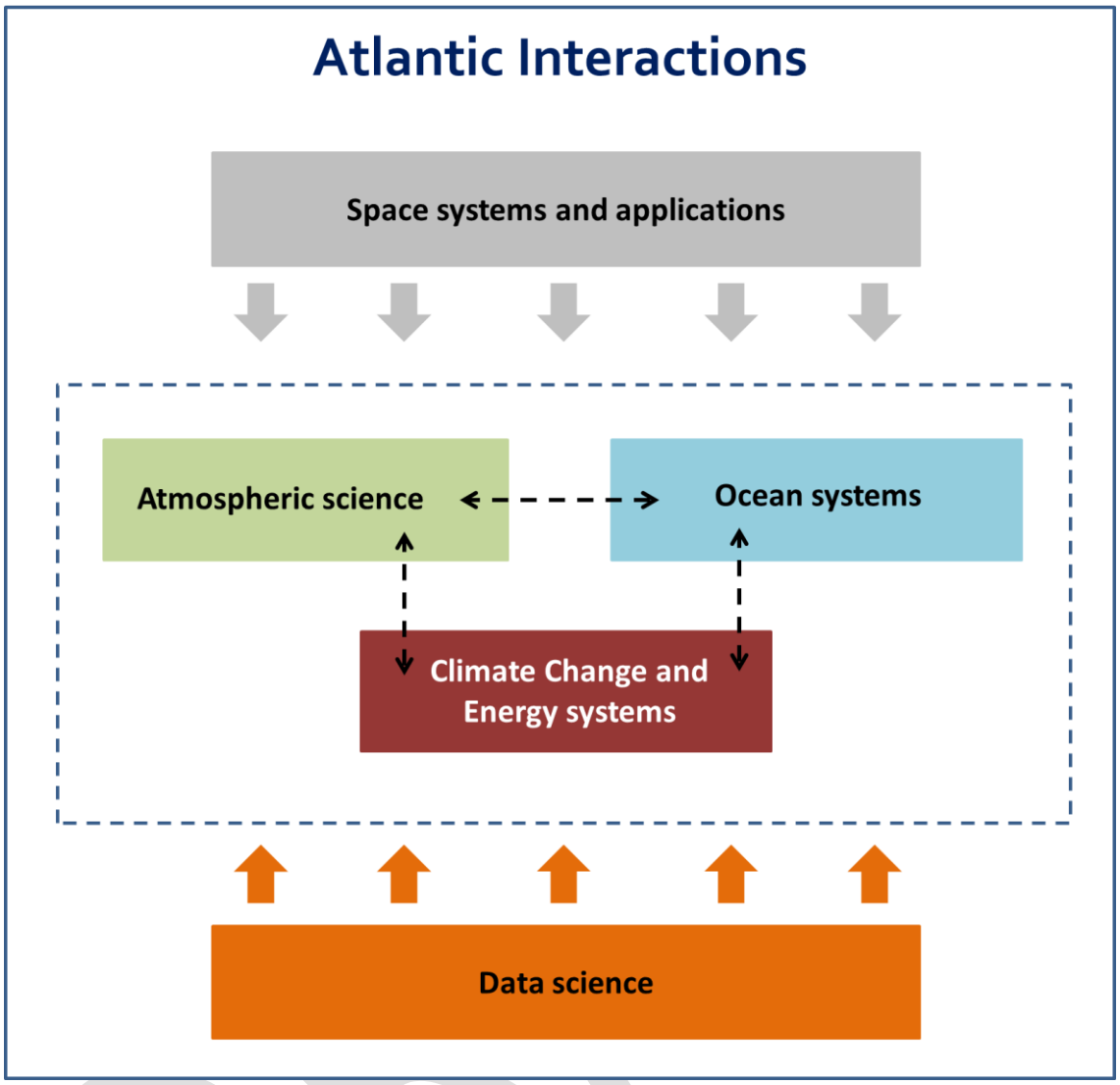

Fig. 1 – Five thematic areas covered by the *Atlantic Interactions* initiative.

The interaction among the thematic areas covered by the *Atlantic Interactions* initiative, Space, Atmosphere, Climate-Energy, Oceans and Data domains, will allow **knowledge and technology developments to understand interactions** of atmosphere-ocean and climate changes making use of advanced space and ocean science and technology.

A **shared and international environment** supporting North-South / South-North cooperation in science and technology, following this integrative approach will require the development of advanced data and network systems, including integrated sensors and monitoring systems over space, air, ground and ocean domains, that allow sustained data gathering to produce better and more precise models which can supply all scientific disciplines involved in order to accurately projecting the future sustainable pathways.

This requires a sustained and globally distributed ocean-observing system, especially at depths where very few observations currently exist, as well as detailed measurements of atmospheric circulation changes, greenhouse gas emissions along with the determination of the Earth's key ecosystems activities and the development of technology to fit science needs. Space applications can help to address great challenges such as climate change, natural hazards, energy dependency and sustainable ocean exploitation as they can provide unique and critical global information for many environmental and climate variables enabling, for example, a sustainable management of marine resources, as well as characterization of the renewable energy potential in islands and coastal environments.

In order to create the desirable positive impact of the knowledge obtained through the *Atlantic Interactions* initiative to the general public we need to bring to the center of our attention all those in the "margins" of knowledge driven societies and knowledge-based economic activities by promoting **scientific literacy**.

A holistic and integrative approach to Space, Atmosphere, Climate-Energy, Oceans and Data thematic areas in the Atlantic can **tackle several interdisciplinary research challenges in the Atlantic region** actively contributing to the Sustainable Development Goals, namely to:

- **SDG 2** – End hunger, achieve food security and improved nutrition and **promote sustainable agriculture,**
- **SDG 7 –** Ensure access to affordable, reliable, **sustainable and modern energy** for all,
- **SDG 11 –** Make **cities** and human settlements inclusive, safe, **resilient and sustainable,**
- **SDG 13 –** Take urgent action to **combat climate change and its impacts**,
- **SDG 14 – Conserve and sustainably use the oceans**, seas and marine resources.

And this intergovernmental effort inherently contributes to:

- **SDG 17 – Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development**

2. Maximizing the potential of Atlantic Islands

Islands are extremely well placed to enable the advances of frontier research in the 21st Century. Darwin's expedition to the Galapagos Islands is the paradigmatic example, given the paramount influence it had on the practice of modern science, and how it highlighted the importance of islands and archipelagos for scientific progress.

By providing relatively small but complete ecosystems islands are perfectly suitable for **holistic research studies and testing of innovative technologies**. They can be seen as natural living laboratories that enable and facilitate the design of scientific studies of international relevance. Island research stations are ideal for validating concepts, techniques, methodologies and innovative business concepts, particularly in remote places and /or in circumstances where reliable platforms are scarce.

The strategic positioning of Atlantic islands can play a critical role in the development of the holistic and integrated approach to research under the ***Atlantic Interactions*** initiative by establishing a **network of island research sites**. For example, symbiotic datasets among the Azores, Madeira, Canary Islands, Cape Verde and São Pedro e São Paulo, for example, can provide flux measurements that single point data sets cannot.

A network of Atlantic islands research sites would also maximize the strategic position of Atlantic islands to respond to global challenges and fostering scientific and technological developments not only for Atlantic countries but also to ultra-peripheral regions. For example, a network of islands research sites can play a central role in the global geodetic observing system (GGOS), underpinning the North-South, East-West cooperation by incorporating infrastructure and data to support global change research in the context of Earth system sciences (Fig. 2).

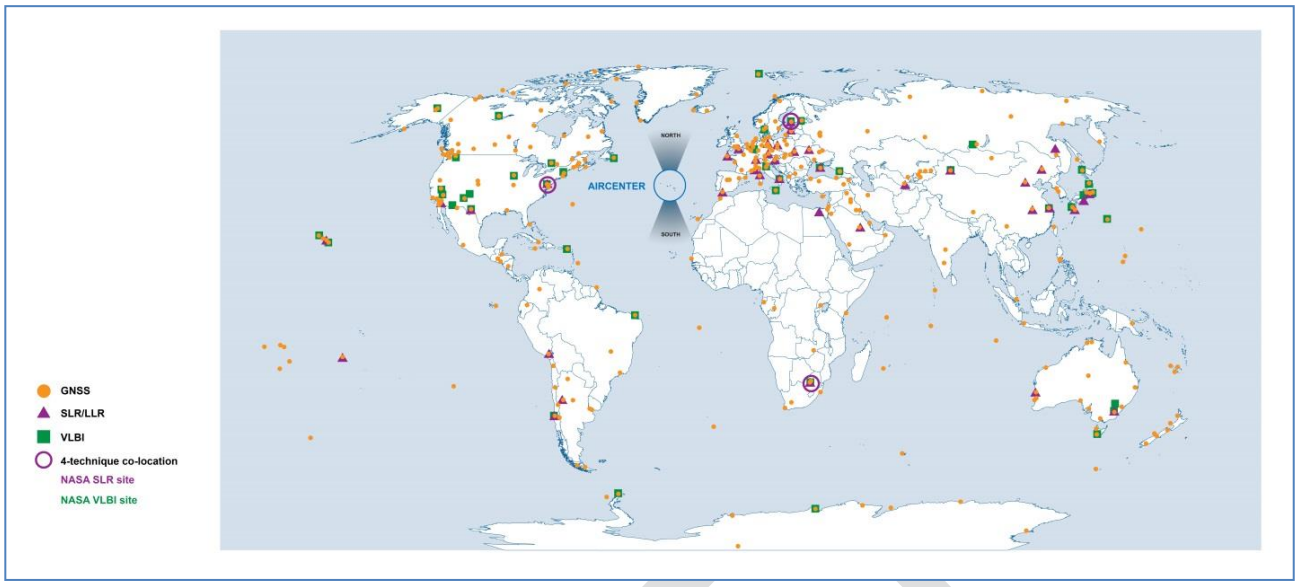

Fig. 2 – The Global Geodetic Observing System (GGOS) and all its core sites

Source: Juan Sanchez, The University of Texas at Austin, US

The enlargement of the above-mentioned network of Atlantic islands research sites to coastal research sites would increase research operational efficiencies by optimising the appropriate use and sharing of research infrastructures, and access to and management of data and platforms (Fig. 3). This **network of research sites** can include research sites in Azores, Madeira, Canary Islands, Fernando Noronha and S. Pedro-S. Paulo, in Brazil, Cape Verde, Nigeria, South Africa, as well as and others.

Fig. 3 – Illustration of a possible network of Atlantic Research Stations under the *Atlantic Interactions* initiative

3. Leveraging the potential of existing infrastructures and initiatives

The development of Research Infrastructures has been, traditionally and still today, to a large extent, based more on the national interest of the hosting countries than on common, global challenges. This has resulted, on the one hand, in a certain level of redundancy, with similar types of facilities in different countries, conducting essentially the same type of research and, on the other hand, in a lack of resources to tackle "moonshot projects", of global significance. The emerging concept of the *Natural Commons* has added a level of co-responsibility, which brought nations together in tackling common scientific matters.

The Atlantic Ocean is a *Natural Commons* for the peoples on its shores, who greatly depend on its resources, but also for the World at large, due to the inter-connectedness of the natural systems it is a part of, including adjacent oceans namely the Mediterranean, the Indian and the Pacific. The global atmospheric and ocean cycles influence and are greatly influenced by what happens at the Atlantic, and the planetary climatic change under way is a cause for, and a consequence of changes in the Atlantic.

In 2013 the realization of the common interest in the Atlantic by the European Commission, the United States of America and Canada has led to the signing of the Galway statement, from which projects have emanated to align research strategies (AORA[3]), observation capabilities and inter-operationalization (AtlantOS[4]), as well as joint efforts to characterize the common resources, to foster sustainable exploitation (ATLAS[5]). The sustainability of this approach to the Atlantic Ocean requires that steps be taken to extend activities beyond the 2020 award period, in an internationally-coordinated way, taking the findings of such projects into account, but bringing other countries and actors into the fold as well. In that sense, the upcoming Belém Declaration is expected to catalyze the integration of South Atlantic Nations in the Atlantic Commons framework.

The *Atlantic Interactions* initiative is fostering the scientific agenda to be implemented under the institutional framework of an intergovernmental organization, the Atlantic International Research Center – AIR Center which, as discussed later, will provide the governance required for the enlargement of the Atlantic Commons actors and their co-accountability, as well as to the expansion in scope of the ongoing initiatives, in order to take space technologies and

[3] https://www.atlanticresource.org/aora/
[4] https://www.atlantos-h2020.eu/
[5] http://www.eu-atlas.org/

energy systems into the fold, as well as accounting for the data systems powering the Intellectual Commons being built under the framework of the EOSC.

Inspired by the success of large-scale intergovernmental Research Infrastructures, such as CERN, ESA or ESO, the creation, in 2002, of the **European Strategy Forum on Research Infrastructures (ESFRI)**[6] has brought EU countries to the table, to plan together the Research Infrastructures of European relevance, in several thematic areas. Today, Europe leads in the policy-making and planning of Research Infrastructures and has 50 pan-European Research Infrastructures/projects in the ESFRI 2016 Roadmap[7].

The ESFRI Roadmap has identified a solid complement of Environmental / Biomedical / Energy Research Infrastructures, several of which being relevant to the *Atlantic Interactions* thematic areas (Fig. 4). In addition to these infrastructures specifically devoted to marine and oceanographic research, the recently created e-infrastructure LifeWatch-ERIC provides a relevant platform for data analysis and model testing in those domains through a dedicated Virtual Research Environment[8].

Some of these Research Infrastructures, such as EPOS (European Plate Observing System)[9] and IAGOS (In-service Aircraft for a Global Observing System)[10] have been put forward as **Research Infrastructures of Global Interest,** by the Group of Senior Officials (GSO) of the G8. Other Research Infrastructures of global interest have been identified by the GSO in Canada (Ocean Networks Canada[11], WindEEE[12]) and the United States of America (Ocean Observatories Initiative[13], the Joides Resolution Drill Ship[14]) and other non-Atlantic countries, such as Japan (ocean drilling vessel Chikyu[15]).

6 http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri
7 http://www.esfri.eu/roadmap-2016
8 http://www.lifewatch.eu/Virtual_Research_Environments
9 https://www.epos-ip.org/
10 http://www.iagos.org/
11 http://www.oceannetworks.ca/
12 http://www.eng.uwo.ca/windeee/
13 http://oceanobservatories.org/
14 http://joidesresolution.org/
15 http://www.jamstec.go.jp/chikyu/e/

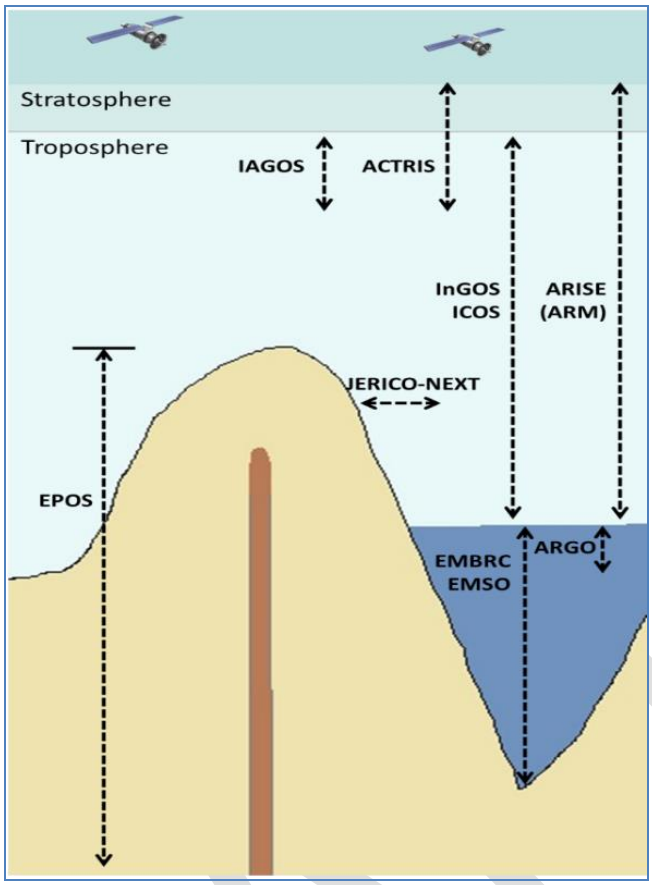

Fig.4 – Illustration of European Infrastructures[16] within the *Atlantic Interactions* thematic areas

Besides the Research Infrastructures labeled as "of global interest", **regionally relevant and, in some cases, truly unique equipment and infrastructure exist in many of the Atlantic nations**. The research vessels coordinated under the EUROFLEETS project[17] and the airborne

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EMBRC – European Marine Biological Resource Centre: a distributed research infrastructure that aims to provide a strategic delivery mechanism for excellent and large-scale marine science in Europe.

EMSO – European Multidisciplinary Seafloor and water column Observatory: main scientific objective of long-term monitoring, mainly in real-time, of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere.

ACTRIS – Aerosols, Clouds, and Trace gases Research Infrastructure Network**:** Atlantic circulation of Aerosols and trace gases; study shallow marine clouds.

IAGOS – IAGOS is a new European Research Infrastructure conducting long-term observations of atmospheric composition, aerosol and cloud particles on a global scale from commercial aircraft of internationally operating airlines

InGOS – InGOS is an EU FP7 funded Integrating Activity (IA) project targeted at improving and extending the European observation capacity for non-CO2 greenhouse gases.

ICOS – The Integrated Carbon Observing System (ICOS) is a pan-European Research Infrastructure which provides harmonized and high precision scientific data on Carbon Cycle and Greenhouse Gas budget and perturbations.

ARISE –The aim of ARISE is to provide observations and models for future assimilation of data by operational weather forecasting models in the perspective of improving weather forecasting to monthly or seasonal timescales.

JERICO-Next – The vision of JERICO-Next is to improve and innovate the cooperation in coastal observatories in Europe by implementing the coastal part of a European Ocean Observing System, to cooperate with other European initiatives.

EPOS – European Plate Observing System: The activities of the European Plate Observing System span a wide range of themes related to Solid Earth Science, such as Near-Fault and Geomagnetic Observations, Seismology, Geological Modeling, Volcanology, GNSS and Satellite data, among others.

EURO-ARGO – active coordination and strengthening of the European contribution to the international Argo program.

17 http://www.eurofleets.eu/np4/home.html

research aircraft coordinated under the EUFAR project[18] are European examples, with counterparts in other quadrants of the Atlantic Ocean. Others are already truly global endeavors, such as the ARGO program[19] and other initiatives grouped under the GOOS (Global Ocean Observing System)[20] umbrella, as well as the European Union Copernicus Earth Observation program[21] and its American counterpart Landsat[22].

The current and future scientific challenges are increasingly complex and multi-disciplinary, with a big focus on data. The vision for ***Open Innovation, Open Science, Open to the World*** starts to materialize in the ***European Open Science Cloud*** **(EOSC)**[23] which, despite its European anchor, is truly a globally relevant structure, which will operationalize an *Intellectual Commons*.

These are exciting times for research. The move towards openness is unrelenting, and the increasingly connected scientific world will all benefit. Europe has led in the creation of the **data networks** in South America (Red Clara) and Africa (WACREN, ASREN, UbuntuNet Alliance). The "BELLA" EU-Brazil cable, under construction, as well as the AfricaConnect and EUMedconnect EU-Africa links are plugging Africa and Latin America to Europe (through GÉANT), and realizing on the ground the network for the Global Science Cloud. Researchers is Montevideo, Lagos, Cape Town or São Paulo will have access to the same data, at great connection speeds, as those in Boston, Lisbon or Cork.

[Include information of national research Infrastructures / initiatives of relevance from the results obtained from the matrix to be filled in by the nations]

This new data-intensive research model, operating under the intellectual commons paradigm, will unlock the scientific and economic potential of the research infrastructures. The Atlantic is the "moonshot project" bounded by the polygon defined by Africa, the Americas and Europe. On its shores, there is the Research Infrastructure necessary to study it, from the deep ocean to the high atmosphere. Framed by the work of the IOC-UNESCO, the Galway and the Belém

[18] http://www.eufar.net/
[19] http://www.argo.ucsd.edu/
[20] http://www.goosocean.org/
[21] http://www.copernicus.eu/
[22] https://landsat.gsfc.nasa.gov/
[23] https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud

statements, and with a view for UN's SDGs, the G7's Tsukuba Communiqué and OECD's Ocean Economy study, as well as other national/regional policy papers and studies, the *Atlantic Interactions* initiative will leverage this rich complement of hardware and software to understand and respect the Atlantic and to realize its potential for sustainably supporting its citizen welfare and sustainable development.

Part II - A Scientific and Technological Agenda integrating Space, Atmosphere, Climate-Energy, Oceans and Data thematic areas

The ***Atlantic Interactions*** vision aims to sustainable manage the Atlantic, our common resource, and unleash its potential to society. This common resource can only be holistically managed through a sound research and technological agenda integrating different thematic areas as Space, Atmospheric, Climate-Energy, Oceans and Data. This chapter includes contributions received from the scientific and technological community from June 2016 to July 2017 identifying several interdisciplinary scientific and technological key activities to foster knowledge-driven solutions facing Atlantic Global societal challenges. For a better organization of this chapter the identified key activities were grouped in three main Global challenges requesting integration among different thematic areas:

1. Understanding, predicting and adapting to climate change and atmosphere dynamics
2. Understanding the Atlantic Ocean system and its natural resources for a healthy and productive ocean
3. Increase the share of renewable energy in the global energy mix and improvement in energy efficiency

These Global challenges will be supported by technological applications in the space allowing for an effective collection of mega-sets of data. The collected data will then be integrated and efficiently curated, analyzed and visualized using appropriate data science tools, amplifying the research developed in the Atlantic region. In order to foster the interest and mobilize younger generations for science and technology, as well as to contribute to the education of society in general, literacy issues have also been considered by the scientific community as a crosscutting activity that cannot be disregarded in the *Atlantic Interactions* agenda.

Among the key research activities identified up to now by the scientific and technological communities we can find both fundamental scientific activities, allowing more knowledge towards achieving the ***Atlantic Interactions*** vision, and technological activities, aiming to support the scientific activities and develop innovative products.

The key scientific and technological activities identified will require a strong disciplinary interaction among Space, Atmospheric, Ocean, Energy-Climate and data systems. They will be leveraged by the use of existing research efforts and infrastructures and may take advantage of a network of islands, for example as test-beds.

The *Atlantic Interactions* research agenda will act as a catalyst for science and innovation in multiple domains ranging from renewable energies, to the interactions of the oceans with atmosphere and global climate phenomena, to the impacts of global changes on ocean and the deep-sea including their biodiversity, as well on the blue economy. More suitable and coordinated data is also needed to improve knowledge on climate change and related issues in the Atlantic region. The smart use of space systems and applications can help to provide such suitable data. Satellite-based technologies can for example contribute to mitigate risks as they can measure several ocean and atmospheric variables. In fact, the democratization of the access to space has become a research and development-intensive sector open to many players, with significant opportunities for science-based innovation and "new space industries" in a wide range of applications.

In the domain of data science, solving problems and answering questions through data analytics is standard practice. Often, data scientists construct a model to predict outcomes or discover underlying patterns, with the goal of gaining insights. There are numerous rapidly evolving technologies for data analysis and building models. In a remarkably short time, they have progressed from desktops to massively parallel warehouses with huge data volumes and in-database analytic functionality in relational databases. Text analytics on unstructured or semi-structured data is becoming increasingly important as a way to incorporate sentiment and other useful information from text into predictive models, often leading to significant improvements in model quality and accuracy.

4. Key activities identified by the scientific and technological community facing Global challenges in the domains of climate change, ocean and Energy

The key activities identified by the scientific and technological community were grouped in the following three main Global challenges requesting integration among different thematic areas.

4.1 Global challenge 1: Understanding, predicting and adapting to climate change and atmosphere dynamics

A better understanding, an increased accurate prediction, a resilient and increasingly adaptive capacity to climate-related hazards and natural disasters will be crucial to better place the Atlantic region to face climate change effects.

Such a holistic challenge requires the interaction of several disciplines through a sound international cooperation allowing the share of already existing research and technological efforts and infrastructures. It also requires fundamental knowledge still missing in areas as such atmospheric and ocean sciences.

Identified scientific and technological key activities that could be pursued by the *Atlantic Interactions* initiative to achieve this goal:

- **Research to understand global, regional and local climatic patterns and climate change impacts**
- **Integrate atmospheric and ocean information in global climate models**
- **Monitor the large-scale Atlantic subtropical gyre circulation variability**
- **Monitor the influx of aerosols and atmospheric pollutants in the Atlantic region**
- **Development of higher resolution regional model for the Atlantic Ocean**
- **Research to understand the effects of aerosols in the cloud condensation nuclei (CCN) budget**
- **Research to understand cloudiness transitions through the integration of in situ ground based, airborne and satellite data**
- **Understand the influence of climate change in primary activities (i.e. fishing, agriculture, etc.) and service sector (i.e. tourism, transport, etc.)**
- **Use the high number of lakes available in different islands of Azores to reconstruct the climate of the Holocene, including the NAO and AMO**

4.2 Global challenge 2: Understanding the Atlantic Ocean system and its natural resources for a healthy and productive ocean

A healthy and productive Atlantic Ocean would not only increase the quality of life of Atlantic countries citizens as well as unleash the economic potential of this common resource to earth inhabitants. A healthy and productive ocean requires a sustainable management of its resources and the protection of its marine and coastal ecosystems to avoid significant adverse

impacts. In order to do so, increased knowledge on the ocean processes and its biological and mineral resources is needed as well as the development of innovative approaches to marine technologies allowing a sustained, persistent and affordable presence in the oceans.

Identified scientific and technological key activities that could be pursued by the *Atlantic Interactions* initiative to achieve this goal:

- **Fill the gaps on the observing capabilities for monitoring the Atlantic variability and change in wider temporal and geographical scales (i.e. mesoscale and large scale)**
- **Build knowledge and explore deep ocean and seamounts, mapping resources and ecosystems**
- **Understanding the knowledge on the physical and biogeochemical process and anthropogenic impacts, including soundscape around the Atlantic Islands**
- **Develop new strategies to gather big data, connect data repositories and realize new sophisticated data analysis and modeling capabilities for the Atlantic Ocean**
- **Observe and monitor the large-scale Atlantic variability and change**
- **Explore new strategies for conservation of marine biodiversity**
- **Develop and test of innovative strategies, technologies and activities for a sustainable use of the ocean and promoting blue growth and economy**
- **Demonstrate innovative business concepts based on marine technology developments**
- **Apply blue biotechnology to sustainable harness biological resources, including fishing and aquaculture**
- **Research to understand major Earth Processes at Ocean Ridges and Ocean Crust Formation**

4.3 Global challenge 3: Increase the share of renewable energy in the global energy mix and improvement in energy efficiency

Energy is the dominant contributor to climate change. An increase of the share of renewable energy and an improvement in energy efficiency can contribute to reduce the global greenhouse gas emissions. An enhanced international cooperation in the area of energy systems in the Atlantic region can promote investment in infrastructure and clean energy

technology boosting the economy of its surrounding countries. An improvement in energy efficiency would also contribute to the decrease of fossil-fuel technology.

Identified scientific and technological key activities that could be pursued by the *Atlantic Interactions* initiative to achieve this goal:

- **Map the potential resources and priority areas for demonstration and testing technologies, innovative and disruptive business concepts**
- **Develop new integrated strategies to accelerate flagship projects, demonstration and pilot initiatives, sharing knowledge and best practices**
- **Monitoring system to better predict the potential of renewable energies with high time resolution**
- **Develop a micro-grid management tool to exploit the use of high penetration of renewable resources, including distributed generation**
- **Foster the integration of multiple efficient and flexible storage systems**
- **Develop multiuse platforms and multi-use concepts to harness marine resources in the Atlantic and a higher efficiency of the renewable energy resources in the Atlantic**
- **Develop tools and systems to predict and manage the energy demand in buildings and large facilities to the availability of renewable energy resources**
- **Develop new mobility models to foster the efficient use of renewable energies**
- **Develop a model to design efficient and affordable autonomous sustainable energy systems**
- **Develop a system to better predict renewable energy assets failure due to weather conditions**

5. Enabling activities: Key space applications and data science tools supporting the key research activities facing Global challenges

The above mentioned Global challenges will be supported by technological applications in the space sector allowing an effective collection of mega-sets of data. The collected data will then be integrated and efficiently curated, analyzed and visualized using appropriate data science and digital media tools, amplifying the research developed in the Atlantic region and its understanding by the general public and decision makers.

5.1 Enabling activities 1: Space systems and applications domain

Space systems and applications can contribute to the above Global challenges through, for example, the **use of mega constellations and small satellites** to closely study and monitor the ocean and the atmosphere. Regarding the oceans, satellites can tell us about ocean bathymetry, sea surface temperature, ocean color, coral reefs, and sea and lake ice. Transmitters on satellites also relay position information from emergency beacons to help save lives when people are in distress on boats, airplanes, or in remote areas.

An important aspect of the launch of systems to space is its high cost. Therefore, a key activity should be to foster an affordable access to space, which includes the **launching of small satellites that allow frequent and regular information on the Atlantic** to the benefit of all citizens on planet Earth. The global demand for coverage by micro and nano satellites emphasizes the need for a polar launch infrastructure. The Azores and Canary Islands geo-strategic position would provide conditions for both take off and return-to-earth for horizontal launch vehicles. Launch sites in the Azores and the Canary Islands for mega constellations and small satellites will provide many new opportunities, as, for example:

- It will create a pull effect for new companies working on new propulsion systems, small launcher development, ground segment for space, lower cost launches, and satellite validation and calibration, among other themes;
- It can serve as a launch and landing facility for an orbital space plane (long runways). Example: Lages airfield was a backup landing site for the U.S. space shuttle;
- It will provide a comprehensive launch capability for nano/micro satellites (payload development, testing and integration services; satellite platform production, integration, testing; constellation networking and operation services; data reception, storage, analysis and dissemination;;
- Spacecraft design and testing and the development of novel technology and experiments for the International Space Station (ISS) will be possible;
- It will facilitate the assembly of satellites and subsystems and can serve as a data-hub for data processing for EO satellites in close interaction with on-site observation capabilities with aircraft, unmanned aerial vehicles (UAVs), ships, and remotely operated vehicles/autonomous underwater vehicles (AUV);
- It can serve as a research hub for conception and development of human spaceflight demonstration projects — development and improvement of materials and

manufacturing processes for the purpose of space exploration (protection of spaceships, astronaut protection, protection against corrosion and wear, exposure to extreme conditions) and science- specific experiments that utilize the orbiting spacecraft environment.

In order to collect useful data, it is important to **define international collector requirements for satellite monitoring systems**. These collector requirements could feed into future satellite generations as part of the Constellation of Constellations Initiative of UNOOSA, EU-Copernicus and others.

In terms of applications, data collected from space can help to better understand the impact of climate change in the Atlantic. Past, current and future satellite remote sensing data have been successfully processed to produce daily-to-monthly composites of these parameters on both regional and global scales. In addition to being decisive information for studies of regional and global climate change – weather and climate monitoring and forecasting, time-series of SST (sea surface temperature) composites, SSH (sea surface height) and most recently SSS (sea surface salinity) – this information is applicable to a number of application areas such as providing support for the analysis of mesoscale variability at the scale of ocean basins affecting fishing activities in the Atlantic ocean current and wave height as an aid in maritime ship routing. The Barcelona SMOS Expert Center is post processing the data from the ESA SMOS mission which is very relevant for the studies of the Atlantic.

Synthesis of these diverse observational data streams into a **unifying modeling, analysis, and prediction framework** would provide a powerful way to enhance the value of these data. The data reception capacity enables real time reception of the satellite data allowing for the development of a more immediate answer to both anthropogenic and natural hazards. In addition, the near real time products would provide a basis for commercial exploitation of the data that can be developed and could be a basis for small business startups. The real-time data acquisition can foster the collaboration with US, European, African and South American activities, such as a consortium that formed the European Gravity Service for Improved Emergency Management (EGSIEM). The EGSIEM is a multi-institutional effort to **improve the response time for regional emergencies**. The *Atlantic Interactions* initiative can be important an important spot for similar regional remote sense-data applications. It is worth mentioning the Space Center in Maspalomas (CEC, Canary Islands) which has a large expertise in providing services as the reception, processing and archiving of Earth Observation Data (CREPAD), monitoring of space missions, operation and maintenance of ground stations to

follow telemetry and telecomand of space missions (scientific, meteorological,...), as well as operational services in real time.

Space systems can also provide Earth Observation data. This data can be used for **innovative geo-information services** that can promote transversal initiatives with applicability in many areas related to coastal and ocean management. The analysis of this data could be use on the response to the challenges of promotion, growth and competitiveness of the maritime economy, in line with the European Commission initiatives such as Blue Growth.

Data obtained from space systems can also serve to **improve safety in the Atlantic.** Space related technologies could cover the following activities:

- Monitoring piracy, illegal and narco activities in Gulf of Guinea & Africa west coast;
- Supporting search and rescue (SAR) Atlantic activities;
- Supporting scientific missions and new economic endeavors;
- Conducting research and testing for UAVs for maritime applications, including a staging and deployment site for regional campaigns.
- Risk prevention in coastal cities.

The *Atlantic Interactions* could also foster the creation and management of a ground facility with radars and optical sensors for the surveillance and tracking of space objects (active or debris). This facility could host any type of surveillance and tracking assets (radars, telescopes, laser ranging systems), such as for example, be a "mirror site" for example of the Haystack radar of MIT Lincoln Laboratory imaging at W band for NORAD (North American Radar Air Defence), or of the Spanish Space Surveillance and Tracking Radar (S_3TSR) in L-band which will be soon part of the EU SST system.. The availability of high accuracy objects data or high resolution images of virtually everything in orbit could be managed as a service.

The *Atlantic Interactions* initiative can benefit from the existing 15-metre antenna hosted in Maspalomas (Canary Islands) with reception in S- and X-Band and transmission in S-band, additional infrastructure also in Maspalomas to provide tacking, telemetry, telecommand and radiometric measurements (ranging, Doppler, meteo), the development and implementation of a large antenna of 15.5 meters in Santa Maria Island – Azores, and the development of new infrastructure to accommodate activities for the EU Space Surveillance and Tracking (SST) program and NATO's Future Surveillance Control Project/AGS.

A summary of the Identified scientific and technological key activities that could be pursued by the *Atlantic Interactions* initiative to support the Global challenges in Chapter 4:

- **Reduce the cost of access to space for the launching of small satellites**
- **Acting as a regional collector of requirements for satellite monitoring systems**
- **Establish innovative geo-information services based in Earth Observation (EO) data for adoption and enhancement of the EU Atlantic Strategy (in particular EU Horizon 2020 project "AtlantOS") and its action plan and of National Ocean Strategies**
- **Installation of an operational network / platform for an efficient "Atmosphere - ocean monitoring and environmental management"**
- **Establish a Surveillance platform / network to leverage the scientific leadership in the Atlantic**
- **Host of infrastructure and activities for the EU Space Surveillance and Tracking (SST) initiative, in view of the location potential, for the benefit of Europe and the Atlantic region**

5.2 Enabling activities 2: Data science and data visualization domains

Science exploration at the *Atlantic Interactions* will generate complex and extensive data that must be analyzed properly to extract knowledge. Data science is focused on extracting knowledge or insights from data in various forms, either structured or unstructured.

Data science can contribute to the above Global challenges through the **development of cognitive processes** combining existing models based on physical properties and large and heterogeneous data sets. The product resulted from these cognitive processes, for research and/or commercial purposes, should be trustable and could for example increase the efficiency and development of several industries.

In addition to extract knowledge from data, it is important that the extracted knowledge is understood by scientists, decision makers and the broad public. Data visualization is therefore quite pertinent to the *Atlantic Interactions* initiative as it can explain and educate the importance of the driven research to policy makers, researchers and the general public in a visual and interactive way. This understanding process could even be extended to areas such as interactive simulations, "serious games" meaning video games currently in use by industry

for education, scientific exploration, health care, emergency management, urban planning, and engineering. These can augment and add to the scientific effort of the Atlantic Interactions as it relates to the willing participation and involvement of the general public.

A scale data collection curation and storage with advanced computing and analysis could also help to achieve the above Global challenges as researchers and practitioners could find the main research information on the Atlantic region in only one place, which may constitute "AIR Kiosks". This **Research Cloud for the Atlantic** should follow the principles of EOSK and could be designed and deployed to integrate a comprehensive set of tools and technologies linking the science and engineering relevant to the *Atlantic Interactions* initiative. It should become a widely used and an indispensable site of reference for the international research community, policy makers and the public in general.

The Research Cloud for the Atlantic can support all the thematic areas of the Atlantic as a technological platform and data hub responsible for providing (Fig. 5):

- A portal, iAtlantic, for web access to host applications providing data and services for science and engineering applications including a directory for search and browse;
- Real-time data collection from several maritime sensors and information sources (land, sea, air and space) that already exist and also from others to be developed;
- Data correlation and fusion through advanced computational models;
- Data storage and retrieval capabilities enabled by big data distributed databases;
- Open interfaces allowing the research and commercial stakeholders build their own services on top of collected data, core cloud services and third parties hosted services;
- Rapid prototyping environment providing core functionalities such as imagery processing, machine learning and business intelligence;
- Application and services hosting;
- Reliable electronic information exchange between stakeholders (including connection to national and international data exchange networks).

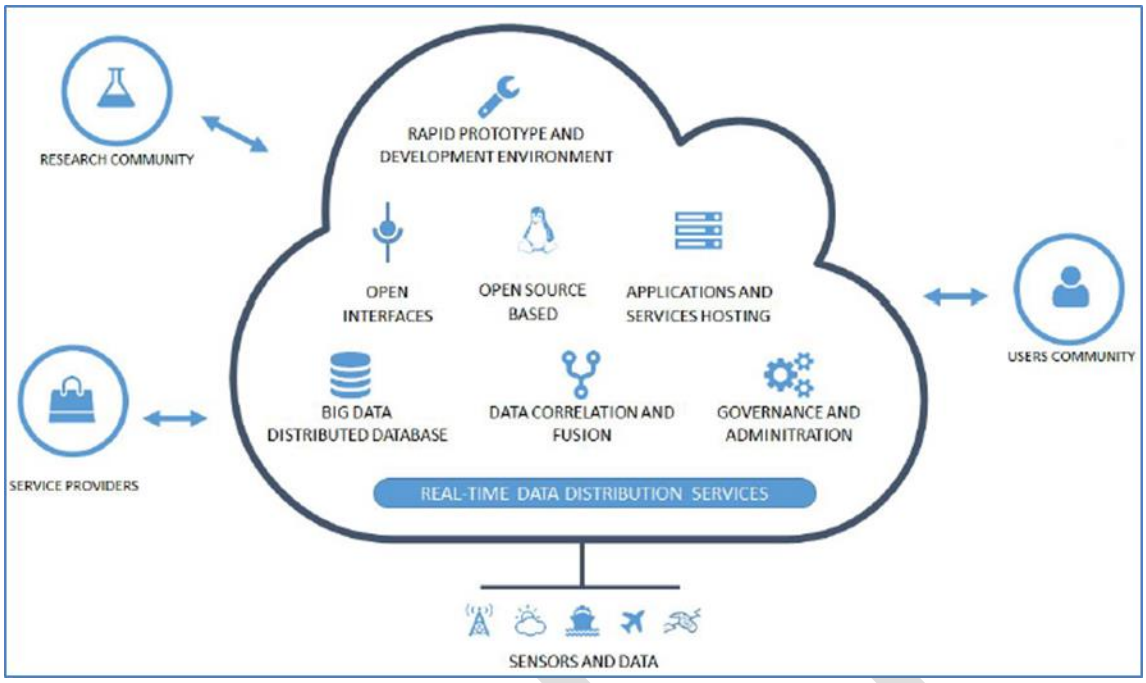

Fig.5 – High-level architecture representation for the Atlantic Interactions Research Cloud

The architecture depicted in Figure 5 can be efficiently set-up based on existing assets to support Atlantic-related operations such as data collection from several sensors (space, land and sea), data fusion through advanced computational models, storage and dissemination.

Science exploration at the *Atlantic Interactions* will generate complex and extensive data that must be analyzed properly to extract knowledge. As data science is focused on extracting knowledge or insights from data in various forms, either structured or unstructured, this endeavor is simultaneous processing of this data, towards its understanding by the scientists and broad public constituencies.

A summary of the Identified scientific and technological key activities that could be pursued by the *Atlantic Interactions* initiative to support the Global challenges in Chapter 4:

- **Create a best in class Data Science team to extract value from Data, including Data scientists, Data engineers / Data software developers, Data solutions architects, Data platform administrators, Full-stack developers, Designers, Product managers and Project managers**
- **Design and develop a content analytics platform and methodologies to apply cognitive analytics solutions**
- **Develop a cognitive process to predict future ocean conditions using a combination of physically-based models and large, heterogeneous data sets**

- **Design and develop of cognitive security solutions to manage cybersecurity threads and keep data trustable**
- **Develop data visualization tools to promote understanding of the collected and analyzed data**
- **Integrate at scale, data collection curation, and storage with advanced computing and analysis – development of a Research Cloud dedicated to the Atlantic, the iAtlantic**
- **Integrate scientific models to promote an holistic analysis over climate-energy-atmosphere-ocean interactions**

6. Crosscutting activities

6.1 Atlantic Ocean Coastal Cities Network (AOCCN) - The City-Ocean Interface

Considering that most of the population lives in coastal cities, whose prosperity is largely dependent on the interactions between oceans/climate/energy/atmosphere, which motivates the *Atlantic Interactions* initiative, there is a basis to call for the development of a formal network of coastal cities as a subset of the larger Atlantic International Research Center (AIR).

The Atlantic Ocean Coastal Cities Network (AOCCN) will catalyze research and foster action on solutions for coastal cities of the Atlantic Ocean in mitigating carbon emissions and adapting to the challenges of climate change. The main focus of the work will be the sea-land interface at the location of major cities along the multi-continental edge of the Atlantic Ocean. Therefore, the partners in this work will be a group of major cities, their municipal governments and associated academic and business partners situated in each member city.

The primary outcome will be the formulation and development of coupled technology-policy actions that deliver economic and equitable solutions for protecting cities through adaptation to climate change while advancing aggressive greenhouse gas mitigation strategies. The Network could proceed through three distinct mechanisms:

1) collaborative and directed research ventures;
2) regular convening for solutions and;
3) community exchange and focused visits.

The first mechanism will prompt the formulation, funding, and staffing of research topics of greatest urgency and relevance to member cities. This will entail a process of vetting and

refining proposals that include international participation by both researchers and member cities. The second mechanism will involve regular convening in different locations of the multidisciplinary network comprised of municipal authorities, business leaders, academics, NGOs, and others with a productive participatory role in advancing solutions. The third mechanism puts in place various exchanges of people from one city to another and from one type of organization to another for maximum collaborative understanding of the priorities to be found in each distinct sector.

This proposal is founded on the belief that a fundamental element of AIR is the role of cities in understanding the Atlantic as both a complex natural system and a bridge between the distinct economies, cultures, histories and priorities of bordering countries.

6.2 Addressing technology transfer

The activities in scope of the *Atlantic Interactions* initiative will foster an innovative and entrepreneurial environment that would be characterized as a "start-up campus" for innovation resulted of the holist approach implemented. For example, NewSpace companies, considered as "high-risk, high-reward" from an investment view point, could take advantage of this entrepreneurial environment. This innovative environment will create appropriate conditions for attracting private investors and will be a perfect place to build capacity and impact the Atlantic's economy.

6.3 Promoting scientific literacy: Knowledge for Space – Space for Knowledge

The *Atlantic Interactions* initiative includes the urgent need to foster knowledge as our common future, and recognize the need to bring to the center stage all those in the margins of knowledge and knowledge-based economic activities as a way to increase social and gender equality and fostering inclusion for everyone, everywhere, anytime.

Scientific literacy has therefore also been tackled by the scientific and technological community as a crosscutting activity to foster the interest and mobilize younger generations for science and technology. The power of literacy lies not just in the ability to read and write, but rather in a person's capacity to apply these skills to effectively connect, interpret and discern the intricacies of the world in which they live.

To promote science and innovation for all, the agenda should include an activity fostering education and knowledge aimed to promote **"Knowledge for Space" and its integration with ocean, earth and climate education in a holistic approach**. This initiative should extend traditional education and science awareness programs to consider new horizons of space technologies in order to foster the access to education for all. This will be achieved by involving telecom operators, broadcast services and space providers in a "Space for Knowledge" network.

Although "star wars" program days are gone, in today's world space activities are still very much perceived by the general public as a dispute for outer space conquests of "rocket" scientists. The majority of the world's population is **unaware of the importance of space activities in our daily lives**. This is in fact a highly relevant theme in today's societies because space science involves a series of disciplines that provide new insights on the Universe (physics; astronomy); allows perceiving earth dynamics which helps in the prediction and preparation for emerging threats; foster new advancements in satellites and robotic engineering, as well as in related technology allowing the exploration of outer space and find new materials and new knowledge of the Universe. A better use of space science and technology opens opportunity for new ventures with economic, environmental and social impact. The impact of a better use space application could foster innovation and developments in fisheries and aquaculture, maritime safety, managements of common resources/goods and foster renewable energy potential as it integrates different areas of knowledge.

It is under this context that several major initiatives have been launched worldwide in the last decades to foster education for space in an effort to bridging the knowledge gap between people and space science. For example, in 2002, UNESCO launched a Space Education program[24] following recommendations from the 1999 World Conference on Science and the Third United Nations Conference on the Peaceful Uses of Outer Space[25]. It is aimed to enhance space subjects and disciplines in schools and university curricula, the improvement of teaching methodologies to raise awareness about the importance of space and space related activities to human development.

To carry out these objectives, UNESCO develops space education workshops and other initiatives that show the importance of the peaceful uses of outer space and the role played by

[24] http://www.unesco.org/new/en/natural-sciences/science-technology/space-activities/related-info/about-sep/
[25] http://www.unoosa.org/oosa/en/ourwork/psa/schedule/1999/unispace-iii.html

space uses and technology in protecting, monitoring, documenting, and sharing our common heritage, both cultural and natural.

In a related action, ESA launched the ESERO initiative[26] (European Space Education Resource Office) with several nations, including activities to help teachers introducing space in the classroom and raising awareness in schools of the importance of space science and technology. Among other initiatives, it has provided teacher-training courses, with special emphasis to primary level education and the reinforcement of the communication between the scientific community, enterprises and schools.

The United Nations Office for Outer Space Affairs (UNOOSA) is the United Nations office responsible for promoting international cooperation in the peaceful uses of outer space and has an extensive capacity-building role achieved through different programs and initiatives. The *Atlantic Interactions* could complement and partner with UNOOSA to deliver capacity-building efforts to developing countries.

By using space as an engaging multidisciplinary challenge, these initiatives are contributing to promote the interest and mobilization of younger generations for science and technology.

Through the initiative **"Knowledge for Space – Space for knowledge"**, the *Atlantic Interactions* will aim to expand and complement existing activities at UNESCO, ESA, NASA and other major players worldwide to raise awareness for the natural, physical and engineering sciences among children, but also to deliver new educational and cultural contents in developing countries through space technologies. Specific activities will aim to promote the diffusion of endogenous knowledge of local cultural and natural heritages, and contributing for educating more children everywhere, all the time.

A sustainable future requires more knowledge and more scientific culture, ensuring the access to science and education as an inalienable right of all.

[26] http://www.esa.int/Education/Teachers_Corner/European_Space_Education_Resource_Office

7. A Scientific and technological agenda – A visual approach

Key identified activities	Atlantic Interactions thematic areas				
	Space systems and applications	Atmospheric science	Ocean science	Climate Change and Energy systems	Data systems
Global challenge 1: Understanding, predicting and adapting to climate change					
Research to understand global, regional and local climatic patterns and climate change impacts		X	X	X	
Integrate atmospheric and ocean information in global climate models		X	X	X	
Monitor the large-scale Atlantic subtropical gyre circulation variability			X	X	
Monitor the influx of aerosols and atmospheric pollutants in the Atlantic region		X		X	
Development of a regional earth system model for the Atlantic Ocean		X	X	X	
Research to understand the effects of aerosols in the cloud condensation nuclei (CCN) budget		X		X	
Research to understand cloudiness transitions through the integration of in situ ground based, airborne and satellite data	X	X			
Understand the influence of climate change in the primary activities (i.e. fishing, agriculture, etc) and in the services sector (i.e. tourism, transport, etc)		X	X	X	
Use the high number of lakes available in different islands of Azores to reconstruct the climate of the Holocene, including the NAO and AMO				X	
Global challenge 2: Understanding the Atlantic Ocean system and its natural resources for a healthy and productive ocean					
Fill the gaps on the observing capabilities for monitoring the Atlantic variability and change in wider temporal and geographical scales (i.e. mesoscale and large scale)	X	X	X		
Build knowledge and explore deep ocean and seamounts, mapping resources and ecosystems	X		X	X	X

Key identified activities	Atlantic Interactions thematic areas				
	Space systems and applications	Atmospheric science	Ocean science	Climate Change and Energy systems	Data systems
Global challenge 2: Understanding the Atlantic Ocean system and its natural resources for a healthy and productive ocean (cont.)					
Understanding the knowledge on the physical and biogeochemical process and anthropogenic impacts, including soundscape around the Atlantic Islands			X		X
Develop new strategies to gather big data, connect data repositories and realize new sophisticated data analysis and modeling capabilities for the Atlantic Ocean	X				X
Observe and monitor the large-scale Atlantic variability and change	X	X	X	X	X
Explore new strategies for conservation of marine biodiversity			X	X	
Develop and test of innovative strategies, technologies and activities for a sustainable use of the ocean and promoting blue growth and economy			X	X	
Demonstrate innovative business concepts based on marine technology developments			X	X	
Apply blue biotechnology to sustainable harness biological resources, including fishing and aquaculture			X	X	
Research to understand major Earth Processes at Ocean Ridges and Ocean Crust Formation			X	X	
Global challenge 3: Increase the share of renewable energy in the global energy mix and improvement in energy efficiency					
Map the potential resources and priority areas for demonstration and testing technologies, innovative and disruptive business concepts	X			X	X
Develop new integrated strategies to accelerate flagship projects, demonstration and pilot initiatives, sharing knowledge and best practices				X	
Monitoring system to better predict the potential of renewable energies with high time resolution	X	X	X	X	

Key identified activities	Atlantic Interactions thematic areas				
	Space systems and applications	Atmospheric science	Ocean science	Climate Change and Energy systems	Data systems
Global challenge 3: Increase the share of renewable energy in the global energy mix and improvement in energy efficiency (Cont.)					
Develop a micro-grid management tool to exploit the use of high penetration of renewable resources, including distributed generation		X	X	X	
Foster the integration of multiple efficient and flexible storage systems				X	
Develop multiuse platforms and multi-use concepts to harness marine resources in the Atlantic and a higher more efficiency of the renewable energy resources in the Atlantic		X	X	X	
Develop tools and systems to manage the energy demand in buildings and large facilities to the availability of renewable energy resources				X	
Develop new mobility models to increase the use of renewable energies				X	
Develop a model to design efficient and affordable autonomous sustainable energy systems				X	
Develop a system to better predict renewable energy assets failure due to weather conditions		X		X	
Enabling activities 1: Space systems and applications domain					
Reduce the cost of access to space for the launching of small satellites	X	X	X	X	
Acting as a regional collector of requirements for satellite monitoring systems	X				
Establish innovative geo-information services based in Earth Observation (EO) data for adoption and enhancement of the EU Atlantic Strategy (in particular EU Horizon 2020 project "AtlantOS") and its action plan and of National Ocean Strategies	X			X	X
Installation of an operational network / platform for an efficient "Atmosphere - ocean monitoring and environmental management"	X	X	X	X	X
Establish a Surveillance platform / network to leverage the scientific leadership in the Atlantic	X		X		

Key identified activities	Atlantic Interactions thematic areas				
	Space systems and applications	Atmospheric science	Ocean science	Climate Change and Energy systems	Data systems
Enabling activities 1: Space systems and applications domain (cont.)					
Host of infrastructure and activities for the EU Space Surveillance and Tracking (SST) initiative, in view of the location potential, for the benefit of Europe and the Atlantic region.	X				X
Enabling activities 2: Data science and data visualization domains					
Create a best in class Data Science team to extract value from Data, including Data scientists, Data engineers / Data software developers, Data solutions architects, Data platform administrators, Full-stack developers, Designers, Product managers and Project managers	X	X	X	X	X
Design and develop a content analytics platform and methodologies to apply cognitive analytics solutions		X	X	X	X
Develop a cognitive process to predict future ocean conditions using a combination of physically-based models and large, heterogeneous data sets			X		X
Design and develop of cognitive security solutions to manage cybersecurity threads and keep data trustable					X
Develop data visualization tools to promote understanding of the collected and analyzed data		X	X	X	X
Integrate at scale, data collection curation, and storage with advanced computing and analysis – development of a Research Cloud dedicated to the Atlantic, the iAtlantic	X	X	X	X	X
Integrate scientific models to promote an holistic analysis over climate-energy-atmosphere-ocean interactions		X	X	X	X
Crosscutting activities					
Atlantic Ocean Coastal Cities Network (AOCCN) - The City-Ocean Interface	X	X	X	X	X

Key identified activities	Atlantic Interactions thematic areas				
	Space systems and applications	Atmospheric science	Ocean science	Climate Change and Energy systems	Data systems
Crosscutting activities (Cont.)					
Addressing technology transfer	X	X	X	X	X
Promoting scientific literacy: Knowledge for Space – Space for Knowledge	X	X	X	X	

Part III - Aligning research strategies through international cooperation in the Atlantic

A "moonshot project" on the Atlantic will require significant research infrastructure and funding. Although the various thematic research infrastructures in countries around the Atlantic have varying degrees of implementation and geographic coverage, the technological capability is in place to allow for a comprehensive thematic study of the ocean area, from the deep bottom to the space above.

Research Infrastructure roadmapping has been spearheaded in Europe, but the practice is spreading elsewhere, with South Africa having recently published their own Research Infrastructure roadmap. A joint EU-CELAC expert group is also being formed to spread best roadmapping practice to Latin American and Caribbean countries. These fora will greatly benefit from the *Atlantic Interactions* initiative, which will promote an integrative planning process in the Atlantic context, and thus more efficient and with a greater impact on the *Atlantic Commons*.

The **alignment of initiatives and infrastructure** for the *Atlantic Interactions* initiative through international cooperation could be three-fold:

1) through the design of a pan-Atlantic research program, leading to coordinated deployment of existing World-class equipment from participating countries, to tackle the big questions on the ground;

2) through the continuing work on data standards and inter-operationalization, as well as the coordination of data flow, in the frame of the EOSC[27], and in close collaboration with national and supra-national data networks, other e-Infrastructures and organizations such as the Research Data Alliance[28] and relevant Research Infrastructures and cluster projects;

3) through the joint planning / roadmapping for new research infrastructures.

The aim should be to benefit of the existing infrastructures developing new ones only when assets are not available, with the aim of not duplicating efforts and resources.

[27] https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud
[28] https://www.rd-alliance.org/

8. Cost of Not Doing

Overall, the global expenditure on R&D has seen only modest increases in the past few decades. Even though the GDP has grown by an average of 3,26%/year since 2000 in OECD countries[29], the share of that GDP going to R&D has grown by a modest 0,75%/year[30]. Compounded by the realization that doing research is an increasingly costly endeavor, these numbers pose a great challenge and call for increased efficiency in spending, if frontier and global challenges are to be addressed.

One way to increase the efficiency is by coordinating different streams of funding into common goals and research programming. In Europe, a whopping 85% of all research funding is estimated to be spent on national programs, with only 15% dedicated to common, pan-EU endeavors, or global programs, such as CERN, or the Framework Programs of R&D. This flies in the face of the borderless nature of science.

The successes of such big science projects are very palpable and the scientific community, as well as the public at large, understands the benefits of common pursuits. In an era of limited resources, their fragmentation should be reduced, coalescing around common scientific and societal goals. A harmonious deployment of resources – physical, human and financial – will make it possible to tackle big questions, in the multi-disciplinarity demanded by their complexity. In the current model, we can only achieve very detailed knowledge of some localized phenomena, with large geographic and thematic gaps remaining, and thus a flawed understanding of the natural World.

The *Atlantic Interactions* initiative will fulfill several of those thematic and frontier gaps bring new knowledge-driven solutions to Atlantic, and possibly global societal challenges at a much lower cost if every nation had to perform similar activities on its own.

9. Aligning infrastructures and initiatives

[This section will be further developed with information from the results obtained from the matrix to be filled in by the nations (EC DGs and UN offices). The idea is to develop a schematic figure/image and some text, if suitable.]

[29] https://data.oecd.org/gdp/gross-domestic-product-gdp.htm
[30] https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm

Through an alignment of existing infrastructures and initiatives the *Atlantic Interactions* initiative will **bring added value to existing research efforts** from deep-sea to Space from both sides of the Atlantic and through North-South cooperation, **empowering those who are already working** to tackle global Atlantic issues, and **catalyzing new initiatives** in a strategic and holistic way, **targeting identified current and future gaps** and communicating progress to a wide range of stakeholders.

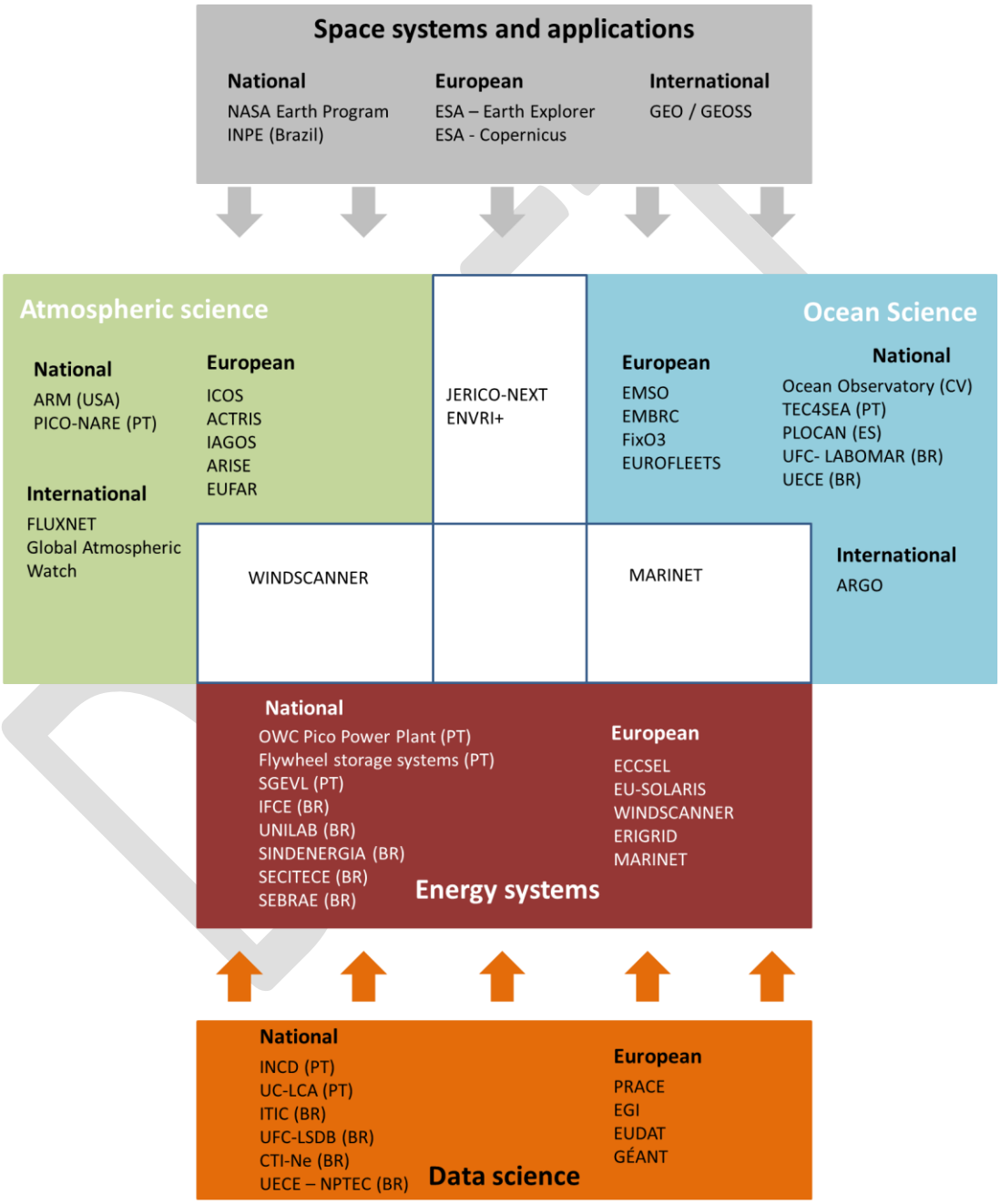

Fig. 6 - Main National, European and International infrastructures and initiatives in the five thematic areas of the Atlantic Interactions initiative and in the frontiers areas.

The main existing infrastructures and initiatives at National, European and International levels that could be aligned and leveraged through the *Atlantic Interactions* initiative are represented in Figure 6.

[Detailed information on how the infrastructures and initiatives could contribute to the Atlantic Interactions agenda can be found in Annex I.]

10. Aligning financial instruments

[This section will be further developed with information from the results obtained from the matrix to be filled in by the nations (EC DGs and UN offices). The idea is to develop tables and some text, if suitable.]

The *Atlantic Interactions*, weaving together Ocean, Atmospheric and Energy-Climate research in the latest generation of data and space technology enablers, is a "moonshot" overarching research subject, of interest mainly to the North/South, East/West Atlantic countries, but also beyond. National, regional, supra-national and private funds should be aligned to enable a common R&I program based on a common R&I agenda. These can be anchored in the European Commission's Framework Program and national program for grants and fellowships.

When tackling larger-than-national scientific questions, it is increasingly common to use mixed funding schemes, in order to enable the very existence of the projects, or to allow the participation of researchers from different origins in common scientific endeavors. In **Europe, Joint Programming Initiatives (JPIs)** have recently been deployed to align the financial instruments of Member States around common-interest research issues. Likewise, **ERA-Nets** (Member States-European Commission co-funding mechanisms) have proliferated in recent years, which have allowed the coalescence of funding instruments and research communities across Europe, but have also dispersed funding to many small-scale ventures. The fact that research communities and funding agencies seek international engagement is a very positive realization for global science, as the links that are created can nucleate future common endeavors. But transformative projects require bold common goals and/or financial packages. That is one of the tenets of **Horizon 2020's International Cooperation approach,** which has led to several non-EU countries establishing matching fund schemes for their research communities to participate in formally "European" projects. The main European financial instruments can be found in Table 1.

Source	Primary targets	Type of support
European Structural and Investment Funds	National Authorities	Grants, fellowships, contracts
European Investment Bank	National, Regional Governments, Public and private institutions, SMEs	EFSI, Loans, mixed instruments
DG RTD (Horizon 2020)	Universities, Research Organizations, Researchers, SMEs, Industry	Grants, fellowships, awards
DG GROW (COSME)	SMEs	Access to finance, markets
DG ENV (LIFE)	Public, private organizations	Grants
DG MARE	Public, private organizations	Grants, Tenders
DG DEVCO (EDF, PI, DCI)	Development policy countries (variable)	Grants, projects

Table 1 – Main European financial instruments

The instruments in Table 1 vary in target, scope and budget. The European Structural and Investment Funds (especially ERDF) are the largest package, but sizeable and very relevant programs exist in different Directorates-General. Of the ones listed, the most attractive for the scope of the Atlantic Interactions initiative are the Horizon 2020 Framework Program (DG RTD) and the DG DEVCO instruments, targeting regions bordering the Atlantic Ocean (Partnership Instrument, Development Cooperation Instrument, European Development Fund).

If the instruments of European dimension are complex and difficult to articulate with each other, these have to be looked at in the context of multiple national programs as well, which are endowed with even larger amounts, disbursed through multiple instruments.

Outside of Europe, **bilateral agreements** have allowed some level of scientific common-interest pursuits between nations, but they have also, in some instances, led to a proliferation of instruments, that make it more difficult to tackle large, multi-country projects. To name just two South Atlantic countries, Brazil and South Africa have in place bilateral research cooperation agreements with 30+ countries each. In addition to bilateral agreements, at **national level** there are innumerous funding instruments that could be aligned to fund common challenges (Table 2). The Atlantic is one such common challenge. The identification of relevant regional, national and supra-national instruments and their coordination around a common agenda will be one of the main focus of this initiative.

Table 2 – Main national financial instruments

[Detailed information on how the financial instruments could contribute to the Atlantic Interactions agenda can be found in Annex II.]

11. Identification of new infrastructures, initiatives and instruments needed to potentiate international cooperation

[This section will be further developed with information from the results obtained from the matrix to be filled in by the nations (EC DGs and UN offices). The idea is to develop tables and some text, if suitable.]

Part IV – Implementation of the Atlantic Interactions vision: Atlantic International Research Center (AIR Center)

The participants of the High-level Industry-Science-Government Dialogue on *Atlantic Interactions* that took place on April 20-21 April 2017 in the Azores (Terceira island) agreed that the **science and technological agenda for an integrative approach to the Atlantic should be implemented through an international network of research, academic and business organizations worldwide**, across both south and north Atlantic countries, as well as non-Atlantic countries, in an international scientific organization, bringing together infrastructures located throughout the Atlantic: the **Atlantic International Research Center (AIR Center)**.

12. The Atlantic International Research Center (AIR Center)

Taking into account the **holistic and integrated approach** of the *Atlantic Interactions* initiative, the AIR Center will consist of an intergovernmental organization, extending the capabilities of research centers around the world and effectively addressing the synergies between Space, Climate-Energy, Oceans and Data Sciences. This approach will pave the way for a sustainable management and exploration of Atlantic common resources. It will also enhance the potential of the existing Atlantic research infrastructures since it would focus on disciplines that combine more than one scientific area, acting as a catalyst for research and innovation in multiple domains ranging from renewable energies, to the interactions of the ocean with the atmosphere and global climate phenomena, the impacts of global changes on the open ocean and the deep sea, including their biodiversity, as well as blue economy.

The AIR Center will also **exploit the potential of the Atlantic islands** by stimulating the necessary knowledge-driven conditions to better use of their natural resources. Thus they would play a role as unique observation networks to better understand oceanic and atmospheric systems but also as central key players in the marine and blue economy providing further insight on the sustainable management of unexplored oceanic realm. A network of Atlantic islands and mainland research sites in Azores, Madeira, Canary Islands and Spanish territory, Fernando Noronha and S. Pedro-S. Paulo in Brazil, Cape Verde, Nigeria, South Africa, as well as others to follow would increase the operational efficiency of research of technology facing global issues as it would **optimise the appropriate use and sharing of research infrastructures, and access to and management of data and platforms**.

Providing an efficient governance to sound international cooperation will be the basis of the AIR Center. Different forms of scientific and technological collaboration with public and private entities from non-Atlantic countries across the globe are also welcome and will allow the openness of the center to the world. The AIR Center aims to provide a truly international shared environment, which will promote amongst others, the development of comparative studies and projects on other seas, oceans, such as the Indian, Artic, and Pacific Oceans and the Mediterranean promoting a sustainable management of common resources.

Taking into account the *Atlantic Interactions* initiative vision, the AIR center will accomplish the following goals:

- Promote a new holistic and integrative approach to knowledge on space, climate-energy, oceans and data scientific areas and related issues in the Atlantic, fostering conditions to provide the world with more science, more knowledge and more scientific culture;

- Foster an inclusive approach to science, technology and economic development, bringing to the center of our attention all of those in the "margins" of knowledge driven societies and knowledge-based economic activities;

- Establish a network of research sites in various Atlantic islands in north and south Atlantic, in close interaction with research, academic and business organizations worldwide, including those across both south and north Atlantic countries, as well as non-Atlantic countries;

- Facilitate the access to space data from the unique position of the Azores, promoting access to new frontiers of knowledge, together with the development of new space industries;

- Stimulate the test of new renewable energy sources and their integration in smart networks in islands environments, promoting test beds for the development of new sustainable energy industries;

- Promote new research in deep-sea, facilitating the access to a better understanding of living organisms in extreme environments and new energy and mineral sources;

- Foster the study of earth processes in the Atlantic triple junction, where three major tectonic plates meet, to contribute for the understanding and risk mitigation of the derived natural hazards, namely earthquakes, volcanism, tsunamis;

- Facilitate the establishment and use of new mega-sets of data on climate, atmosphere, earth, ocean and energy related themes stimulating new forms of data science and the development of new technology-based companies oriented towards big data processing and usage;

- Promote and foster the education and knowledge agenda "knowledge for Space – Space for knowledge" and its integration with ocean, earth and climate education in a holistic way, fostering the interest and mobilization of younger generations for science and technology, as well as contributing for educating more children everywhere, anytime.

The central location of Azores in the Atlantic and its proximity to complex oceanographic and ocean-atmosphere interaction processes, the existing expertise in ocean and atmosphere-climate research and the existing research facilities make them a natural headquarter for research. Its complex geological nature and activity, its climate and waves provide alternative energy sources, while its isolated nature is already a stage for energy storage experiments, placing the Azores in a privileged scenario in terms of energetic resource exploitation potential. The meteorological conditions, the large distance from inhabited landmasses, the existing space related infrastructures (European Space agency's Tracking Station; Galileo Sensor Station, Copernicus Collaborative Station; Earth Observation Station, Atlantic Network of Geodynamical and Space Stations; NAV Portugal Air Traffic Control Center) provide a favorable set of conditions for the implementation of microsatellite launching facilities, thus putting the Azores and Canary Islands in a central position in the Space scene. In the given context, the Azores archipelago appears as a natural choice for hosting AIR Center's headquarters.

Through an enhanced international cooperation among world-wide research institutions, initiatives and the private sector the AIR Center will allow to put in place the ***Atlantic Interactions*** **initiative vision**: a common approach to address societal challenges and unleash the potential of the Atlantic for science, economy and society.

Annex I – Existing infrastructures and initiatives

[To be further developed and reorganized with information collected from the matrix to be filled in by the countries. At the moment includes information already received from some countries/regions.]

A. Portugal – Existing infrastructures

	Infrastructure name	Short Name	Managing Organisation	Short description	Status	Webpage	Contribution to the Atlantic Interactions agenda
Space systems and applications Thematic Area	**Portuguese infrastructure for storing and providing images of Sentinel satellites**	IPSentinel	Direção-Geral do Território; IPMA	The infrastructure IPSentinel provides free and open access to data from Sentinel satellites in the Portuguese territory including the area of responsibility for search and rescue in the Atlantic. It has a privileged quick access (minutes) to Sentinel 1 data through Santa Maria Ground Station. The infrastructure IPSentinel is already aligned with the proposed high-level architecture for the Atlantic Interactions Research Cloud. With some upgrades it could provide computing capabilities.	Operating	https://ipsentinel.ipma.pt/	Enabling Activities 1
	Portuguese ALMA Centre of Expertise	PACE	IA (CAUP, Fciências.ID)	ESO-recognized Centre of Expertise part of the European ALMA Regional Centre, focused on the support and exploitation of the Atacama Large Millimetre Array. PACE supports portuguese and EU users of ALMA, including with the ALMA archive, and helps ESO validate ALMA data. It includes expertise in data handling and radio astronomy, of relevance for the Atlantic Interactions agenda.	Operating	http://pace.oal.ul.pt/	Enabling Activities 1
	Laboratory of Optics, Lasers and Systems	LOLS	FCUL	Laboratory facility developing multidisciplinary activity for scientific instrumentation. Of particular relevance, the activity in the area of Astronomy and Space Sciences; Computer Vision; Flight Dynamics; Geospatial Information Systems; Image Processing; Lasers and Quantum Electronics; Navigation and Position Fixing; Photodetectors, Optical Sensors and Solar Cells; Photogrammetry and Remote Sensing; Photonics and Electro-Optical Engineering (excl. Communications); Photonics, Optoelectronics and Optical Communications; Satellite, Space Vehicle and	Operating	https://ciencias.ulisboa.pt/en/lols-laboratory-optics-lasers-and-systems	Enabling Activities 1

				Missile Design and Testing; Signal Processing; Simulation and Modelling.			
	Astronomical instruments for ground-based observatories	--	IA	Future ground based instruments (ESPRESSO@ESO, MOONS@ESO, HIRES@ELT,...): the expertise in the development of state-of-the-art astronomical instruments for ground-based observatories is extremely relevant for the international collaboration in the Atlantic Area considering, in particular, the international observatory of the Canary Islands and potential future space observing facilities in Azores and Madeira.	Under Construction	--	Enabling Activities 1
	ESA Tracking Station		EDISOFT	An Estrack stations with launcher tracking capability and is used to receive real-time telemetry from launches originating from ESA's spaceport in Kourou, French Guiana. It is capable of tracking Ariane 5, and was first used to track the launch of ESA's Automated Transfer Vehicle (ATV) *Jules Verne* in early 2008.	Operating	http://www.esa.int/Our_Activities/Operations/Estrack/Santa_Maria_station	Enabling Activities 1
	ESA - Perth Antenna		Azores Regional Government - EMA-Espaço; EDISOFT	15-metre antenna with transmission and reception in both S- and X-band.	Under Construction		Enabling Activities 1
	Galileo Sensor Station	GSS	EDISOFT	*To be completed*	Operating	http://www.edisoft.pt/	Enabling Activities 1
	EUMETSAT Station	EUMETSAT	EDISOFT	*To be completed*	Operating	http://www.edisoft.pt/	Enabling Activities 1 Global Challenge 1
	Atlantic Network of Geodynamical and Space Stations	RAEGE	Azores Regional Government - EMA-Espaço	Two fundamental geodetic stations (Santa Maria is operational and Flores is under construction); data infrastructure	Planned and Operating	http://raege.morfose.net/en/about-us/raege-in-vgosggos/	Enabling Activities 1 Global Challenge 1
	Permanent	REPRA	Azores Regional	*To be completed*	Operating	http://www.	Enabling Activities 1

	Geodesic Station Network of Azores	A	Government - Directorate for Environment			repraa.azores.gov.pt/SpiderWeb/frmIndex.aspx	
	SST Infrastructures		Azores Regional Government - EMA-Espaço	Optic infrastructure foreseen for Graciosa Island and RADAR infrastructure for Santa Maria Island; possible data centre in Terceira Island	Planned		Enabling Activities 1
	Sattelite Launchers' Space Port		Azores Regional Government - EMA-Espaço	*To be completed*	Planned		Enabling Activities 1 Crosscutting activities: Addressing technology transfer
	Drone Test Area		ANA Aeroportos	Test area defined in Santa Maria in a protocol between the Azores Government and the airport and air traffic authorities, subscribed by some private companies have signed up.	Operating		Enabling Activities 1
	Enabling Green E-science for Square Kilometer Array	ENGAGE SKA	Instituto de Telecomunicações	ENGAGE SKA implements an action plan coupling frontier research and technological development in close collaboration with the Portuguese industry, promoting the participation of Portugal in the Square Kilometer Array, the largest radio telescope of the XXI century, to be installed in Southern Africa and Australia. ENGAGE SKA offers a wide variety of activities, such as advanced training in radio astronomy, radio frequency and core optical technologies for radioastronomy, training in computational astrophysics, characterization and testing facilities with inclusion of Green (Solar) technologies, Aperture Array technologies optimization, solar observations (radio and optical), astronomy software development and E.Science, Cloud Computing and Data Storage. It includes: - VLBI techniques (for connection with RAEGE + EU/Africa VLBI networks) - SST pilots (space debris programs) - SATCOM/DSN techniques (Dopler tracking)	Under Construction	www.engageska-portugal.pt	Enabling activities 1

Atmospheric science and Climate Change Thematic Area	**Portuguese E-Infrastructure for Information and Research on Biodiversity / Azorean Biodiversity Portal**	PORBIOTA-AZORESBIOPORTAL	Owner: Azorean Biodiversity Group (cE3c); Funding Managment: Fundação Gaspar Frutuoso	It includes online species spatial distributions at 500 m x 500 m for 6500 marine and terrestrial species for Azores: Scientific and citizen data is available since 1850; Modelling tools will be available for Big Biodiversity Data, useful for modelling the impact of climatic changes on marine and terrestrial ecosystems.	Under Construction	http://azoresbioportal.uac.pt/	Global Challenge 1
	Biodiversity on oceanic islands: towards a unified theory	ISLANDLAB	Owner: Azorean Biodiversity Group (cE3c); Funding Managment: Fundação Gaspar Frutuoso	Database with a long term ecological study in the natural forest of several Azorean islands aiming to monitor the flying insect fauna in order to understand the impact of climatic changes in the productivity of Azorean native forests.	Under Construction	http://islandlab.uac.pt/	Global Challenge 1
	Eastern North Atlantic (ENA) Atmospheric Radiation Measurement (ARM) facility	ENA-ARM	US Energy Department and University of Azores	It provides the research community with continuous data about clouds, aerosols, energy, and precipitation from Graciosa Island in the Azores, Portugal. Installed by a team from Los Alamos National Laboratory, the new observation site mirrors ARM's other long-term atmospheric measurement stations around the world.	Operating	https://www.arm.gov/news/features/post/23692	Global Challenge 1 Global Challenge 3
	Pico Mountain Air Pollution Observatory - North Atlantic Regional Experiment	PICO-NARE	University of Azores	An air pollution observatory that allows to study the free atmosphere (not directly affected by the ocean) and see pollution transport events originating in North America and Europe. The station was developed to study the global impacts of human activities on the atmosphere. It has also proven valuable for learning about the effects of large wild fires in North America and even Siberia.	Operating	http://www.cee.mtu.edu/~reh/pico/	Global Challenge 1

	José Agostinho Meteorological Observatory	OJA	IPMA	Located at the north surroundings of the Angra do Heroismo town, the facility has near 19100 m2 of area, including a main building (observatory) with 3 floors and 10 offices. It has also a manual weather station and a automated weather station with 1 technician. It also has a seismic station with 2 technicians.	Operating	http://www.ipma.pt/pt/index.html	Global Challenge 1
	Santa Maria Meteorological Center	LPAZ	IPMA	Located at the Santa Maria international Airport, the facility consists in a building with only one office, a manual weather station and 2 automated weather stations. It has 6 technicians working in shifts 24/7.	Operating	http://www.ipma.pt/pt/index.html	Global Challenge 1
	Graciosa Meteorological Center	LPGR	IPMA	Located at the Graciosa Aerodrome, the facility consists in an office, a manual weather station and an automated weather station. It has 2 technicians working in shifts.	Operating	http://www.ipma.pt/pt/index.html	Global Challenge 1
	Regional Government's network of hidrometeorological sensors	--	Azores Regional Government - Directorate for the Environment	The hydrometeorological network of the Azores intends to monitor the hydrological cycle of the archipelago, as well as hydrometric levels of the lagoons, through a network of 44 stations spread across the 9 islands, contributing to monitoring climate change.	Operating	http://servicos-sraa.azores.gov.pt/morhi/	Global Challenge 1
	Regional Government's air quality monitoring station	--	Azores Regional Government - Directorate for the Environment	Equipped with automatic analyzers of atmospheric pollutants, as well as meteorological parameters such as wind speed, temperature, relative humidity, precipitation and solar radiation, allowing evaluation of air quality, based on methods and measurement criteria common throughout the national territory.	Operating	http://www.azores.gov.pt/Gra/srrn-ambiente/menus/secundario/Qualidade+do+Ar+Ambiente/	Global Challenge 1
	Meteo Radars	--	IPMA	3 Meteorological radars operational in mainland Portugal and 1 under construction in Porto Santo Island, Madeira	Operating (mainland Portugal) Under	--	Global Challenge 1

					Construction (Porto Santo island, Madeira) – Planned to be operational in 2018		
Ocean Systems Thematic Area	**Research Vessel Mar Portugal**	--	IPMA	Deep-sea 76m research vessel, certified by Lloyds, for geophysical and remote operated vehicles operations and trawling activities. Capacity for 30 researchers and 15 crew members	Under Construction (is being adapted to support fisheries research and ROV operations)	http://marportugal.ipma.pt/en/	Global Challenge 1 Global Challenge 2
	Research Vessel Arquipélago	--	Azores Regional Government - Directorate for Fisheries; IMAR	Oceanographic Research Vessel	Operational	http://www.horta.uac.pt/port/equipamento/ships_1.html	Global Challenge 1 Global Challenge 2
	Research Vessel Águas Vivas	--	Azores Regional Government - Directorate for Fisheries; IMAR	Oceanographic Research Vessel	Operational	http://www.horta.uac.pt/port/equipamento/ships_2.html	Global Challenge 1 Global Challenge 2
	Observing Systems in VOS	OBSERVA.PT	IPMA	Meteo and oceanographic observations on board commercial voluntary observing ships	Planned	--	Global Challenge 1 Global Challenge 2

	(Voluntary Observing Ships) in the Portuguese sea						
	School of the Sea	--	Azores Regional Government - Directorate for Maritime Affairs	Professional training in ocean and technology related matters	Under construction		Global Challenge 2
	DeepSeaLab	--	University of Azores / IMAR	Facility designed to maintain and experiment on deep sea fauna (e.g. from hydrothermal vents and seamounts), under simulated hydrothermal vent (sulphide, methane) and climate change (pH, temperature) scenario conditions	Operating	http://www.dop.uac.pt/	Global Challenge 2
	Experimental high pressure vessel	--	University of Azores / IMAR	Experimental high pressure vessel (up to 4000m), to conduct experiments with deep-sea fauna under natural and extreme pressure conditions on the effect of scenarios under pressure.	Operating	http://www.dop.uac.pt/	Global Challenge 2
	Hydrothermal vent observatory	--	University of Azores / IMAR	*To be completed*	Operating	http://www.dop.uac.pt/	Global Challenge 2
	Condor observatory located in the first seamount marine reserve for scientific purposes	--	University of Azores / IMAR	*To be completed*	Operating	http://www.dop.uac.pt/	Global Challenge 2
	Deep sea moored array of acoustic	--	University of Azores / IMAR	*To be completed*	Operating	http://www.dop.uac.pt/	Global Challenge 2

	receivers for the tracking and monitoring of marine animals						
	Lula 1000	--	Rebikoff-Niggeler Foundation	The manned submersible LULA1000 carries a crew of 3 to 1000 metres of depth. LULA1000 has been optimized for high quality video and audio documentation and for the collection of oceanographic data and samples.	Operating	http://www.rebikoff.org/	Global Challenge 2
	ADA REBIKOFF	--	Rebikoff-Niggeler Foundation	The 17m motor catamaran serves as support vessel for diving missions with the LULA1000 submersible. The vessel is used for transporting the sub within the Arquipelago and for towing it from harbour to the dive site. Furthermore, the catamaran is used for missions with the purpose of collecting bathymetric data.	Operating	http://www.rebikoff.org/	Global Challenge 2
	Rebikoff-Niggeler equipment	--	Rebikoff-Niggeler Foundation	L-3 Communications ELAC NAUTIK SeaBeam 1050 High Resolution Multibeam; Sonar System; L-3 Communications Klein System 3000 Digital SideScanSonar and Klein Sonar; Workstation; SeaSpy Explorer Marine Magnetometer; CTD 60M Sea and Sun Tecnolology Memory Probe with 4 integrated sensors; TrackLink 1500HA USBL Acoustic Tracking System; NavQuest 300P DVL (Doppler Velocity Log); Tritech Super Seaking DST Digital CHIRP Sonar; Onboard video cameras; Motion Sensor; e-infrastructure: data server with (video) image and data bank	Operating	http://www.rebikoff.org/	Global Challenge 2
	Observing system in the Gulf of Cadiz	OBSERVA@GoC	IPMA Coordinator + Consortium Portugal/Spain/France	Integrated observing and modelling system in the Gulf of Cadiz	Planned	--	Global Challenge 2
	Operational Numerical Modelling	ONMA	MARETEC - Instituto Superior	Operational numerical models are operated in a daily basis to provide with the best forecasts to the area of application and generate a database of previous events that can be accessed a posteriori. Those systems allow to	Operational	http://forecast.maretec.org/	Global Challenge 2

	Applications		Técnico	provide services such as oil spills; operation and maintenance (O&M) services for Marine Renewable Energy; search and rescue operations or to generate products for fisheries. For the AIR centre two large Atlantic applications can be highlighted: for circulation and waves. The Lusitania application (http://forecast.maretec.org/maps_Lusitania.asp) is a General Circulation Model (GCM) that covers a wide area of the eastern Atlantic Ocean and the Western Mediterranean Sea. It was designed to provide forecast, analysis and management capacity for the Portuguese EEZ and to supply boundary conditions to the existing operational models that run on a daily basis for the continental region, Madeira and Azores archipelagos. The North Atlantic Area wave forecast is provided by the WaveWatch III operational model application (http://forecast.maretec.org/maps_WWIII_ATN.asp) designed for the waves generated in western Atlantic that reach the Portuguese waters and that are latter downscalled to local coastal areas.			
	Marpocs Platform	MARPOCS	MARETEC - Instituto Superior Técnico/ Action Modulers	The MARPOCS Platform tries to answer to the need for an integrated framework for preparedness and response to oil and HNS spills. This tool allows integrating: - Operational model hindcast and forecast results for different spatial domains (circulation, meteorology, waves); - Vessel positions and other vessel info are obtained through AIS system; - Field data visualization; - Maps and time series; - On-demand marine pollution incident simulations (oil, HNS spills, SAR) based on best available information.	Operational	http://marpocs.actionmodulers.com/	Global Challenge 2
	Portuguese Coastal Monitoring Network	CoastNet	MARE	CoastNet is designed to improve the understanding of coastal ecosystems functioning and variability through the development of a remote coastal monitoring system. The real-time acquisition of relevant chemical, physical and biological variables will allow this valuable information to be integrated in a structured database,	Under Construction	--	Global Challenge 2

				which will be available online to the scientific community.			
	Modular Platform for Research, Test and Validation of Technologies supporting a Sustainable Blue Economy	TEC4SEA	INESC TEC	The TEC4SEA is a unique and pioneer platform in Europe to support research, development, and test of marine robotics, telecommunications, and sensing technologies for monitoring and operation in marine environments. The research infrastructure brings together a set of laboratories, testbeds, equipment, and support facilities, enablers of R&D activities, technical experiments and validations, both in controlled and real environments. It also allows a fast and easy access to the deep sea, occupying a unique position among European Research Infrastructures, with the potential to leverage technological R&D activities at maritime and Deep-sea environments. TEC4SEA has a unique capacity to impact in several different economic sectors ranging from fisheries and aquaculture, passing through sustainable resource exploration (living and non-living resources - including at Deep-sea), robotic and autonomous systems, ICT applied to marine environments (above and below water), new materials, surveillance, navy maintenance and repair, manufacturing industries, renewable energies (at sea environments), among many others.	Under Construction	www.tec4sea.com	Global Challenge 2
	Portuguese Biological Data Network	BioData.pt	Instituto Gulbenkian de Ciência (IGC/FCG)	*To be completed*	*To be completed*	*To be completed*	Global Challenge 2
	Institute of Science and Innovation for Bio-Sustainability	IB-S	University of Minho	IB-S is a research Institute that aggregates different areas of knowledge such as Biology, Civil Engineering, Electronics, Advanced Materials, Physics and Mathematics. This multidisciplinary team has the goal to find technological solutions for complex societal challenges related with Sustainability. IB-S can contribute to the *Atlantic Interactions* agenda since it has significant experience in research projects related with the Oceans and Climate. Also the Institute has a close connection with companies		www.ib-s.uminho.pt	

				translated by a Strategic Council with representatives of 15 important companies of different areas. Finally, the topic of renewable energies, mainly those produced in the ocean is a topic that is on IB-S near future research agenda.			
	3B's Research Group and European Institute of Excellence on Tissue Engineering and Regenerative Medicine	3B's	University of Minho	The 3B's Research Group (Biomaterials, Biodegradables and Biomimetics) develops its activity in the areas of biomaterials, tissue engineering, regenerative medicine, nanomedicine, and stem cell isolation and differentiation. One of its main areas of work is related with the valorization of marine resources and its by-products for the development of applications with high added value, with emphasis on health and well-being. It plays a very important role in the field of marine biotechnology and valorization of marine biological resources following the vision of the sustainable use of marine resources. Its facilities correspond to 2800 m2 completely dedicated to research, with several laboratories (chemistry, materials processing, physical-chemical characterization, morphology, mechanics, microscopy, biology, cell culture, among others). The infrastructure will soon be extended, with the construction of a new building that will host the headquarters of the new Discoveries Center.	Operating	http://www.3bs.uminho.pt/	Global Challenge 2
	Center for Valorization of Technology in Marine Resources (Centro de Valorização de Tecnologia baseada em Recursos Marinhos)	CVTMar	University of Minho + CM Esposende	CVTMar will be an infrastructure dedicated to the valorization of marine resources and their by-products. It will focus on technological and innovation developments in partnership with the local businesses, aiming to effectively transfer knowledge and technology to industry.	Planned	--	Global Challenge 2

	Multidisciplinary Institute of Marine Science and Technology (Instituto Multidisciplinar de Ciência e Tecnologia Marinha)	IMCTMar	UMinho + CMEsposende	IMCTMar aims to actively contribute to monitor the North Coast Natural Park and to characterize its marine ecosystem, to characterize and valorize its marine biological resources and the by-products resulting from industry activity. Together with the Portuguese Hydrographic Institute it will provide support for activities in the field of the oceanography.	Planned	--	Global Challenge 2
Energy Systems Thematic Area	**Pico Wave Power Plant**	Pico Plant	WavEC Offshore Renewables	Pico plant is a shoreline Oscillating Water Colum (OWC) wave energy plant in 7m water depth, fully exposed to the North-westerly Atlantic swell of the Archipelago. It is a real environment test bench for OWC air turbines with pneumatic power available up to 700 kW, and about 50-100 kW during summer, which is a unique full-scale test scenario. The plant has been operating for several years but shows significant signs of structural damage; significant parts of the electrical and mechanical components needs to be replaced in order to serve as a research infrastructure.	Operating	www.pico-owc.net	Global Challenge 3
	Pico Vermelho Geothermal Power Plant	--	EDA RENOVAVEIS, S.A.	Geothermal power plant located in S. Miguel island, Azores	Operating	www.edarenovaveis.eda.pt	Global challenge 3
	Ribeira Grande Geothermal Power Plant	--	EDA RENOVAVEIS, S.A.	Geothermal power plant located in S. Miguel island, Azores	Operating	www.edarenovaveis.eda.pt	Global Challenge 3
	Ribeira Grande Hydroelectric Power Plant	--	EDA RENOVAVEIS, S.A.	Hydropower plant in Flores island, Azores	Planned	www.edarenovaveis.eda.pt	Global Challenge 3

	Além Fazenda Hydroelectric Power Plant	--	EDA RENOVAVEIS, S.A.	Hydropower plant in Flores island, Azores	Operating	www.edarenovaveis.eda.pt	Global Challenge 3
	Flores PowerStore Flywheel Project	--	EDA, S.A.	The PowerStore is a compact and versatile flywheel-based grid stabilizing generator. Its main purpose is to stabilize power systems against fluctuations in frequency and voltage	Operating	http://www.energystorageexchange.org/projects/760	Global Challenge 3
	Graciosa PowerStore Flywheel Project	--	EDA, S.A.	The PowerStore is a compact and versatile flywheel-based grid stabilizing generator. Its main purpose is to stabilize power systems against fluctuations in frequency and voltage	Operating	http://www.energystorageexchange.org/projects/761	Global Challenge 3
	System of hybrid power (wind and solar), supported by an innovative battery system	--	Graciolica, Lda	System of hybrid power (wind and solar), supported by an innovative battery system, that will enable uninterrupted power supply, to be constructed in Graosa island, Azores	Operating and under construction	https://www.younicos.com/case-studies/graciosa	Global Challenge 3
	Vulcanology + Seismicity monitoring infrastructures/ equipment	--	University of Azores / CIVISA	*To be completed*	Operating	http://www.cvarg.azores.gov.pt/civisa/Paginas/homeCIVISA.aspx	Global Challenge 3
	Portuguese Windscanner	Windscanner.PT	University of Porto	The WindScanner facility is a laser-based wind measurement system that can generate detailed maps of wind conditions covering several square kilometres. The facility relies on innovative, remote-sensing, laser-based	Under Construction	--	Global Challenge 3

	Facility			devices called lidars. WindScanner will be used by the wind energy industry to develop better and more durable turbines, and by the aviation industry to detect wind shear and turbulence along runways, making flying, and especially landing, safer			
	National Research Infrastructure in Solar Energy Concentration	INIESC	University of Évora	INIESC is focused on thermal conversion of solar energy and aims at the development of solar energy concentration technologies. INIESC addresses different applications, ranging from water desalination or industrial process heat to thermoelectric production or solar fuels, promoting technology transfer to industry and enabling a holistic approach to the product development process. It looks into technology development as a process leading to marketable products and solutions.	Operating	--	Global Challenge 3
	Biomass and Bioenergy Research Infrastructure	BBRI	Laboratório Nacional de Energia e Geologia, I.P. (LNEG)	*To be completed*	*To be completed*	*To be completed*	Global Challenge 3
	Research Infrastructure on Integration of Solar Energy Systems in Buildings	NZEB_LAB	Laboratório Nacional de Energia e Geologia, I.P. (LNEG)	*To be completed*	*To be completed*	*To be completed*	Global Challenge 3
	Smart grid and electric vehicle laboratory	SGEVL	Instituto de Engenharia de Sistemas e Computadores do Porto (INESC Porto/FEUP)	*To be completed*	*To be completed*	*To be completed*	Global Challenge 3

	Collaboratory for Geosciences	C4G	University of Beira Interior	C4G is a distributed Research Infrastructure that shares equipment, data, collections and tools in Solid Earth Sciences (SES). C4G comprises the disciplines of geology, hydrogeology, geochemistry, geodesy, geophysics, geomechanics and geomathematics, and provides services (see below) in the transversal areas of georesources, natural hazards and the environment, onshore and offshore. C4G collaborates at European level in the ESFRI project European Plate Observing System (EPOS) and it has been very active collaborating with African and South American Institutions. C4G offers access to a wide variety of services related to the Geosciences, including seismic data and networks, geophysical exploration, laboratories of rock physics and geomechanics, geodetic data and networks (including gravity data), geochemical and mineralogical laboratories, magnetic data and observatories, geological data and laboratories, geomathematics, remote sensing and paleomagnetism laboratories.	Operating Under construction	http://www.c4g-pt.eu/	Global Challenge 3
Data Science Thematic Area	**Laboratory for Advanced Computing**	UC-LCA	University of Coimbra	Provides advanced computing services. It includes (1) High Performance Computing (HPC) systems of a variety of architectures to enable larger simulations, analyses and faster computation times than are possible using computers available to individual researcher and (2) Data Storage/Archival systems to store data that result from performing simulations on HPC systems and (3) assistance to use these advanced computing resources effectively. UC-LCA is the national node of PRACE – Partnership for Advanced Computing in Europe.	Operating	http://www.uc.pt/lca	Enabling Activities 2

	Portuguese National Distributed Computing Infrastructure	INCD	INCD Association	INCD is a research-devoted digital infrastructure that aims to provide computing and storage services to the national research and high-education communities from all fields of knowledge. Three INCD nodes are already underway, located in the North, Center and Lisbon regions. This modular approach supports expansion to other regions (as the scientific community requires) while infrastructure services are horizontal and independent of the physical nodes. Cloud services of IaaS, PaaS and SaaS are already planned, providing data analysis and advanced modeling tools for several areas, including ocean and coastal sciences.	Operating and Under Construction	http://www.incd.pt/	Enabling Activities 2
	Azores Government Data Infrastructure	--	Azores Regional Government - Directorate for Environment	It encompasses metadata, spatial data sets and services, network services and technologies, as well as agreements on the sharing and interoperability of the same geographic data, aims at solving some of the problems identified and creating common rules to ensure that Information and services are compatible with each other, in accordance with Directive 2007/2 / EC of the Parliament and of the Council of 14 March 2007 (INSPIRE), covering the connection and use of data and Services of other European programs.	Operating	http://www.ideia.azores.gov.pt/Paginas/inicio.aspx	Enabling Activities 2
Crosscutting activities	**Environmental Observatory of Azores**	OAA	Associação Observatório do Ambiente; Azores Regional Government - Directorate for Science and Technology	Science communication in areas related to the environment	Operating	http://oaa.centroscience.azores.gov.pt/	Crosscutting activities: Knowledge for Space – Space for Knowledge

	Portuguese Language expertise centre of the Office of Astronomy for Development (of the International Astronomical Union)	PLOAD	NUCLIO + IA (CAUP, Fciências.ID)	Coordinated by NUCLIO in collaboration with the Institute of Astrophysics and Space Sciences. PLOAD is providing support to space-related outreach and educational (including higher education) activities in PALOP countries (namely Brasil, Cabo Verde, São Tomé e Príncipe, Moçambique), with the final aim to implement IAU's strategic plan in portuguese speaking countries.	Operating	http://pload.org	Crosscutting activities: Knowledge for Space – Space for Knowledge
	Astronomic Observatory of Santana	OASA	Cooperativa "A Ponte Norte"; Azores Regional Government - Directorate for Science and Technology	Science communication in areas related to Space	Operating	--	Crosscutting activities: Knowledge for Space – Space for Knowledge
	Azores Sea Observatory	--	Associação Observatório do Mar dos Açores; Azores Regional Government - Directorate for Science and Technology	Science communication in areas related to the ocean	Operating	http://www.oma.pt/	Crosscutting activities: Promoting scientific literacy

	Copernicus academies and relays	--	European initiative	Copernicus academies and relays are a European initiative to leveraging user uptake of space applications and Copernicus, targeting University, Research, Private and Public actors, as well as Public Authorities. The EC is setting up a toolbox of user uptake measures, including a wide range of targeted initiatives such as supporting business creation through the Copernicus Start-ups Program, supporting the internationalization of Earth observation companies, ensuring the most of EU financial instruments for Copernicus, setting up new financial tools (Framework Partnership Agreement) to co-finance local initiatives in the Copernicus Participating Countries, or addressing the Earth observation skill gap through the development of dedicated educational programs and trainings.			

B. Spain – Existing infrastructures

	Infrastructure name	Short Name	Managing Organisation	Short description	Status	Webpage	Contribution to the Atlantic Interactions agenda
Space systems and applications Thematic Area	**National Institute of Aerospace Technology "Esteban Terradas"**	INTA	.	A Public Research Agency specialized in Aerospace technological research and development, as well as covering R & D in the fields of land, naval and defense. Its main functions include: -Conducting all types of tests to check and certify materials, components, subsystems and application systems in their fields of activity; -Technical advice and the provision of services to official entities and agencies, as well as to industrial and technological companies; -The acting as technological center of the Ministry of Defense. As an example of an infrastructure: INTA Maspalomas Station, featuring a 15-metre antenna.	Operating	http://www.inta.es	Enabling Activities 1
	Center of Air Traffic Control of the Canary Islands	ACC	ENAIRE	The ACC, located next to the Gran Canaria airport, manages all Canary Island FIR traffic, except for the APP (TAP) - Tenerife Norte and Tenerife Sur - and the towers of control. Within this ACC is the inflow management position (FMP) which, in continuous contact with the data processing center and central inflow management unit (CFMU) in Brussels, is responsible for coordinating the transit flow of Arrivals and departures of the Canary Islands. In this way, the capacity of different sectors is not	Operating	http://www.enaire.es/csee/Satellite/navegacion-aerea/es/Page/1047382340145/	Enabling Activities 1

				saturated and helps to maintain a safe and orderly flow of air traffic.			
	Network of Permanent Stations of the Canary Islands		**Cartographic of the Canary Islands** (GRAFCAN)	17 GNSS stations -Global Navigation Satellite System	Operating	https://www.grafcan.es/red-de-estaciones	Enabling Activities 1
	Teide Observatory	OT	Institute of Astrophysics of the Canary Islands	The observatory was more than 20 telescope installations from institutes of all over the world, including solar telescopes. Its geographical location (between the eastern and western solar observatories), together with the clarity and excellent quality of the sky, mean that the Observatory del Teide is ideally suited for studying the sun.	Operating	http://www.iac.es/eno.php?op1=3&lang=en	Enabling Activities 1
	Institute of Astrophysics of the Canary Islands	IAC		International research center which comprises: -The Institute of Astrophysics, the headquarters, which is in La Laguna (Tenerife). - The Center of Astrophysics, La Palma (CALP) -The Observatory del Teide (OT), in Izaña (Tenerife). -The Observatory del Roque de los Muchachos (ORM), in Garafía (La Palma). The exceptional quality of the sky over the Canaries for astronomical observations is protected by law. The IAC's Sky Quality Protection Office (OTPC) regulates the application of the law and its Sky Quality Group continuously monitors the parameters that define observing quality at the IAC Observatories. The IAC's research programme includes astrophysical research and technological development projects. The IAC is also involved in researcher training, university teaching and outreach activities.	Operating	http://www.iac.es/	Enabling Activities 1

	Cartographic of the Canary Islands	GRAFCAN		GRAFCAN facilitates the operations and institutionally performs the functions of the Canary Islands geographic institute. As an example, GRAFCAN was as product IDECanarias (Spatial Data Infrastructure of the Canary Islands with the objective of making the Canary Islands' geographic information available to all users through various services)	Operating	https://www.grafcan.es/	Enabling Activities 1
	Observatory of Roque de los Muchachos	ORM	Institute of Astrophysics of the Canary Islands	More than 15 telescopic installations from all over the world. Conditions at the Observatory are ideal not only for night time observations but also for Solar Physics. The Observatory also attracts researchers in High Energy Astrophysics.	Operating	http://www.iac.es/eno.php?op1=2&lang=en	Enabling Activities 1
	Gran Telescopic of Canary Islands	GRATECAN	Institute of Astrophysics of the Canary Islands	largest and one of the most advanced optical and infra-red telescopes in the world. Its primary mirror consists of 36 individual hexagonal segments that together act as a single mirror. The light collecting mirror surface area of GTC is equivalent to that of a telescope with a 10.4m diameter single monolithic mirror. Thanks to its huge collecting area and advanced engineering the GTC classes amongst the best performing telescopes for astronomical research	Operating and Under Construction	http://www.gtc.iac.es/	Enabling Activities 1
	Cherenkov Telescope Array – telescope North	CTA	CTA Observatory gGmbH (CTAO gGmbH	Ground-based gamma-ray detector, with more than 100 telescopes located in the northern and southern hemispheres. Spain will participate in Las Palmas for the northern array site.	Under Construction	https://www.cta-observatory.org/	Enabling Activities 1
	The Gravitational-wave Optical Transient Observer	GOTO	Astronomy and Astrophysics group at the University of Warwick.	A project to identify optical counterparts to gravitational wave events. The GOTO project consists of a set of wide-field telescopes on a single mount, necessary to map the large source regions on the sky that accompany detections of gravitational waves with LIGO and VIRGO.	Operating and Under Construction	https://goto-observatory.org/	Enabling Activities 1

			Located Roque de Los Muchachos *observatory* on La Palma.				
	Center for Reception, Processing, Archiving and Dissemination of Earth Observation Data	CREPAD Center	INTA	It provides users with easy access to Earth Observation and Atmosphere data and products, through the maintenance of infrastructures for the reception and processing of images coming from Earth Observation space missions, the systematic processing of parameters (i.e., Sea Surface Temperature: Multi- Channel Sea Surface Temperature - MCSST and no Lineal Sea Surface Temperature - NLSST , normalized Difference Vegetation Index – NDVI, Marine Chlorophyll - Chlor_a; SST and Chlor_a temporal averages , NDVI maximun Value Composite, Aerosol Optical Thickness – AOT, Diffuse attenuation coefficient - K_490), the archiving and maintenance of all the processed data which can be available for end users, and the development of new applications that make use of the information coming from Earth Observation satellites	Operating	http://crepadweb.cec.inta.es/	Enabling Activities 1
	National Meteorological Agency	AEMET	Ministry of Agriculture, Food and Environment, Secretary of State for the Environment	Aims: the development, implementation and delivery of meteorological services within State scope in support of other public policies and private activities; contributing to the safety of people and goods and to the welfare and sustainable development of Spanish society.	Operating	http://www.aemet.es/es/portada	Enabling Activities 1
	Barcelona Expert Center	BEC		Provides support to the Spanish SMOS-related activities (Soil Moisture and Ocean Salinity): -provides assessment to ESA as a Level 2 Ocean Salinity Expert	Operating	http://bec.icm.csic.es/	Enabling Activities 1

				Support Laboratory -contributes to the SMOS instrument calibration and lower level algorithm developments -develops new algorithms for the generation of added-value products at Levels 3 and 4 -participates in validation activities -products under development: Salinity in marginal seas; Salinity in cold waters; Ocean currents; Sea ice concentration and thickness; Sea surface winds, convergence, and vorticity; Coastal and extreme winds; Ocean forcing; High-resolution soil moisture; Fire risk index.			
	Spanish National Earth Observation Satellite Programme (Ingenio and Paz satellites)			Spain is developing two EO Satellites named Ingenio and Paz, to be launched in 2017 and 2019: -Ingenio is a 2,5 m PAN/NIR satellite with a 55 km swath. -Paz is a 1m resolution X-band SAR satellite Both satellites have been designed for national applications (including maritime surveillance)a and will also be integrated into the Copernicus initiative. They can be used for international cooperation.	Operating		Enabling Activities 1
Atmospheric science and Climate Change Thematic Area	**Center for assessment and management of air quality**	**CEGCA**		Ambient air quality controller in the Canary Islands, CEGCA. Must manage and provide the ambient air quality information according to the parameters regulated in the applicable regulations, as well as jointly manage the meteorological information related to the parameters of temperature, relative humidity, atmospheric pressure, precipitation, wind direction, Wind and global radiation. Centralize data from the various automatic stations, both public and private, scattered throughout the archipelago.	Operating	http://www.gobiernodecanarias.org/medioambiente/piac/temas/atmosfera/medidas-y-factores/calidad-del-aire/medida	Global Challenge 1

						s-sobre-calidad-aire/cegca/	
	Aerosol monitoring reference station of Pico de la Gorra			Monitoring Aerosols	Operating		Global Challenge 1
	Monitoring and control Network of air quality in the Canary Islands	**RVCCAC**	Dirección General de Salud Pública - Comunidad Autónoma Canaria	Five fixed stations and one mobile automatic, that measure in continuous the quality of the air. All this information generated by the equipment installed in the stations is received in the control center, generating a database that is processed and analyzed daily, being able to signal in real time alarm situations.	Operating	http://www.gobiernodecanarias.org/medioambiente/calidaddelaire/inicio.do	Global Challenge 1
	Atmospheric observatory of Izaña		Centro de Investigación Atmosférica de Izaña CIAI	- Five offices available for researchers and technicians who visit; - A Observation Tower with 15 laboratories and a terrace of 150m2 with free horizon of obstacles where the radiation instruments and the different shots for air samples are located; - A laboratory for the calibration of radiometers, photometers and spectrometers (horizontal, vertical and angular calibration); - An electronics workshop; - Two mechanics workshops; - A cylinder filling station with ambient air, identical to NOAA's in Niwot Ridge (Colorado) for the manufacture of standard gases worldwide.; - Two cisterns for storage of rain water with a capacity of 216m3 each;	Operating	http://izana.aemet.es/index.php?option=com_content&view=article&id=121&Itemid=136&lang=es	Global Challenge 1

				- A large installation of solar panels for heating and hot water.			
	Izaña Atmospheric Research Center	CIAI	AEMET	Research and Monitoring the atmospheric components capable of causing a change in the Earth's climate (greenhouse gases and aerosols) and a deterioration of the world's ozone layer, as well as those components that play a fundamental role in the quality of air, both locally and globally. Infrastructures available at the Center: Atmospheric Observatory of Izaña, Izaña; CIAI Headquarters and Observatory of Santa Cruz de Tenerife; As an additional unit there is an ozone station; computer and communications systems	Operating	http://izana.aemet.es/	Global Challenge 1
	Aerosol reference station of Izaña		Observatorio Atmosférico de Izaña	Monitoring Aerosols Part of Aerosol Research Program of the Atmospheric Observatory of Izaña, which is part of the World Metrological Organizations	Operating	http://izana.aemet.es/index.php?option=com_content&view=article&id=121&Itemid=136&lang=es	Global Challenge 1
	University Research Institute for Oceanography and Global Change (Univ. Las Palmas de Gran Canaria)	IOCAG		IOCAG arises to structure and coordinate a number of consolidated and interdisciplinary research groups at the University of Las Palmas de Gran Canaria, and it is intended to assess the ocean's role in the Climate Change, while investigating how this change affects the planet in the singular marine and coastal ecosystems. It comprises the following facilities: - Oceanography instruments and analysis - Environment and remote sensing - Spanish Bank of Algae (BEA)	Operating	http://iocag.ulpgc.es/	Global Challenge 1

	University Research Institute of Bioorganic "Antonio González"	IUBO-AG		IUBO-AG is a multidisciplinary research center oriented to the investigation of Bioactive Natural Products. It aims to isolate pharmacologically active substances from natural sources, biosynthesis, microorganism cultures, biotechnology and total synthesis. In addition biological evaluation, toxin isolation and production, NMR studies of biological process, natural insecticide and repellents, etc. are research areas of current interest.	Operating	https://www.ull.es/view/institutos/iubo/Inicio/es	Global Challenge 1 Global Challenge 1 Global Challenge 1
Ocean Systems Thematic Area	**Oceanic Platform of the Canary Islands**	PLOCAN		PLOCAN is a multipurpose technical-scientific service infrastructure that provides support for research, technological development and innovation in the marine and maritime sectors, available to public and private users. PLOCAN offers both onshore and offshore experimental facilities and laboratories, operational throughout the whole year thanks to the Canary Islands excellent climatic conditions. PLOCAN provides: - An ocean observatory for the continuous and real-time monitoring in fields such as the study of global change and ocean acidification, water-column and deep-sea ecosystems, ocean biogeochemistry and geophysics. - A test bed for the research, demonstration and operation of marine technologies, especially those related to marine renewable energy. - A base for underwater vehicles: (1) own a series of underwater unmanned state-of-the-art technologies such as gliders, ROVs and AUVs; (2) support missions deploying customers´ vehicles. - A training platform for institutions and enterprises. - An innovation hub offering efficient and high quality R&D&I project management services.	Operational	http://www.plocan.eu/index.php/en/	Global Challenge 1 Global Challenge 2 Global Challenge 3

	Multi-instrumented permanent deep-sea observatories ESTOC – EMSO	ESTOC – EMSO		European Station for Time series in the Ocean Canary islands (ESTOC) is a multi-instrumented permanent deep-sea observatory located at a depth of 3600 m, initiated with the main objective of contributing to the ocean observation international programs. It is presently the oceanic observation node of the PLOCAN and EMSO.	Operating	http://observatorios.plocan.eu/index.php/en/description	Global Challenge 2
	University Research Institute in Sustainable Aquaculture and Marine Ecosystems (Univ. Las Palmas de Gran Canaria)	IU-ECOAQUA		IU-ECOAQUA aims to contribute to the economic development of the Canaries through the generation of knowledge on conservation and sustainable use of the different resources, including coastal resources and aquaculture, and their transfer to society, allowing the construction of new business opportunities. It is a platform on platform on Sustainable Aquaculture under an Ecosystem Approach.	Operating	http://ecoaqua.ulpgc.es/IU-ECOAQUA	Global Challenge 2
	University Research Institute for Environmental Studies and Natural Resources (Univ. Las Palmas de Gran Canaria)	i-UNAT		i-UNAT focused in integrating research from different disciplines to generate studies related to the environment and natural resources, as well as the implementation of new measures suitable for sustainable environmental development and the optimal conservation, use and management of natural resources. It contributes effectively and energetically to research, innovation and the development and sustainable growth of the Canary Islands.	Operating	http://www.iunat.ulpgc.es/iunat-home	Global Challenge 2

	Spanish Bank of Algae (Univ. Las Palmas de Gran Canaria	BEA		The Spanish Bank of Algae, is a national R & D + i of the University of Las Palmas de Gran Canaria linked to its Scientific and Technology Park (FPCT) whose basic objectives isolation , identification, characterization, conservation and supply of microalgae and cyanobacteria. Besides these features, BEA is intended as a service to facilitate the development of a new sector based bioindustrial cultivation and application of microalgae and cyanobacteria. Some services: A. Strain identification by microscopy; B. Strain identification by DNA analysis; C. gDNA "à la carte"; D. Strain isolation and purification; E. Patent depository; F. Deposit for maintenance; G. Flow Cytometry; H. International Courses; I. Acceptance of strain donations. Some products: A. Strains (Main catalog, Axenic strains, gDNA Strains, Sequenced DNA strains); B. g-Strains "easy-to-grow"; C. Genomic DNA; D. Culture media and seawater	Operating	http://www.marinebiotechnology.org/en/	Global Challenge 2 Global Challenge 3
	Macaronesian Marine and Maritime Network	R3M		The Macaronesian Marine and Maritime Network is an initiative including Azores islands, Madeira Islands, Cape Verde islands and Canary islands) aimed at increasing the quantity and quality of marine environment observation, in order to understand and predict both the phenomena that take place in it and the environmental and socioeconomic impacts these may entail. The initiative is essentially inclusive and its main goal is to make all the observations carried out in the Macaronesian marine environment compatible and accessible. The integration spreads over the instrumental approach, because the aim is to add and make available the historical observations of different platforms in the Macaronesian area, "in-situ" observations from both moored and drifting devices, on surface or undulate through the water column, and remote sensing carried out by satellite.	Operating	http://r3m.estramar.eu/index.php/en/	Global Challenge 1 Global Challenge 2

	Instituto de Productos Naturales y Agrobiología	IPNA		IPNA's objectives are varied taking into account that it is a multidisciplinary center and its activities are framed in three Research Areas: - Chemical Sciences and Technologies - Agricultural Sciences - Natural resources	Operating	https://www.ipna.csic.es/	Global Challenge 2
	Granadilla Environmental Observatory	OAG		OAG aims to collaborate with the departments and institutions of the Autonomous Community of the Canary Islands and other Macaronesian archipelagos as well as with the institutions of the State Administration, with competence in the conservation of the marine environment, and with the entities of Scientific or conservationist nature linked to the marine environment. It comprises: - Environmental monitoring activities - Activities including the evaluation of the conservation status of species and habitats included in the European Habitat Directive; - Marine data repository activities, including storage, integration and custody of marine data, with a view to the maximum possible exploitation of the data (see below) - Ocean literacy activities	Operating	http://www.oag-fundacion.org/	Global Challenge 2
	Canary Islands Marine Integrated Data Repository	REDMIC		REDMIC is an integrated marine data repository following the Open Data philosophy. It has been designed for the Canary Islands and, by extension, Macaronesia.	Operating	http://www.oag-fundacion.org/index.php/redmic/redmic/introduccion-redmic	Global Challenge 2

	Environmental Hydraulics Institute of Cantabria	IHC		Is a joint research center that carries out research, knowledge transfer and training of specialists in the fields of fresh and saltwater. It has several infrastructures of interest to the Atlantic Interactions: **Ocean science:** - Wave Basins: Directional Wave Tank (TOD), Cantabria Coastal and Ocean Basin (CCOB; water tank of deep water - Wave and Current Flumes: Wave-Current-Tsunami Flume (COCOTsu), Wave-Current Flume (COC), Channel Variable Slope (CPV) - Hypersaline Tank - TESEO: Oil spill modelling - Coastal Modeling System - Meteocean data (wind, wave, currents and sea level) **Climate Change:** - C3sim **Renewable Energies:** - Floating infrastructures - Fixed infrastructures	Operating	http://www.ihcantabria.com/en/	Global Challenge 1 Global Challenge 2 Global Challenge 3
	Spanish Institute of Oceanography	IEO		IEO conducts basic and applied research and provides scientific and technological advice to administrations in matters related to oceanography and marine sciences. It has centers distributes all over Spain. Several research infrastructures can be relevant to the Atlantic Interactions initiative: - Satellite data Reception Station at Santander - Distributed Data Center on Oceanographic Data - Experimental Plants on Aquaculture and Sea farming (Canary Islands, Vigo, El Boal, and Mazarron) - Research vessels (see below) and ROV LIROPUS 2000	Operating	http://www.ieo.es/web/ieo/acerca-del-ieo	Global Challenge 2

	Research vessels (ICTS FLOTA)	IEO and CSIC		An infrastructure shared by the Spanish Institute of Oceanography (IEO) and the Spanish Research Council (CSIC) to manage a research fleet encompassing 10 oceanographic vessels: - Hesperides - Sarmiento de Gamboa - García del Cid - Ramón Margalef - Ángeles Alariño - Mytilus - Francisco de Paula Navarro - José María Navaz - Lura - SOCIB	Operating		Global Challenge 1 Global Challenge 2
	Antarctic Research Stations	IEO and CSIC		An infrastructure shared by the Spanish Institute of Oceanography (IEO) and the Spanish Research Council (CSIC) to manage the Antartic Research Stations: - Juan Carlos I Spanish Research Station - Gabriel de Castilla Spanish Research Station	Operating	http://www.csic.es/grandes-instalaciones	Global Challenge 1 Global Challenge 2
	CSIC Ocean Research Infrastructures	CSIC		CSIC Ocean research infrastructures include: - Technological Marine Unit (Vigo and Barcelona) - Satellite ocean-colour products (Cádiz) - Gibraltar Fixed Time Series (Strait of Gibraltar) - OVIDE Repeated Section (Portugal-Greenland) - Observations-model coupling (Cádiz) - Integrated CO_2 and non CO_2 greenhouse gases observing system (Cádiz and Vigo) - Improving knowledge on and management of EU Fisheries outside Europe (Cádiz)	Operating		Global Challenge 1 Global Challenge 2

	El Pardo Hydrodynamics Experimental Channel	**CEHIPAR**		Is a public and independent, internationally recognized hydrodynamic center for model tests, projects and research. It is a service and consulting company for customers from the administration and the industry, such as shipyards, engineering offices, manufacturers, ship-owners, research centers, as well as from sports associations, and individuals:	Operating	http://www.cehipar.es/index.php?lang=english	Global Challenge 3
Energy Systems Thematic Area	**Technological Institute of the Canary Islands**	ITC		The competences of the ITC are framed in the fields of Research, Development and Innovation at a regional level, with the aim to fostering technological advancement to improve the quality of life. The ITC supports Islands integral development through the implementation of practices and the deployment of projects related to R&D&i. It also encourages and promotes technological innovation in local businesses and boost an economy based on knowledge and built on the capabilities of existing research and technological developments in the Canaries. One of the areas where it develops services is in the energy area, including studies about the stability of islands electric networks.	Operating	http://www.itccanarias.org/web/	Global Challenge 3
	PLOCAN test site for renewable ocean energy	PLOCAN		A Offshore Platform for the research, demonstration and operation of marine technologies, especially those related to marine renewable energy, with capacity to validate development of offshore wind, wave and tidal converters.	Operating	http://www.plocan.eu/index.php/es/servicios	Global Challenge 3

	Technological Institute of Renewable Energy	ITER		ITER was established with the aim of supporting sustainable development and innovation on the island of Tenerife. Today, ITER stands as an international centre of reference for research into renewable energies, engineering, telecommunications and the environment. Two of its main goals are: (1) to extend the use of renewable energies on the island of Tenerife and (2) to provide the region with cutting-edge R&D&i infrastructure. Among its facilities and technical resources one can find: - Photovoltaics Laboratory, known as SiCell Lab - Several meteorological stations for the measure of meteorological parameters such as wind, solar radiation, humidity and temperature - Photovoltaic installations - Photovoltaic modules factory - Wind parks - Generation Control Centre of the Institute of Technology and Renewable Energies (CCG-ITER) - Wind tunnel	Operating	http://www.iter.es/	Global Challenge 3
	Centro demostrador de hidroeólico de Gorona del Viento	--		The hydroelectric project includes a wind farm, a pumping group and a hydroelectric plant. The wind farm is capable of supplying electricity directly to the grid and, simultaneously, feeding a pumping group that holds water in a raised tank, as an energy storage system. The hydroelectric power plant harnesses the stored potential energy, guaranteeing the electrical supply and the stability of the network. The wind farm realizes the capture and transformation of wind energy into electrical energy. The hydraulic system running as a pump, makes of accumulator of energy surplus; Operating as a generator, acts as producer of electric power and regulator of the electrical system on the island.	Operating	http://www.goronadelviento.es/index.php?accion=articuloseccion&IdSeccion=73	Global Challenge 3

	Solar Research Platform at Almeria	PSA	CIEMAT	It is the largest concentrating solar technologies development and test center in Europe. It encompasses: - Concentrating Solar Technologies: Medium and High, Solar fuel and industrial processes at high temperature, and thermal storage - Solar desalination technologies - Solar water treatment unit	Operating	http://www.psa.es/en/	Global Challenge 3
	CIEMAT Testing Laboratory for power take-off devices	--	CIEMAT	Testing laboratory for power take-off devices at the Research Centre for Energy, Environment and Technology (CIEMAT).	Operating	http://www.ciemat.es/	Global Challenge 3
	Biscay Marine Energy Platform	**bimep**		bimep is an open-sea facility to support research, technical testing and commercial demonstration of pre-commercial prototype utility-scale floating Marine Renewable Energy Devices. BiMEP provides manufacturers of such devices with ready-to-use facilities to validate their designs and to test their technical and economic feasibility. bimep occupies a 5.3 km2 marked area excluded for navigation and maritime traffic, and located at a minimum distance of 1,700 m from shore, close enough for fast access to deployed devices. The water depth in this area ranges from 50 to 90 m. The total power of 20 MW is distributed over four offshore connection points of 5 MW each.	Operating	http://bimep.com/en	Global Challenge 3
Data Sciences	**University Institute of Intelligent**	SIANI		The Institute of Intelligent Systems and Numerical Applications in Engineering (SIANI) owns several research laboratories and teaching classrooms that permit the development of new technologies. It includes a Data Processing Centre (CPD).	Operating	http://www.siani.es/en/home.html	Enabling activity 2

	Systems and Numeric Applications in Engineering (Univ. Las Palmas de Gran Canaria)						
	Spanish Supercomputing Network	RES	BSC	RES, lead by the Barcelona Supercomputing Center (BSC) consists of a distributed virtual infrastructure of supercomputers located in different sites, each of which contributes to the total processing power available to users of different R&D groups in Spain or based in another country but developed by with participation of Spanish researchers. The RES is currently composed by 12 institutions and its supercomputers. See below information on the network infrastructures and networks, activities and additional resources to the Atlantic Interactions.	Operating	https://www.bsc.es/res-intranet	Enabling activity 2
Crosscutting activities	**Technological Centre for Innovation in Communications (Univ. Las Palmas de Gran Canaria)**	IDeTIC		IDeTIC laboratories are provided with material for the design, development, implementation, construction and testing of communications systems and signal processing applications ranging from low frequency communication systems up to 40GHz, identification systems based on biological characteristics, communications systems based on infrared or visible light, sensor networks, etc. Some services related to the Atlantic Interactions Initiative are: - Development of comprehensive control systems and data acquisition; - Design, development and assembly of radar systems	Operating	http://www.idetic.ulpgc.es/idetic/index.php/en/	Crosscutting activities: Addressing technology transfer

Data Management by domain – Spanish Supercomputing Network led by the Barcelona Supercomputing Center (BSC)

	Infrastructures and networks	Activities	Additional resources
Space systems and applications	--	--	--
Atmospheric science and climate change	• EC-Earth Earth system model • SDS-WAS and BDFC (dust centres in collaboration with AEMET and WMO)	• Contributions to the sixth coupled model intercomparison project (CMIP6) • Participation in the World Weather Research Programme and World Climate Research Programme • Contributions to the Copernicus programme • Scientific and technical contribution to the EC-Earth consortium • Use of air quality and climate information as a support for public policy and decision making processes • Pollutant transport at urban scale • Coupling of atmospheric models and urban scale models • Volcanic ash forecast and impact on civil aviation • Volcanic hazard assessment	• Data portal for the dissemination of climate simulations (ESGF node) • Modelling of cross-boundary pollutant transport • Discovery and simulation in climate research through modelling and data analysis • Air quality and climate service development based on multiple (internal and external) data sources • Development of a capability to model and predict global carbon fluxes • Assistance for the use of high-end IT solutions in environmental data analysis and modelling • Online service • Nowcasting of urban scale winds and air quality
Ocean science and technology	• NEMO ocean community model	• Scientific and technical contribution to the NEMO ocean community model development	• Sea-ice modelling and forecasting • Ocean net primary production modelling and forecasting • Evaluation of disaster scenarios in ocean evolution
Energy systems	• Marenostrum4 supercomputer • EUROfusion	• Scientific and technical contribution to the NEMO ocean community model development • Development of HPC simulation tools for multi-physics problems • Applications in wind, fusion and marine energies • High resolution wind modelling • Wind resource assessment • Development of geophysical exploration tools for geothermal energy	• Assessment of the impact of dust exports on solar energy generation • A HPC simulation tool for multi-physics problems

Data science		• Development of a solution to incorporate real-time ship emission data in urban emission models for air quality forecasting • Deep learning for automatic operation of energy systems • Real time analytics and visualization of large volumes of streaming sensor data.	

C. Brazil

[To be completed and rearranged in a similar table to the one for Portugal and Spain after receiving the national information in the matrix file sent]

The workshop held in Brazil allowed the identification of synergies that fully exemplify the type of cooperation that can be established through the AIR Center, combining national research priorities and the research opportunities presented by international interdisciplinary cooperation for attaining better and more comprehensive datasets for innovative research (Table 3).

	Synergies with Brazil		
Space Science and Technology	Satellite launch and operation	Satellite data collection and processing	Interoperability between different computational systems
Atmospheric Science	Cloud formation identification mechanisms and modeling	Monitoring of the atmospheric transport of pollutants emitted in the South American and South African continents	
Ocean Science and Technology	Ocean and ocean-atmosphere interaction monitoring programs	Satellite based Oceanography	Ocean technologies and renewable energy
Climate Change	Biogeochemical variability at the tropics and CO_2 flows quantification	Global climate change models development and calibration	Climate change scenarios analysis: Project PNUD and Project PROBIO
Energy Systems	Data sets to model and design sustainable energy systems: Project SONDA; Project SWERA	Wind forecasting: Project PREVENTO	Public disclosure of renewable energy availability data

Table 3 – Potential Synergies of the Atlantic Research Center with Brazil

In addition, the development of a cooperative agenda between the AIR Center and INPE for capacity building of young undergraduate and graduate students is an imperative for a long-term perspective of scientific and technological aspirations of tackling global issues in areas of space and oceans. Moreover, the possibility of applying technology transfer mechanisms, as foreseen by the "IOC Criteria and Guidelines on Transfer of Marine Technology", would be key to enhance cooperation North to South.

After the meeting in Brazil specific points of cooperation with the State of Ceará were also identified (Table 4):

Area of cooperation	Objective	Organization
Ocean Science and Technology	Understanding and determination of impacts suffered by the Oceans and coastal areas as a consequence of economic exploitation of renewable and non-renewable resources.	UFC (LABOMAR), UECE
Climate Change	Use of climate information as a support for public policy and decision making processes for Ceará economic sectors of interest such as agriculture, industry, environment and energy	FUNCEME, UECE e UFC
Energy Systems	Development of technologies of energetic efficiency	IFCE, UNILAB, SINDENERGIA, SECITECE e SEBRAE
Data Scence	Development of a platform for Ocean monitoring (internet of things) – development of specific sensors interconnected used for identification and prediction of phenomena	IFCE, ITIC, UFC (LSDB), UECE (NPTEC), CTI-Ne UFC (LSDB); CTI-Ne; UECE (NPTEC), ITIC
Space Science and Technology	Development of sensors for space applications	CTI-Ne, ITIC, UECE, IFCE

Table 4 – Potential Synergies of the Atlantic Research Center with Brazilian State of Ceará

D. European level – Existing infrastructures

	Infrastructure name	Short Name	Managing Organisation	Short description	Status	Webpage	Contribution to the Atlantic Interactions agenda
Space systems and applications Thematic Area	*To be completed*						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
Atmospheric science and Climate Change Thematic	*To be completed*						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						

Ocean Systems Thematic Area	*To be completed*						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
Energy Systems Thematic Area	*To be completed*						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
Data Sciences Thematic Area	*To be completed*						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						
	To be completed						

Crosscutting activities	**Copernicus academies and relays**	--	European Comission	Copernicus academies and relays are a European initiative to leveraging user uptake of space applications and Copernicus, targeting University, Research, Private and Public actors, as well as Public Authorities. The EC is setting up a toolbox of user uptake measures, including a wide range of targeted initiatives such as supporting business creation through the Copernicus Start-ups Program, supporting the internationalization of Earth observation companies, ensuring the most of EU financial instruments for Copernicus, setting up new financial tools (Framework Partnership Agreement) to co-finance local initiatives in the Copernicus Participating Countries, or addressing the Earth observation skill gap through the development of dedicated educational programs and trainings.	Operating	http://copernicus.eu/news/copernicus-academy-network-cornerstone-build-skills-sustainability-growth-and-jobs	Crosscutting activities: Knowledge for Space – Space for Knowledge
	To be completed						
	To be completed						
	To be completed						

Annex II – Financial Instruments

[To be developed with information collected from the matrix to be filled in by the countries.]

Atlantic Interactions

A Science and Technology Agenda for an integrative approach to the Atlantic:

Integrating Space, Climate, Oceans and Data Sciences through North-South / South-North Cooperation

Towards the

Atlantic International Research Center (AIR Center)

A scientific and technological agenda developed by a group of international experts promoted by the Portuguese Foundation for Science and Technology (FCT) with the support of an open international consultation and a series of research workshops and high-level events.

Portuguese Foundation for Science and Technology

(Fundação para a Ciência e a Tecnologia, FCT), Portugal

August 2017