Conservation and restoration of marine ecosystems in the context of deep-sea mining

DEEP REST – Second Newsletter

Drawing by Damien Roudeau during the Momarsat cruise 2022 on the Mid-Atlantic Ridge. Downloading data from deep-sea sensors. Copyright D Roudeau/Ifremer.

September-December 2022

Editorial – Dear DEEP REST team, first of all, I wish you and your families a wonderful year, full of surprises and discoveries. This Newsletter is yours, it is there to share information, questions and adventures! Do not forget to keep aside whatever you think would be interesting for this community for the next one. See you in May, either in person or virtually!

-Jozée

Making plans for engaging with stakeholders through interviews, focus groups, and surveys

Manuel Bellanger (WP5 leader, UBO/AMURE)

DEEP REST partners involved in WP5 "Ecosystem services, governance & geopolitical dimensions" met twice online on Dec 7th 2022 and Jan 16th 2023 to share information on project progress and discuss plans for research activities in interaction with stakeholders. Next steps for Task 5.1 include a series of interviews with policy-makers, NGOs, industries, and scientists to integrate stakeholder perspectives in the identification of opportunities and barriers for key conservation and restoration scenarios. Discussions also focused identifying potential study sites to anchor the valuation work planned in Task 5.2 with relevant stakeholders and opportunities to run focus groups and surveys. These brainstorming sessions considered the potentialities of alternative sites in terms of availability of geological and ecological data as well as jurisdictions to investigate stakeholders' appetite for co-construction of a governance framework that promotes good environmental stewardship.

Trait workshop

Ana Hilario & Lara Macheriotou (WP2 leaders)

Good news for the project, thanks to the WP2 leaders, we were able to secure money from EuroMarine to organize a workshop on functional traits that will be hosted at the University of Aveiro next March (22-24). The FDmine workshop will bring together experts on various aspects of deep-sea biology and functional ecology to generate the first ever comprehensive functional trait database for the different compartment of the benthic fauna (meio- to megafauna) from areas targeted for seabed mining. This workshop will set the basis for future deep-sea trait-based research by establishing a database that allows cross-ecosystem comparability in observations and support functional diversity assessments in areas rich in mineral resources. The workshop outputs should provide unique knowledge on the impacts

of mining disturbance on the functional aspects of deep-sea ecosystems. Ultimately, results will contribute directly to developing standardised monitoring protocols for mining and inform policies for deep-sea spatial planning and conservation. The workshop was preceded by a pre-workshop meeting that occurred online at the beginning of January 2023 with a few deep-sea scientists. The aim of this preliminary workshop was to set the basis for the discussions around the creation of the functional traits database that would help support functional diversity studies in environments targeted for deep-sea mining. These preliminary discussions served at improving a draft trait list, associated categories and correspondent terminology in a format that suits the comparison across the target ecosystems.

Development of a new sulphide particle spreader (SPIDER)

Jozée Sarrazin & Laurent Bignon (contribution to WP3)

A new particle spreader, called SPIDER –sulphide PartIcle spreaDER- was developed at Ifremer to replace the prototype used in 2017 during the MIDAS European project which required improvement. This tool, manipulated by a submersible, has to be able to uniformly spread particles over a faunal community to mimic the plumes that could be generated by deep-sea mining. Our technician Laurent Bignon (Figure 1), who has long experience working with submersible came up with a simple, low-cost prototype that will be tested during the Momarsat 2023 cruise at 1700m depth on the Lucky Strike vent field. One reference and one impacted sites over a *Bathymodiolus azoricus* mussel assemblage will be targeted. If the test is conclusive, six SPIDER will be developed to realize an *in situ* experiment at the same site in 2024. The ultimate goal of this experiment is to evaluate the impact of the sulphide plume particles on the becoming and health of vent faunal communities. The effects of short-term *in situ* exposure to sulphide, sediments or other types of particles on the organisms will be evaluated. This experiment will also contribute to the FTC funded project BIDIRISK piloted by Nelia Mestre from University of Algarve.

Figure 1. Technician Laurent Bignon who has to developed the new tool called SPIDER. Photo credit : Jozée Sarrazin

SO 295

Alizé Bouriat (technician in biology at Ifremer)

The SO295 cruise took place form October 29th to December 23rd of 2022 aboard the research vessel SONNE in the Clarion-Clipperton Zone (CCZ). The main objective was to go back 18 months after the nodule collector impact in the two areas (BGR for the German area and GSR for the Belgium area) and implement a multidisciplinary sampling strategy. To analyze the impact of the Patania II on the environment and biological communities, multiples devices were deployed from the surface such as multicorer, boxcore, bottom water sampler, CTD, trawled camera and microprofilers. ROV and AUV dives were also done.

Figure 2. Recovery of a successful boxcore in the CCZ. Photo credit: Tim Kavelage.

In the MiningImpact2 project, Ifremer participated to the fieldwork onboard to sample macrofauna with the boxcore and foraminifera with the multicore. During the scientific cruise, up to 80 boxcorer and multicorer deployments were done, bringing back sediment samples (Figure 2).

Each boxcore sample has to be processed immediately after being brought on deck to better preserve all the specimens for later morphological identifications and DNA analysis. Slicing the boxcore, sieving the three layers and live sorting of the first layer was the major and time-consuming task to do onboard (Figure 3). The Foraminifera sampling was a new task to do. These little individuals are present in every ecosystems since millions years and are well described as bio-indicators. Studying Foraminifera help to understand the resilience of the deep-sea ecosystem after the mining test impact. Each core analyzed was sliced and preserved either for fossils communities or for leaving communities studies (Figure 4). With such a successful sampling cruise, a lot of time in the lab is to come to process all the samples. Access the expedition blog link: https://miningimpact.geomar.de.

Figure 3. Live-sorting from a boxcore sample
Photo credit: ©Tim Kavelage

Figure 4. Photo of a core dedicated to the Foraminifera sampling. Photo credit: Katja Schmidt, BGR

Facing a New Ocean Decade: Geopolitical Change and Challenges in Ocean Governance, Geopolitics (2023)

Juan Luis Suarez de Vivero & Juan Carlos Rodríguez-Mateos
Universidad de Sevilla

The fifty-year period since UNESCO announced its 'Decades' devoted to the oceans has witnessed some deep changes in ocean geopolitics: a new international community made up of a greater number of nation-states that have transformed their territorial bases through the inclusion of large maritime jurisdictions. This, and the decline in the international regulatory ideal, have led to marine governance being addressed very differently from the way it was in the 1970s and presenting a challenge for the future governance of the oceans. This article explores the political change that has occurred during this time and focuses on the State, its maritime territory and the effects of jurisdictional expansion. Methodologically, the geopolitical focus is framed in geographical premises supported with data prepared by the author and premises formulated in the fields of law and political science. The conclusions include some of the effects of unilateral action in marine governance and show that differences and inequalities are the most visible aspects of this new marine territoriality. https://doi.org/10.1080/14650045.2022.2151901

On board “art & science” workshop

Jozée Sarrazin (Deep-Rest coordinator)

Jozée Sarrazin, Thomas Cloarec, Charlotte Heillman, Gwenole Peaudecerf, Sébastien Durand. On board “art & science” workshop for University & engineer school students. September 30-October 2nd 2022.

Ifremer and Teatr Piba, funded by the ISblue University Research School, joined forces in 2022 to carry out a second transdisciplinary onboard workshop. This "art and science" workshop took place from September 30 to October 2 2022 on the island of Batz (Britanny, France) and gathered 10 students from the ISblue community which bring together scientists and engineers working on different aspects of the marine environment. The students worked on the theme of marine resources, particularly those of the deep sea, as well as on the energy transition and questioned themselves on certain major current societal issues: What do we need? What are the marine/ deep-sea resources? What do we covet and why? Can we do otherwise? A scientist, artists and students gathered on this island for a weekend and intertwined their research, their know-how and their personal experiences. Writing, acting, sound and cooking workshops, preceded by a conference on deep-sea ecosystems, served as a springboard for creation. The workshop aimed to raise awareness of the issues of deep-sea exploitation while trying to find innovative solutions to tomorrow's challenges.

Short theatrical forms were presented in front the general public at the center for discovery of the Ocean Océanopolis (Brest, France) November 4th as part of the Festival des Arts Pulseurs (Figure 5). 160 persons attended the event.

Figure 5. The workshop team after the representations at Océanopolis.

Become part of the team to build the role player game BLUE DiplomaSEA

Joëlle Richard (WP6 leader)

In the context of the WP6 of the project, we are developing a role player game on the exploitation *versus* conservation of the deep sea (Figure 6). We would like to form a group of scientist's volunteers to develop the game.

It would be great if the PhD students and postdocs of the project would work together on the construction of the game. We would like to create this group as soon as possible and have a work session on it during the next annual meeting in May in the Azores. If you want to join the team or just have some questions, please contact Joëlle Richard at the University of Brest, France.

Contact: Joelle.Richard@univ-brest.fr

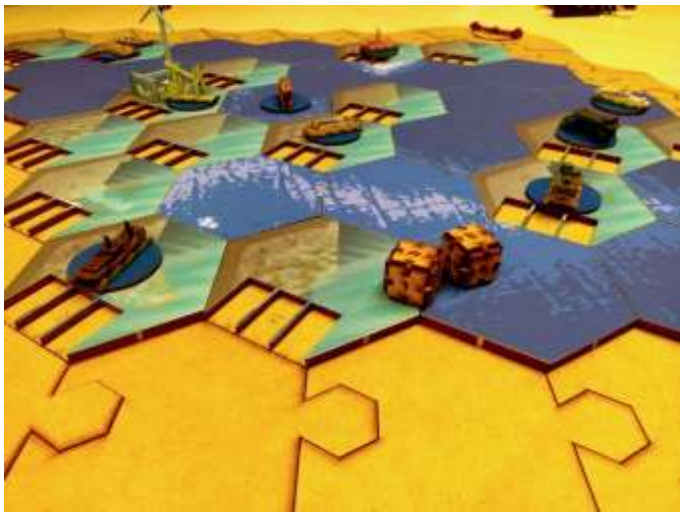

Figure 6. Board game under development. Photo credit: Charline Guillou.

The SPLUJ and DONVOR adventure continues

Jozée Sarrazin (Deep-Rest coordinator)

SPLUJ means "dive" in Breton… while DONVOR means "deep-sea" and it is really in a first dive that Teatr Piba invites the audience to discover the ocean depths. Wearing headsets and eye masks, the spectators are comfortably installed in deckchairs to experience the adventure of a research cruise on the oceanographic vessel Pourquoi-pas? in a sensorial manner. Extracts from David Wahl's logbook from the MoMARSAT 2017 cruise are narrated live by two actors alongside 3D sounds representing life on board. The representations are often followed by interactions between the public, artists and scientists. Scientific mediations in schools before or after often accompany the show. This creative art & science project began in 2016 when Teatr Piba artists met scientists Pierre-Marie Sarradin and Jozée Sarrazin, who lead the Deep-Sea Lab at Ifremer in Brest. Together, they embarked in a long-term adventure linking research and art. Over 20 000 spectators have seen the show and over 287 communications by the media have been released since the beginning.

SPLUJ was presented at the Cité de la Mer in Cherbourg in October 2022 and at the POGO meeting in Toulon, in January 2023. The Partnership for Observation of the Global Ocean, POGO, is a forum created in 1999 by directors and leaders of major oceanographic institutions around the world to promote global ocean observing.


Le Télégramme

À Morlaix, le jumelage entre le théâtre et le collège Mendès-France, une belle histoire de partage

Figure 7. Scientists Jozée Sarrazin & Pierre-Marie Sarradin at the Morlaix college.

DONVOR, which is the longer version of the play, was presented twice at *La Fête de la Science* in Landivisiau in October 2022 and twice at the SEW in Morlaix in November 2022. The representations in Morlaix were preceded by several interventions in schools for college and high-school students. An article in the regional journal *Le Télégramme* (Figure 7) as well as an interview with *Radio U* were done.

Scientific communications on outreach strategies

Jozée Sarrazin (Deep-Rest coordinator)

A series of three conferences were done at the COMMOCEAN conference in Sète last November. CommOCEAN is primarily a communications conference and all delegates are attending to improve, or learn new, communications skills and techniques. Most work in some kind of ocean science institute or organisation and already understand the broad challenges facing the ocean.

1. P.M. Sarradin, C. Borremans, J. Burdallet, M. Ferraris, M. Matabos, J. Sarrazin, J. Tourolle, L. Virard. Light on the abyss. Commocean: 5th International Marine Science Communication Conference 30 November-1st December. Sète, France.
2. J Sarrazin, T Cloarec, D Wahl, C Heillman, G Peaudecerf, N Renard, PM Sarradin. Coupling “arts & sciences”: inspiration and innovation to increase ocean literacy. Commocean: 5th International Marine Science Communication Conference 30 November-1st December. Sète, France.
3. M Matabos, D Roudeau, N Le Roy, J Sarrazin. A journey between two deep-sea scientists, a seaman and a cartoonist. Commocean: 5th International Marine Science Communication Conference 30 November-1st December. Sète, France.

Jozée Sarrazin and co-authors also presented a conference in an “art & science” venue held by the National Museum of Natural History in Paris in January 2023.

Sarrazin, J. T Cloarec, D Wahl, C Heillman, G Peaudecerf, N Renard, PM Sarradin. Les projets "art & science", de puissants outils de médiation scientifique. Colloque Les arts face aux problématiques océaniques contemporaines : révéler, témoigner, réparer. Museum National d’Histoire Naturelle de Paris. January 11 2023.

A paper entitled: Art & Science projects, powerful tools for scientific mediation” was recently submitted to the journal Nature, Science et Société.

Sarrazin, J, Cloarec T, Wahl D, Sarradin PM. Les projets "art & science", de puissants outils de médiation scientifique. Nature, Science et Société, January 2023.

Collaboration with Damien Roudeau, cartoonist

Jozée Sarrazin (Deep-Rest coordinator)

Figure 8. Damien Roudeau drawings at POGO.

The cartoonist Damien Roudeau participated to the Momarsat cruise in 2022. During the cruise, he managed to draw about a hundred drawings that he donated to Ifremer. An official convention was written together with Ifremer law department to consolidate this partnership. From his experience and contacts with scientists, pilots and crew members, Damien will produce a cartoon book on deep-sea ecosystems and mineral resources that should be issued in 2024/2025. Twenty of his drawings were exposed during the POGO meeting in January 2023 (Figure 8).

Other outreach activities

- ✓ ArteTV documentary on DSM (screened 28 July 2022), 90 min
- ✓ Arte 42 show on DSM (to be screened in January)
- ✓ Theatre play of Silke Huysman and Hannes Dereere "Out of the Blue", on tour through Europe in 2022 and 2023
- ✓ Colaço, A.- No quentinho das hidrotermais adaptações ao extremo, Horta, Portugal 5th December 2022
- ✓ Colaço, A. The deepsea, deepsea habitats and impacts from mining- seminar to NTNU Delft, Netherlands Master students, 4th November 2022
- ✓ Colaço, A. O Mar Profundo, esse ilustre desconhecido. Noite Europeia dos Investigadores BlueNIGHTs, Horta, Portugal, 30 September 2022
- ✓ Podcast- Azul do Jornal Público- oitavo episódio do podcast Azul, ouvimos Ana Colaço, bióloga do centro Okeanos, da Universidade dos Açores falar sobre a exploração do mar profundo (https://www.publico.pt/podcast-azul)
- ✓ Podcast-Uma gota no Oceano- Episódio 14 – à descoberta do oceano profundo com Ana Colaço (https://umagotanooceano.pt/ep-14-a-descoberta-do-oceano-profundo/)
- ✓ Colaço, A. 2022. The deep nature of the sea. An umbrella partnership for the protection of the deep sea. CBD COP15 side event 16th December. Co-hosts: Governments of Chile, Costa Rica, France, Germany, Palau and Spain in partnership with the Deep Sea Conservation Coalition, Conservation International, Sustainable Ocean Alliance and the International Union for Conservation of Nature.

Louise Ras, Master student, UMR AMURE (Brest, France)

Louise Ras has joined the team of AMURE, in Brest, to contribute to the stakeholder interviews of WP5. Since receiving her Master degree in International Relations in 2016, she has worked in NGOs and research, specializing in the science-policy interface on ocean issues. Always up for interdisciplinary challenges and passionate about collecting testimonies from the field, since 2020 she has interviewed over one hundred actors on local environmental issues along the French Atlantic coast.

Louise at sea

William Johnson, PhD student, UMR BEEP (Brest, France)

William has recently joined the Deep Sea Lab at Ifremer for his PhD under the supervision of Jozée Sarrazin, Marjolaine Matabos and Pierre-Antoine Dessandier. He is a Brazilian biologist from the Universidade Federal Rural de Pernambuco. He has a Master in Biodiversity and Marine Ecology from Universidade Federal de São Paulo. Since the beginning of his career, William has investigated the ecology, evolution and taxonomy of small organisms- called meiofauna- that live on the sea floor. These animals perform important ecosystem functions such as nutrient cycling and organic matter decomposition, and can be found from calm environments to extreme environments, such as hydrothermal vents.

William in the deep-sea lab at Ifremer. Photo credit : Marcos Da Silva/Ifremer

The aim of William's thesis is to investigate the resilience of meiofauna in relation to an induced disturbance at the Lucky Strike vent field. Its data have been obtained in the Mid-Atlantic Ridge and represent an important opportunity to reveal impacts of disturbance on the resilience and recovery of meiofaunal communities. Along with ecological aspects, William investigates the taxonomy of free-living marine nematodes, one of the most abundant animal groups on Earth, with high species and functional diversity. In addition to his thesis, William has strong interests in Brazilian literature, racial anthropology and political science.

Kenza Herman, MSc student, UMR BEEP (Ifremer)

My name is Kenza Herman and I had the chance to join the Deep Sea laboratory at the beginning of January in the frame of my Master degree. I will work for 6 months on the evaluation of the resilience of meiofaunal communities to an induced disturbance on the Lucky Strike hydrothermal field with the precious help and supervision of Marjolaine, Jozée, Pierre-Antoine and William. I am in a double master's program between La Rochelle University and the University of Costa Rica where I had the chance to study for 7 months last year. But I was born in Brest and grew up in the most western village of continental France! I look forward to meeting you.

Cláudia Viegas, PhD student, University of the Açores (Portugal)

Cláudia Viegas is a PhD candidate at the University of the Azores, supervised by Dr Ana Colaço and Dr Manuela Juliano. During her PhD project, she implemented a hydrodynamic and biogeochemical model for the Azores region. In conjunction with the physical oceanographic model, she applied a particle-tracking model to assess connectivity between deep-sea sponge populations in the Azores. Her background is in environmental engineering, with a degree from the Nova School of Science and Technology (FCT NOVA). She starts working on numerical modelling at the MARETEC, a Research Centre for Marine, Environment and Technology at Lisbon University.

Claudia at sea

Using 3-D hydrodynamic nested ocean and coastal models, and water-quality and lagrangian models to study the dispersal and fate of pollution plumes and objects. In 2016, she moved to the Azores, where she started working at the University of the Azores, pursuing her objective to apply modelling tools to the Azores region, including the deep-sea environments. In the Deep Rest project, her task is the study of species connectivity at the Mid-Atlantic Ridge, using modelling tools, applying hydrodynamic and biophysical models, throughout larvae dispersal, considering known life-history traits and larval patterns for these species. Larvae dispersal

plumes and connectivity matrices will provide information to enhance better ecosystem management and conservation.

Riwan Leroux, post-doc fellow, UMR BEEP (Brest, France)

Riwan Leroux is a researcher in aquatic ecology with a post-doc position at the Deep-Sea laboratory (LEP, Brittany). He works with Marjolaine Matabos and Jozée Sarrazin on evaluating the impact of research activities on hydrothermal vent fields. After a PhD in Canada, where he worked in trophic ecology and specialized in big data analysis, he chose the deep sea to unravel the impact of human activities in these remote areas.

The PROTECT project, standing for “impact indicators in a deeP-sea maRine prOtecTed arEa and reCommendations for managemenT”, aims at (1) map and evaluate the intensity of scientific activities on the Lucky Strike (LS) vent field over two decades; (2) assess the effects of research activities on LS ecosystems and the cascading impacts from biodiversity to ecosystem services; (3) propose indicators of impacts to be included in management plans and (4) bring citizen science into environmental monitoring to increase research capacity and co-construct management strategies. This project will contribute to several planned projects including SARGADOM (FFEM, PI D Bailly) in support to BBNJ treaty and two projects on the conservation and restoration of deep-sea ecosystems in the context of mining: DEEPREST (Biodivrestore, PI J. Sarrazin) and the LIFE-DEEPER (PPR, PI MA Cambon, see below).

A new national French project LIFEDEEPER

Marie Anne Cambon (Deep-sea microbiologist at Ifremer)

LIFEDEEPER is a consortium led by Ifremer (MA Cambon), together with University of Brittany, Sorbonne University, MNHN, IRD and CNRS. It was launched November 28th and 29th 2022. Our consortium is leading a five cruise series (2014- 2023/4) in the framework of the French contract for exploration of Atlantic polymetallic sulphides resources (ISA). At 3600 meters depth, the TAG hydrothermal field is an area of choice for studying the geo-biodiversity of so-called inactive SMS deposits, and is, with the young and volcanic Snake Pit hydrothermal field,

at the heart of our studies. Separated by 300 kms of ocean ridge and a major transform fault shifting its axis by 150 km, these sites show similarities in terms of biological diversity, raising the question of their connectivity. Exploration of the area revealed geochemical evidences for unknown active vent sites located between TAG and Snake Pit and further south. These sites constitute potential relays for organism dispersal, a key point in the overall understanding of ecosystems and their relationships along ridge segments.

LIFEDEEPER intends to develop new approaches, combining *in situ*, *in vivo* and lab experimentations, modelling and qualitative research in social sciences to disentangle the geological, geochemical and biological natural functioning of deep-sea hydrothermal ecosystems. In addition to the coordination work package (WP1), 4 multidisciplinary, complementary scientific WPs and one communication WP are proposed:

- WP2. Exploration and description of ecosystems associated with inactive and active massive sulphide deposits, towards integrated definitions of active and inactive vents.
- WP3. Integrated 3D study coupling hydrodynamics, distribution of trace metals and numerical modelling to assess the biogeochemical impact of the hydrothermal plume to the deep ocean geochemistry.
- WP4. Study the connectivity and life cycle of holobiont models, their capacity of adaptation and acclimation allowing community resilience.
- WP5: Legal and political analysis of international regulatory regimes, sociological analysis of science-technology-society, capacity building.
- WP6 will produce effective educational and public outreach activities targeting citizens, students, scholars, organizations and various stakeholders, through participative science, educational science and art.

Ultimately, LIFEDEEPER will establish a precise map of contrasting sites at the scale of a 600 km ridge segment, in order to provide key parameters to understand the natural functioning of these environments, both from a geological and biological point of view. Key components of the functioning of these ecosystems and associated services, along activity gradients, will permit establishing global-scale inter-comparison protocols. In a holistic and multidisciplinary approach, LIFEDEEPER aims to acquire definitions of reference ecological profiles and preservation strategies in the current context of the growing interest in deep mineral resources for the carbon-free and digitized world economy. LIFEDEEPER will propose solutions to allow future informed guidelines and decision-making.

LIFEDEEPER and DEEP REST partners will work in close collaboration, jointly providing data on the TAG and Snake Pit vent fields. Moreover, efforts made in WP5 and WP6 will be mutualized.

The final version of the **consortium agreement** has been sent to all DEEP REST partners, please make sure that it is signed promptly!

The **data management plan** also needs your inputs. Please take a few minutes to identify the data you will be using during this project.

Communication tools
Web site: https://deep-rest.ifremer.fr/
Mailing to deep-rest organization team (WP1): deeprest2022@gmail.com
General DEEP REST mailing list: deeprestall@listes.ifremer.fr
WP leader list: deeprestwpleader@listes.ifremer.fr

Our advisory board is composed of: Samantha Smith, David Billet, Luciana Genio and Claire Armstrong. You can see their profiles on the web site and contact them directly by using their mailing list: advisory_board_deep-rest@listes.ifremer.fr. Thanks to all of them to be part of our great project!

Please cite DEEP REST in your acknowledgements (publications, conferences, activities)
This research is part of the DEEP REST project that was funded through the 2020-2021 Biodiversa and Water JPI joint call for research projects, under the BiodivRestore ERA-NET Cofund (GA N°101003777), with the EU and the following funding organisations : Agence Nationale de la Recherche (ANR-21-BIRE-0003), France, Ministry of Agriculture, Nature and Food Quality (LNV), Netherlands, Research Foundation – Flanders (FWO), Belgium, German Federal Ministry of Research (BMBF) through VDI/VDE-IT, Germany, Environmental Protection Agency (EPA), Ireland, Fundação para a Ciência e a Tecnologia (FCT), Portugal, Fundo Regional para a Ciência e Tecnologia (FRCT), Portugal-Azores and State Research Agency (AEI), Spain.

See you all in person or virtually for our first annual meeting in Horta (Faïal Island, Azores), May 3 & 4, 2023!