atlas
UNDERSTANDING DEEP ATLANTIC ECOSYSTEMS

A trans-Atlantic assessment and deep-water ecosystem based spatial management plan for Europe

ISSUE 5 | MARCH 2019

project news

25+1 PARTNERS

12 COUNTRIES

IN THIS ISSUE:

ATLAS is a four-year research and innovation project that aims to advance our understanding of the deep Atlantic Ocean ecosystems. **ATLAS** provides essential new knowledge for effective ocean governance and adaptive management strategies that stimulate Blue Growth. Funded under the European Union's Framework Programme for Research and Innovation, Horizon 2020, **ATLAS** brings together 25 partners (and one linked third party) from 10 European countries, the USA and Canada and is led by the University of Edinburgh (Scotland, UK).

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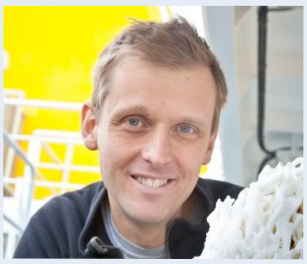
Designed and developed by AquaTT, with input from ATLAS partners

WELCOME FROM THE ATLAS COORDINATOR



Prof J Murray Roberts,
ATLAS Coordinator,
The University of Edinburgh
(UEDIN), Scotland, UK

I write this at the end of February 2019 as we assemble the second 18-month **ATLAS** periodic report – time is whipping by faster than a bluefin tuna!

So far **ATLAS** has produced 52 papers (including one *Science* and one *Nature* publication) and has 71 more in preparation. Our workplan is now shifting to pull these findings into our Maritime Spatial Planning and Policy Work Packages. To do this we need to build up our industry and other stakeholder work and I'd like to thank Jake Rice and the whole Advisory Board for the great work they do to help us with this.

It's wonderful to see how our industry activities have evolved over the duration of the project, from things we planned at the outset through to wonderful new opportunities like the collaboration between SAMS and the Chicago-based US start-up Parallel Works. Do read the article by Stefan Gary to see how **ATLAS** and Parallel Works teamed up to use parallel computing and the Google Cloud to massively speed up the time it took to model larval dispersal across the Atlantic Ocean. Our industry activities continue to grow including surveys planned for Ocean Business (9-11 April) followed by detailed work with our industry partners on ways they will use **ATLAS** findings in the future.

ATLAS is now entering its all-important final year. From our industry plans through to events at the UN Biodiversity Beyond National Jurisdiction Intergovernmental Conference, we have a busy year ahead! It's a huge privilege to coordinate **ATLAS** and I'm really looking forward to our General Assembly to discuss our new findings and continue our plans to translate these across to industry and policy throughout our final year.

Murray.Roberts@ed.ac.uk

HIGHLIGHTS AND HEADLINES

ATLAS Advisory Board member Prof Biliana Cicin-Sain to be awarded Grand Prize of Sciences of the Sea

HSH Prince Albert II of Monaco will award the prestigious 'Prince Albert I de Monaco Grand Prix des Sciences de la Mer' to **ATLAS** Advisory Board member Prof Biliana Cicin-Sain in Paris in April 2019. Cicin-Sain, Professor and Director of the Gerard J. Mangone Center for Marine Policy at the University of Delaware (USA), has made outstanding contributions to the preservation of the world's oceans, particularly to the international agreements related to these efforts. This included the coordination of 'Policy Recommendations on Oceans and Climate' at the 2016 Oceans Day COP21 in Paris. This is the most prestigious prize awarded by the Oceanographic Institute, rewarding highly qualified researchers in the field of oceanography for work throughout their career, outstanding discoveries, and also rewards those who have committed to making the oceans known, loved and protected. From all of us at **ATLAS**, we sincerely congratulate Prof Biliana Cicin-Sain on this impressive achievement!

BBNJ Capacity Development in the Context of Climate Change

ATLAS is delighted to announce co-sponsorship and hosting of a side event at 'BBNJ IGC2 Capacity Development in the Context of Climate Change' which will take place at the United Nations in New York from 25 March to 5 April 2019. This conference is the second of four sessions of the 'Intergovernmental Conference (IGC) on an international legally binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ)'. This **ATLAS** side event on 26 March will focus on Possible Modalities for Implementing BBNJ Capacity Development Regarding Area-based Management, EIA, and Marine Genetic Resources and how **ATLAS** contributes to the UN Voluntary Specific Workplan on Biodiversity in Cold-water Areas within the Jurisdictional Scope of the Convention on Biological Diversity. To learn more about these events, please visit: **www.un.org/bbnj/**

Frontiers, Research Topics: Managing Deep-sea ecosystems at Ocean Basin Scale

J. Murray Roberts (UEDIN) and Telmo Morato (IMAR-UAz) are co-editing the Research Topic 'Managing deep-sea ecosystems at ocean basin scale', in the journal Frontiers in Marine Science. Three calls for submissions to this special issue journal extend beyond the end of the project, bringing together **ATLAS** partners and deep-sea researchers from outside the consortium, maximising the impact and legacy of the **ATLAS** project. In case you need another reason to submit your research to this journal, Frontiers will receive its first Impact Factor this summer, projected to be 2.449! The deadline for manuscripts to the first call has been extended until 31 March 2019 and the second call for abstracts will open in Summer 2019. For more information and to submit your abstract, please see: **https://www.frontiersin.org/research-topics/7768/managing-deep-sea-ecosystems-at-ocean-basin-scale**

ATLAS NEWS AND STORIES

Shipwrecks provide shallow refugia for cold-water corals

*By: Anthony Grehan and Oisín Callery, **ATLAS** partners, NUI Galway, Ireland.*

In January 2019, **ATLAS** partners Anthony Grehan and Oisín Callery (NUI Galway, Ireland), teamed up with the University of Limerick Centre of Robotics and Intelligent Systems, Ireland (UL CRIS) led by Ger Dooly for an exciting mission. Scientists were invited to select challenging targets to trial the new ocean-capable UL CRIS Remotely Operated Vehicle (ROV) and purpose-built autonomous control systems. Here, Anthony and Oisín tell us about some surprising discoveries, and what they mean for the future design and management of marine protected areas.

We were interested in examining shallow shipwrecks to look for colonies of *Lophelia pertusa*, the reef forming coral that is usually found in depths below 500 metres in Irish waters. We identified two World War 1 wrecks (Fig. 1) lying at around 160 m depth, off the west coast of Kerry – well beyond the reach of scuba divers – using the INFOMAR wreck database.

Figure 1. A multibeam sonar image showing a large debris field that wasn't visible on the original INFOMAR map of the wreck, suggesting a violent impact with the seabed. ©UL CRIS, courtesy of Oisín Callery, NUI Galway.

Profiting from extremely benign weather for January, we were able to dive on both wrecks. The skilled University of Limerick ROV pilots, aided by their novel vehicle control systems that make use of artificial intelligence to improve 3D perception, successfully navigated the ROV through the difficult wreck environment, made more hazardous by the quantities of lost fishing gear snagged on the wreck superstructures.

Both wrecks were colonised by abundant epifauna (Fig. 2). However, the biggest surprise was finding a large colony of *Lophelia pertusa* hanging from the apex of two sundered hull plates (Fig. 3). The apparent shelter appears to protect the colony from fishing impacts while still ensuring a plentiful food supply.

This find shows that *Lophelia* can survive in much shallower waters in Ireland than was previously thought, with implications for the design and management of marine protected areas and habitat restoration.

Figure 2. Colourful anemones including the aptly named *Sagartia elegans*, colonising the superstructure of the wreck found off the coast of Kerry. ©UL CRIS.

Shipwrecks off the west coast of Ireland may act like artificial reefs providing habitat for species such as *Lophelia* more typically found in deeper waters or in canyons. The wrecks, as well as providing refugia, may provide 'stepping stones' promoting species colonisation and re-colonisation of damaged areas. This in turn may contribute to improved species' resilience to human impacts and climate change by increasing population connectivity.

With over 4000 records in Irish waters, shipwrecks likely contribute to the 'ocean sprawl' of anthropogenic structures described by fellow **ATLAS** researcher Lea-Anne Henry (UEDIN) and colleagues in their excellent recent paper: Ocean sprawl facilitates dispersal and connectivity of protected species, Scientific Reports (2018) 8:11346.

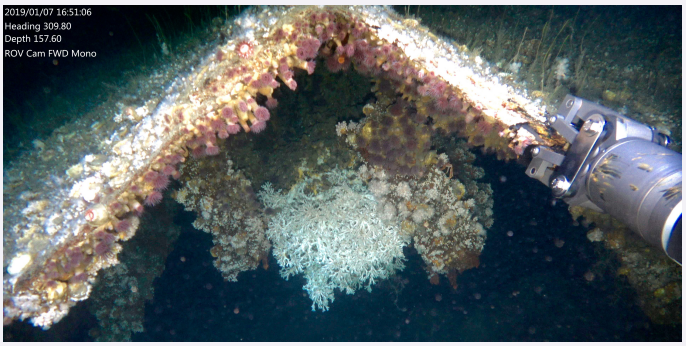


Figure 3. A colony of the coral reef forming *Lophelia pertusa*, a species usually found below 500 metres or deeper in Irish waters. ©CRIS, UL.

Anthony and Oisín's findings also featured in the national news in Ireland. Read more here.

We are always eager to hear about your exciting research results and stories! Please send your news to: atlas@aquatt.ie

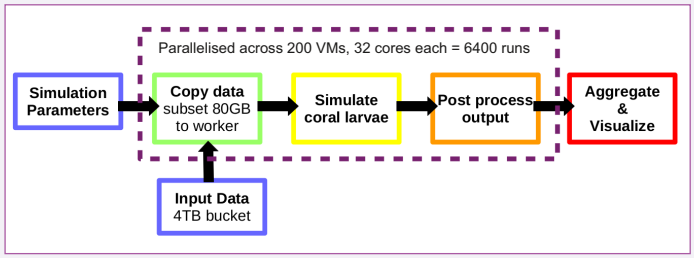
ATLAS NEWS AND STORIES CONT'D.

Baby coral swimming in the Google Cloud – an oceanographic expedition into parallelisation

*By: Dr Stefan Gary, **ATLAS** partner, The Scottish Association for Marine Science (SAMS), UK.*

Cold-water corals live scattered across the bottom of the North Atlantic and, due to the shelter their skeletons provide, cold-water coral colonies may be nucleation points for biodiversity hotspots along the deep ocean floor. We wanted to learn more about how cold-water corals spread across the ocean bottom so as part of the **ATLAS** project we set out to simulate the connectivity among these colonies.

Simulating the spread of cold-water coral larvae requires reading a huge input data set and a few hours' FORTRAN (computer language) number crunching. The real challenge, though, is that the swimming behaviour of the larvae is largely unknown, so exploring how changes in this behaviour impacts spreading increases the scale of the calculation by a factor of 30. Partnering with ParallelWorks (startup company in Chicago), and running the calculation on Google's Compute Engine, we managed to speed up our coral larval swimming parameter sweep from 2 weeks to 1 hour.



Parallelisation schematic of the calculation. Each virtual machine (VM) had 34 cores, but 2 of those cores were devoted to operating system needs leaving 32 cores for the simulation ©Stefan Gary

For oceanographers interested in larval spreading or ocean currents, there is a technical barrier of simulating large ensembles of particle tracks.

There are three challenges: the first is accessing the multi-terabyte (TB) ocean circulation model data sets that are used as the velocity field input to particle tracking simulation codes; the second is the particle simulation itself; and the third is visualising millions of particle tracks. We parallelised all of these challenges across 6,400 processors, or cores, distributed over 200 virtual machines (VM), or workers.

To address data access, we stored 4TB of ocean current data in a cloud "bucket" and then pulled data subsets to each of the 200 workers created when we started the calculation. Copying data to one worker took the same time as simultaneously copying data to many workers.

Each of the 200 workers was tasked with running 32 concurrent coral larvae simulations. While each simulation was using different swimming behaviours (i.e. simulation parameters), they drew on the same input data so the large dataset read to memory could be shared among simulations, minimising the data reading bottleneck.

Finally, the unforeseen benefit of parallelisation was that it had subdivided the output into many independent subsets. We are now able to selectively aggregate data for analysis. For example, we can present the results from seasonal or annual subsets or the total aggregated results faster than if the calculation had been executed as a single large block.

This project required technical expertise from both computer scientists and oceanographers. ParallelWorks, via the open-source SWIFT parallel scripting language, provides an environment where a workflow encapsulates our simulation and can be called into action with a few clicks of a mouse. A possible next step is to generalise the workflow and open it up to the scientific community as a turnkey particle laboratory.

Read more about the **ATLAS**-Parallel Works collaboration on Google for Education.

INDUSTRY CORNER

ATLAS Blue Growth Workshop at Ocean Business 2019

Ocean Business 2019 is a hands-on ocean technology exhibit and training forum, taking place in Southampton (UK) from 9 – 11 April. As the biggest international sea technology show in 2019, and hosting high profile meetings and industry events, **ATLAS** is pleased to participate through the **ATLAS** workshop 'Science, Policy and Blue Growth: An Atlantic Assessment' which will be held on 10 April. The workshop is free and open to all, and participants with interests in marine spatial planning (MSP), blue growth sectors, policy, and regulation are especially encouraged to attend. The workshop will showcase the initial results from the Work Package 7 'Industry reactions to **ATLAS** recommendations' study. As part of this study, we are conducting a survey on the impacts of **ATLAS** scientific findings on blue growth sectors including cables & pipelines, oil & gas, deep-sea mining, fishing, shipping, tidal & wave, wind, tourism, biotechnology, and aquaculture.

The workshop will feature a dedicated talk programme presenting key **ATLAS** scientific findings and their potential impacts for blue growth, detailed sector perspectives, and policy and regulatory insights. There will be a poster session providing more detail on **ATLAS** science. The workshop will provide ample opportunity for **ATLAS** partners to discuss their research with Ocean Business delegates.

To attend the **ATLAS** workshop, you will need to register as a visitor to Oceans Business. Registration is free and online registration is now open.

To get involved, or for more information, please contact Rachel Boschen-Rose: **rachel.boschen-rose@seascapeconsultants.co.uk.**

POLICY SPACE

Influencing policy on EBSAs

ATLAS partners David Johnson (Seascape Consultants, UK) and Ellen Kenchington (DFO, Canada) have co-authored a short Policy Perspective article published in Conservation Letters, to propose that climate change resilience and refugia become a major consideration when describing and reviewing Ecologically or Biologically Significant Marine Areas (EBSAs).

Their rationale builds on work that reviewed the impact of large-scale environmental changes being highlighted by **ATLAS** on traits for North Atlantic species and habitats listed for protection (Johnson et al., 2018). The new article also draws on discussions held at the **ATLAS** International Symposium on North Atlantic Area-Based Management Tools held in Montreal in May 2018. The new article is available to read here.

Ongoing MSP process in the Azores welcomes inputs from regional stakeholders

*By: Aida Silva, **ATLAS** partner, Regional Directorate of Sea Affairs, Direção Regional dos Assuntos do Mar-DRAM, Azores, Portugal.*

Maritime Spatial Planning (MSP) is moving forward in the Azores, with expectations that **ATLAS** results, particularly from Work Package 6 and IMAR-UAz will provide important inputs to the process and the so-called 'Situation Plan'. This process aims to be transparent and regional authorities are now calling on all relevant stakeholders and interested parties to inform the process.

The Azorean MSP process (locally referred to as OEMA – Ordenamento do Espaço Marítimo dos Açores) is currently being developed by the competent regional authority Direção Regional dos Assuntos do Mar (DRAM), in cooperation with the national process under an established legal framework. The key MSP instrument in Portugal or 'Situation Plan', identifies the temporal and spatial distribution of current and potential maritime uses and activities, aiming to promote the sustainable, rational and efficient use of the maritime space and its resources. In December 2018, an Advisory Committee was established by the Azorean Interdepartmental Commission for Sea Affairs (CIAMA) to evaluate and support the development of the 'Situation Plan'.

OEMA receives funding under EU project MarSP which supports the implementation of MSP processes in the three outermost regions of Macaronesia: the Azores, Madeira and the Canary Islands. Results, new seabed data and actions from MarSP contribute directly to the Azorean MSP process. The project also integrates mechanisms for cross-border cooperation and targeted actions to ensure stakeholder engagement.

Another important project contributing to the process is the EU-funded PLASMAR project, which aims to define and propose robust scientific methodologies

Participants of the first stakeholder engagement workshop held in the Azores ©MarSP project

in support of MSP and blue growth in the context of Macaronesia, while also backing OEMA. The project will include pilot zoning exercises for potential blue growth areas, which DRAM and IMAR-UAz are collaborating on.

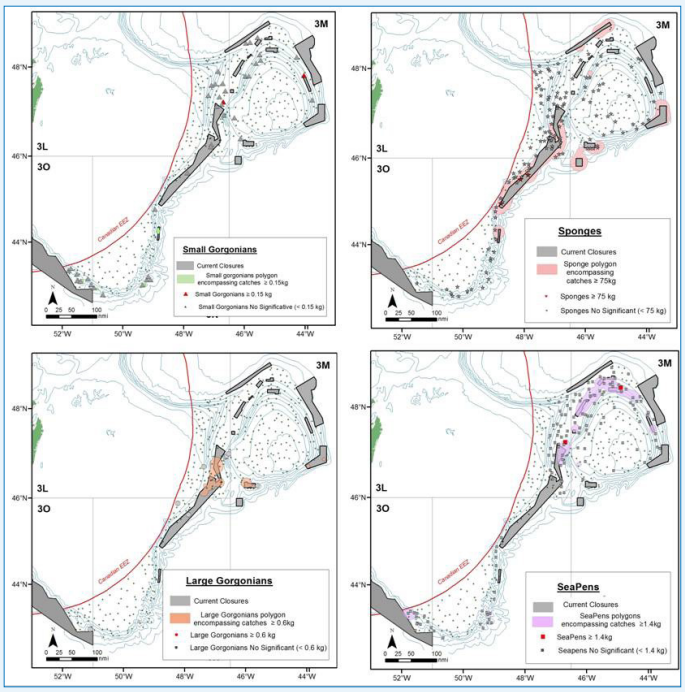
Both projects and **ATLAS** are contributing to the compilation and analysis of data that will be shared on a new spatial data infrastructure and MSP platform that will facilitate the information flow between the authorities and marine users, and support decision-making.

Stakeholder engagement workshops were recently held under the framework of MarSP. A provisional concept was established for the Azorean MSP process at this workshop and potential uses and conflicts of maritime use were defined. Further workshops are scheduled in Spring 2019. To participate in the next workshop and to stay informed on the developments of the Azorean MSP process, please see **https://oema.azores.gov.pt**, contact DRAM **info.dram@azores.gov.pt** or speak to Aida Silva (DRAM) directly +351 292 240 644.

CASE STUDY 11 – FLEMISH CAP

*By: Pablo Durán Muñoz, Mar Sacau and Ana García-Alegre, **ATLAS** partners, IEO-VIGO, Spain.*

ATLAS is built around 12 case studies. Here, the IEO-VIGO **ATLAS** team tell us more about recent developments on species distribution modelling (SDM), biological traits approach (BTA) and maritime spatial planning (MSP) at Case Study 11, the Flemish Cap. To learn more about other **ATLAS** case studies, please see EU-**ATLAS**.



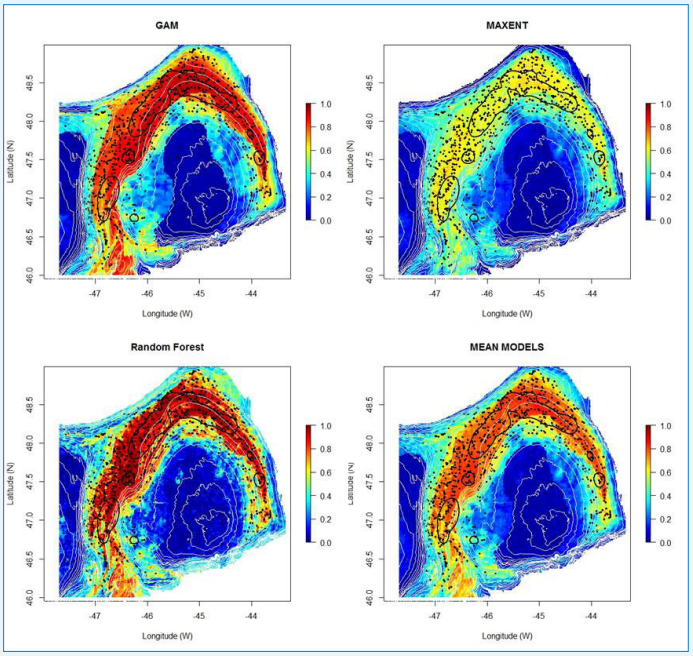
Cold water corals and sponges as VME indicator species in the NAFO Regulatory Area ©IEO-VIGO

In November 2018, we presented **ATLAS** results from **Case Study 11 – Flemish Cap** at the 11th Working Group on Ecosystem Science and Assessment (WGESA) of the Northwest Atlantic Fisheries Organization in Canada, where the value of the MSP efforts developed under the **ATLAS** project was praised. The WGESA-NAFO noted that the results will support advice on sustainability of deep-sea fisheries as well as on other human pressures that could potentially impact fisheries resources and biodiversity in the high seas.

New data on the distribution of Vulnerable Marine Ecosystem (VME) indicator species was collected during Spanish and European bottom trawl groundfish surveys in the Regulatory Area in 2018 on board the Spanish R/V Vizconde de Eza. This information is particularly important for refining the boundaries of areas that are closed to bottom fishing, as part of the management strategy for sustainable exploitation of fisheries resources in areas beyond national jurisdictions, which aims to prevent Significant Adverse Impacts (SAIs) on deep-sea ecosystems.

IEO-VIGO have integrated environmental parameters and fishing effort data into SDMs (e.g. GAM, Random Forest, MAXENT and a combination of these) and have applied these models to several species to map VMEs in **ATLAS** Case Study 11. In addition, the team have looked at defining the biological traits for corals which best describe the VMEs in the area. This work is the first step to improve the understanding of VMEs and develop a robust assessment of SAIs in the NAFO Regulatory Area.

The **ATLAS** team have also produced maps of relevant natural and socio-economic components of the deep-sea ecosystem of the **Flemish Cap** through the application of the Maritime Spatial Planning (MSP) framework. From these maps, they have identified potential conflict areas between different users of the marine space (e.g. hydrocarbon industry versus high-seas fishers), or between users and natural ecosystem components (e.g. hydrocarbon industry versus VMEs). IEO-Vigo are now set to explore different tools to assess the cumulative impacts of the human activities in the area using Geographical Information Systems (GIS) and open source software (e.g. EcoImpactMapper).



Example of habitat suitability for *Anthoptilum grandiflorum*. ©IEO-VIGO

ATLAS OUTREACH & PUBLIC ENGAGEMENT

Engaging the public with deep-marine ecosystems

*By: Emma Paterson, **ATLAS** partner, Dynamic Earth, Scotand, UK*

Dynamic Earth's Learning Officer, Emma Paterson, has been busy developing the **ATLAS** Outreach Educational Portfolio over the last few months and participating in outreach events across the UK. Here we catch up with Emma as she shares her experience and some top tips on public engagement from recent conferences.

In October 2018, I attended the annual conference of the European Marine Science Educators Association (EMSEA) in Newcastle, UK, and presented a poster titled 'Engaging the public with deep-marine ecosystems' which you can view here. There was an interesting mix of presentations, from small-scale projects to Portugal's 'Blue Schools' programme, all focusing on the importance of Ocean Literacy – understanding the ocean's influence on you, and your influence on the ocean. Dynamic Earth is now planning to attend EMSEA 2019 and present some of the resources from the **ATLAS** Outreach Educational Portfolio.

CommOCEAN2018, hosted by the National Oceanography Centre (NOC) in Southampton, UK in December 2018, brought together about 150 communication experts and marine scientists. With help from **ATLAS** partners Laurence De Clippele (UEDIN) and Annette Wilson (AquaTT), I ran a 'public engagement exhibition' table and demonstrated the draft versions of **ATLAS** outreach activities including a biodiversity mat, ROV litter picker game, pressure and ocean acidification experiments, and 360° viewers. This was a big success with delegates showing a great deal of interest, with many saying, 'I'll use this experiment!'. It was open to the public for one afternoon, allowing for concentrated

Emma Paterson presenting the ATLAS Outreach Portfolio at the ATLAS Public Engagement Exhibition at CommOCEAN2018 ©Emma Paterson

engagement with very positive responses. A highlight for me was having the chance to talk with David Shukman, BBC Science Editor, discussing clarity and highlighting commonly misunderstood words. For example, 'cruise' – while most people think 'Caribbean and cocktails!' a clearer term would be 'expedition' within the framework of what we do in **ATLAS**. This talk from an expert communicator really drove home the importance of language and choosing your words carefully when communicating complex ideas and findings.

If you'd like to find out more about simple changes like this which you can make to enhance your public engagement, Emma will be running a session with Laurence de Clippele (UEDIN) at the upcoming **ATLAS** General Assembly in April 2019. In the meantime, she shares a great summary that was presented at CommOCEAN by Jan Seys, Head of Communication Department, Flanders Marine Institute, Belgium (VLIZ).

- Understand your audience/public (e.g. closer to the sea might mean more knowledge about the sea)
- Understand the environment your public is part of, think about social aspects
- Realise your audience has choices e.g. don't try to compete with a popular concert!
- Emphasise positive change! People are put off by depressing information
- Be prepared
- Be creative
- Be active & co-creative
- Make use of aquaria and science centres
- Involve scientists - they are trusted people
- Always evaluate
- Use technology (when it works!) which can add value
- Use the power of good visuals but don't forget the other senses e.g. marine noise
- Have a good story and finally, try to add humour!

Useful ocean outreach resources highlighted at the conference include:

- EMODNET and European Atlas of the Seas for data sharing and creating your own maps
- The Ocean Plastics Lab - an international travelling exhibition that focuses on ocean plastics
- Ocean Edge – a collection of general ocean-themed activities developed by the EU H2020 project SEACHANGE
- World Oceans Day online portal. The theme for the next World Oceans Day is "Gender and the Oceans" and it will take place on the 8 June 2019!

ATLAS OUTREACH & PUBLIC ENGAGEMENT CONT'D.

Winter Wonders at the Royal Society of Edinburgh, Scotland, UK

*By: Georgios Kazanidis, **ATLAS** Post-Doctoral Researcher, UEDIN, Scotland, UK*

The UEDIN-**ATLAS** team were invited by the Royal Society of Edinburgh to participate in the festive family event 'Winter Wonders' in December 2018. J. Murray Roberts, **ATLAS** coordinator, Georgios Kazanidis, **ATLAS** Post-Doctoral Research, and Anna Gebruk, PhD student, presented work from the Changing Oceans Group. The **ATLAS** stand was a 'hot spot' for attendees who had the opportunity to virtually 'sail' in the Canadian Arctic and enjoy a 360˚ experience on the Amundsen icebreaker, using the **ATLAS**-designed virtual reality headsets. Visitors also enjoyed the LEGO research ships and underwater vehicles engineered by Georgios and stories from past expeditions in the North Atlantic.

LEGO model of a manned underwater vehicle ©Georgios Kazanidis

ATLAS RECENT PUBLICATIONS

Since our last newsletter, **ATLAS** partners have published **21** new research articles. Please find all new **ATLAS** articles and publications here, with the six most recent below;

Fox A D et al. (2019) **An Efficient Multi-Objective Optimization Method for Use in the Design of Marine Protected Area Networks.** Frontiers in Marine Science 6, 17.

Johnson D E and Kenchington E L (2019) **Should potential for climate change refugia be mainstreamed into the criteria for describing EBSAs?** Conservation Letters, e12634.

Lozier M S et al. (2019) **A sea change in our view of overturning in the Subpolar North Atlantic.** Science 363, 516-521.

Orejas C et al. (2019) **Chapter: Cold-water coral in aquaria: advances and challenges. A focus on the Mediterranean. In book: Mediterranean Cold-Water Corals: Past, Present and Future**, Eds C Orejas & C Jiménez, Springer.

Rueda J et al. (2019) **Chapter: Cold-water coral associated fauna in the Mediterranean Sea and adjacent areas. In book: Mediterranean Cold-Water Corals: Past, Present and Future of Mediterranean Cold-Water Corals**, Eds C Orejas & C Jiménez, Springer.

Van Engeland et al. (2019) **Cabled ocean observatory data reveal food supply mechanisms to a cold-water coral reef.** Progress in Oceanography 172, 51-64.

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ATLAS - Deep Discoveries

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