



Partnership for
Observation of the Global Ocean

  @POGO_Ocean #POGO24

POGO-24

Plenary Meeting Report

24 – 25 January 2023

Meeting Hosted by

Institut Français de Recherche pour l'Exploitation de la Mer

Centre Ifremer de Méditerranée

Toulon, France



Ifremer

Agenda

Venues:

*Casino JOA de La Seyne, 340 Cours Toussaint Merle, 83 500 La Seyne-sur-Mer
(24th & 25th Jan)*

and

Centre Ifremer de Méditerranée, Zone Portuaire de Brégaillon, 83 500 La Seyne-sur-Mer (26th Jan)

	Mon 23 Jan	Tues 24 Jan	Wed 25 Jan	Thurs 26 Jan
	Ice-breaker reception	POGO-24 Open Meeting <i>(Venue: Casino JOA, Salle de Spectacle)</i>	POGO-24 Open Meeting <i>(Venue: Casino JOA, Salle de Spectacle)</i>	POGO AGM (members only) <i>Venue: Ifremer Mediterranean Centre)</i> & Excursion (all participants)
Morning		Plenary session	Plenary session	Closed session
Lunch		Lunch for delegates provided on-site	Lunch for delegates provided on-site	Lunch for AGM delegates provided on-site
Afternoon		Plenary session	Plenary session	Closed session
		Poster session	Poster session	
		Plenary session	Plenary session	16:15 Vineyard tour <i>(Domaines Bunan La Cadière)</i>
Evening	19:00 – 21:00 Ice-breaker: All delegates <i>(Venue: Musée national de la Marine)</i>	19:00 – 22:00 Conference Dinner SPLUJ theatre performance <i>(Venue: Casino JOA)</i>	19:00 – 21:30 Members' dinner <i>(AGM attendees only, Venue: La Fabbrica di Marco)</i>	20:00 – 22:00 (TBC) Board dinner <i>(Venue: Racines)</i>

The full agenda can be accessed here: <https://pogo-ocean.org/wp-content/uploads/2022/12/POGO-24-agenda-final.pdf>.

POGO-24 Meeting Report

Open Meeting

24th-25th January 2023

The list of participants is accessible to all at <https://pogo-ocean.org/wp-content/uploads/2023/04/POGO-24-Meeting-Participants-final.pdf>. Background documents, recordings and presentations are available to registered delegates at: <https://pogo-ocean.org/pogo-24-documents-and-links/> (password sent to delegates only)



POGO members and colleagues were delighted to be able to meet once again in-person, for the 24th POGO Annual Meeting (POGO-24), from 24 to 26 January 2023. Despite the pause in physical meetings and travel over the last 2-3 years, the meeting was very well attended, bringing together a total of 77 delegates from 22 countries, plus 14 on-line speakers.

1. Opening Session (Chair: Vincent Rigaud)

The opening session started with a welcome from **François Houllier, CEO of the meeting host institution, Ifremer**. He gave a brief overview of the scientific and geographical scope of Ifremer research and observations, highlighting in particular their relationship with private industry for technology development, and the importance of social science within Ifremer. He warmly thanked the Director of the Ifremer Mediterranean Centre, Vincent Rigaud, and his team, who had worked very hard to organise the meeting, together with the POGO Secretariat. He also highlighted the role of the Ifremer International Office, headed by Natalia Martin Palenzuela, and paid tribute to Gilles Lericolais, who was due to step down as a POGO trustee, but unfortunately had not been able to attend the meeting.

This was followed by welcome remarks from **Thierry de la Burgade**, Deputy Préfet Maritime of the Mediterranean. He explained that his office is responsible for safety at sea, therefore it is important

for them to have accurate forecasts to predict both natural and man-made hazards (climate, geohazards, etc).

Remarks were then given by **Olivier Poivre d'Arvor**, Ambassador for the Poles and Maritime Issues. He congratulated POGO on its successes. He reiterated France's commitment to preserving the ocean and announced that France and Costa Rica had been confirmed as organisers for the 3rd UN Ocean Conference in France in 2025 (with high-level events in Costa Rica in 2024). He mentioned plans to establish an International Panel for Ocean Sustainability (IPOS, equivalent to IPCC for the ocean), working hand in hand with the World Ocean Assessment, which will benefit from POGO's network of scientists. He mentioned important progress had been made through intergovernmental processes in 2022, such as the binding instrument on plastic pollution, WTO agreement to end subsidies for IUU fishing, the One Ocean Summit in Brest, the UN Ocean Conference, UNFCCC COP 27, CBD COP 15 France, and the High Ambition Coalition on Nature and People. IPOS will work for 2 years on the first synthesis of existing knowledge and recommendations on the ocean in light of the SDGs.

Finally, **Nick Owens, Chair of the POGO Board of Trustees**, and Director of the Scottish Association for Marine Science (SAMS), welcomed the participants on behalf of POGO. He was delighted to meet PGO members and colleagues face-to-face once again, after the last 3 years of on-line meetings. He thanked the hosts, and recalled the previous meeting hosted by Ifremer in Brest many years ago. He expressed his sadness that Gilles Lericolais had not been able to attend the meeting, and thanked him for all his input to the Board of Trustees, as well as for arranging for Ifremer to host the meeting. He also thanked Vincent Rigaud and the entire team who had organised the meeting on the ground. He also thanked the Secretariat staff for their work in organising the meeting. He said he was very pleased to see the growth of the POGO community and how much more diverse it has become. He welcomed the industry participants and expressed POGO's wish to interact more closely with industrial partners.

2. Showcase of oceanography and ocean observing in France (Chair: Richard Sempéré)

Pierre-Yves Le Traon (Mercator Ocean International) presented **"Towards a French Ocean Observing System FrOOS"**. He highlighted the increasing and pressing needs for systematic and long-term ocean observation (weather/climate evolution, climate mitigation/adaptation, sustainable management, blue economy, protection of marine ecosystems and biodiversity). Between 2000 and 2020, Coriolis was the integrated ocean observing infrastructure for operational oceanography and research. Today, France has an integrated ocean observing system (in situ and satellite observations, modelling and data assimilation). France contributes to GOOS and the European integration (EOOS). FrOOS is under development, as a joint initiative between Ifremer, CNRS, SHOM, IRD, MeteoFrance, cerema and CNES. The main building blocks are ILICO (coastal), EMSO (deep sea), Argo France, and OHIS (open sea). FrOOS will organise interactions between marine research observation infrastructures and other observation networks, interactions with satellite component, with ocean, weather and climate modelling centres, users and socio-economic aspects, and European/international integration.

Guillaume Charria and **Alain Lefebvre** (Ifremer) gave a presentation on **Coastal Observation Project Highlights**. ILICO is a multi-agency infrastructure for coastal ocean observations established in 2016, with an annual budget of 10M EUR. It is the French node of the European infrastructure JERICO. It is highly distributed (including overseas territories), including gliders, HF radars, fixed platforms etc. It

consists of 9 observing networks, covering physics/biogeochemistry, tropical coral ecosystems, coastal morphodynamics, phytoplankton, surface temperature, sea level and benthic macrofauna. He presented some technological innovation projects for coastal observations (low-tech bottom observations and micro-AUV). He presented some HAB early detection work based on coastal observations and machine learning, some results of long-term nutrient observations, and impacts of hydro-meteorological extreme events on coastal ocean salinity.

Paschal Coyle (CNRS) gave a presentation *“From Deep Sea to Space: Le Laboratoire Sous-Marin Provence Mediterranee”*, a very local project located in the Toulon Marseille areas. The underwater laboratory is a multi-disciplinary cabled marine observatory hosting the KM3NeT/ORCA neutrino telescope and also marine instrumentation, as part of the EMSO network.

3. Updates on POGO activities (Chair: Jan Mees)

The next session focussed on updates on POGO activities, with **Nick Owens** providing the highlights of 2022, where he picked 1 or 2 elements from the new [POGO annual report](#) to highlight. These included fellowships (7 this year); the Ocean Biomolecular Observing Network projects meeting in Plymouth and side-event at COP 27; and the International Quiet Ocean Experiment (IQOE), which produced a very high-impact publication this year (top 5% of most cited publications in Altmetric). In terms of member engagement, 96% of members were actively engaged in one area or other or POGO activities. In terms of partnerships, he highlighted that POGO has been partnering with SCOR for 21 years and that POGO’s relationship with GOOS has been strengthened, particularly through the joint statement of intent produced after the last POGO Meeting. POGO’s Strategy has been translated into French, Spanish, Portuguese and Arabic, which was a very important step. He cited the focus on low-cost acoustic underwater recording devices and POGO’s projects on observations in the Gulf of Guinea, as well as OpenMODs and SAGITTA projects on low-cost observing instruments. He thanked the Nippon Foundation for their continued support for the NF-POGO Centre of Excellence, and the AWI for their continued commitment to hosting the CofE, and mentioned other training initiatives hosted by POGO members this year (GEOMAR, SAMS, INCOIS). He then mentioned POGO’s outreach activities, including citizen science/outreach projects (COLLECT and SEAGRASS), and POGO’s presence at COP 26 and 27 and at the UN Ocean Conference. He thanked the Board of Trustees for ensuring that POGO is operating in compliance with charity law, and finally urged the audience to read the annual report, which is very impressive.

This was followed by general updates from the Secretariat on the 3 pillars of POGO. **Sophie Seeyave (POGO CEO)** presented the Work Plan, which was produced about a year ago. She walked through the 12 activities grouped under the 3 main POGO objectives (observations, capacity development and outreach/advocacy). It is a 3-year rolling Work Plan, updated annually, so this is just being updated for the first time. This will be discussed in more detail during the AGM. Sophie summarised the reporting that takes place during the year (to the Board, to the Finance Committee, to the Remuneration Committee, and to members and partners), and summarised the reporting that is conducted as part of POGO’s compliance with UK charity law. She summarised the progress on Action Items from AGMs (all Actions from 2021 completed, 4/9 completed for 2022 and remainder to be closed by end March 23), from Board Meetings (40/44 completed for 2021, 26/34 completed for 2022), and from the Finance Committee (all 11 will have been completed by AGM). She then provided a bit more detail on

member engagement (47% involved in observation-related activities; 33% involved in training; 53% in POGO outreach; 36% in POGO governance, and 89% attended on-line POGO annual meeting).

Lilian Krug (POGO Scientific Coordinator) highlighted that POGO had a very busy year in terms of capacity development, having fully recovered from the pandemic. We offered 15 fellowships (10 on-board research vessels) and had 204 participants in training courses, bringing the total number of trainees to 1204 from 93 countries. The 2022 Centre of Excellence ran from January to October 2022 and collaborated with other POGO projects, including OpenMODs and the POGO “miniboats” project. The CofE scholars also had the opportunity to participate in the “North-South Atlantic Training transect” (NoSoAT), as well as 3 additional fellows. Lilian provided an update on the NF-POGO Alumni Network for the Ocean (NANO), including the participation of NANO members in various international meetings (UN Decade Laboratory, UN Ocean Conference, COP 27) and the SAGITTA project.

Fiona Beckman (POGO Communications Officer) provided an update on POGO outreach/advocacy and communications. She highlighted the meetings that POGO had participated in this year, both in-person and virtually: UNOC, COP 27, European Maritime Day, CommOcean, etc. POGO was a partner in the first ever Ocean Pavilion at COP and co-hosted 2 side-events within the Pavilion, as well as hosting an official UNFCCC side event and participating in various others. She highlighted various communications materials produced this year, focussing in particular on the ocean observing case studies (phase 1 on water quality monitoring, phase 2 on climate-critical observing, and phase 3 well underway on geohazards). Fiona presented the “miniboats” project, which involved partners and schools in Ireland, Germany, Spain and South Africa, video calls between scholars/teachers on-board and the school students who assembled the boats.

There followed individual updates on the following POGO-sponsored activities:

Lucia di Iorio (University of Perpignan) presented an update on the [International Quiet Ocean Experiment](#), including the Ocean Sound Essential Ocean Variable (EOV) draft Implementation Plan recently released for community review. Two tasks of particular relevance to POGO include (1) the development of GOOS-compatible underwater acoustic recording systems, and (2) the development of low-cost underwater acoustic recording systems. IQOE legacy also includes the MANTA software and OPUS portal, which are working towards the implementation of passive acoustics in GOOS. The Global Library of Underwater Sounds publication attracted huge media interest and there is now a lot of pressure to develop the library/platform for researchers, managers and citizens. There will be a workshop in April to develop a structure for this platform. IQOE allowed the open-access publication of a book on “Exploring Animal Behaviour through Sound”, which has already been downloaded over 65K times.

Subrata Sarker presented an update on the [NANO-DOAP](#) project. This is a global study of Deoxygenation, Ocean Acidification and Productivity at selected sites, which supports observations promotes capacity development as well as outreach. Mandatory variables being measured monthly or bimonthly at the stations are temperature, salinity, pH, dissolved oxygen and chl-a. All data are being compiled and an interstation comparison is being conducted, with a plan to submit the data to an open-access database. The project is also providing foldscopes for members to run outreach activities, and running a webinar series.

Nubi Olubunmi Ayoola (NIOMR, Nigeria) presented the [Acquisition of Oceanographic Data for Sustainable Resources Management in the Gulf of Guinea Project](#). The project involved Nigeria, Ghana, Cote d'Ivoire, Benin and Togo, with GEOMAR as a technical partner. The NIOMR research vessel *RV Bayagbona* was used, and the project was linked to the NF-POGO shipboard training programme. Shipboard training fellowships were provided to 6 early-career scientists, who received training at NIOMR before, during and after the research cruise. Sampling of physical, chemical and biological parameters was conducted in the water column as well as sediments at 7 stations off the coast of Nigeria. A hybrid workshop was conducted to analyse the acquired data in Sept 2022.

Ana Catarino (VLIZ, Belgium, on-line) presented the [Citizen Observation of Local Litter in Coastal Ecosystems \(COLLECT\) project](#), also on behalf of her Co-PI Edem Mahu. The project is funded by the Richard Lounsbery Foundation. The project was conducted in Morocco, Cabo Verde, Nigeria, Ghana, Benin, Cote d'Ivoire and Malaysia. POGO member institutions involved provided the training to the school students, using common protocols and training materials created by the project, for sampling of macro-, meso- and microplastics. Field sampling took place in Oct-Nov 21 and March-April 22 and questionnaires were developed to assess changes in the students' attitudes and behaviours due to their participation in the activities. Working languages were English, French, Portuguese and Spanish. She presented some preliminary results from the data collection and social science study.

Eva-Maria Brodte (AWI, Germany, on-line) presented the [Open Access Marine Observation Devices \(OpenMODs\)](#) project on behalf of all the partners. Three fully-assembled TD probes were built, as well as a LoRa communication system with integrated TD data transmission and a WiFi gateway to guarantee data transmission even using a mobile phone network. Training on the use of the platform was provided (remotely, by OGS/Italy partners, with local AWI support) to the NF-POGO Centre of Excellence scholars. Open ocean testing was conducted by the project partners at IMar in Cabo Verde and the outcomes summarised in a report. She presented the next steps for Phase 3 of the project (blue prints, 3D printing, build a community of young OpenMODs ambassadors).

Eva-Maria Brodte also presented the [Empowerment/Employment of female researchers in Key Assignments \(ERIKA\)](#) Working Group. This has been hampered by the Covid pandemic, whereby the planned workshops have not taken place. There is not a lack of female researchers, but perhaps the fostering atmosphere for female researchers is missing in some parts. We have some good examples in our community of female researchers who are shining as researchers and international project coordinators. The approach is to have a high-level coordinating event, install moderated social media channels and install a position with a young female researcher for one year with the aim to connect female researchers and female-run projects.

Aileen Tan Shau Hwai (CEMACS, Malaysia, pre-recorded) presented the [South East Asia project for General Regional Awareness of Seagrass by Society \(SEAGRASS\)](#) initiative. Expected to end in May-June 2023, the project focusses on the Middle Bank in Northern Straits of Malacca, adjacent to the Penang World Heritage Site. They intend to engage the local government in creating a Marine Sanctuary and engage the local community/students in this effort. Preparation is underway for school field trips and preparation of pamphlets and learning materials. Regular field sampling has been carried out, as well as capacity building and stakeholder engagement with local government and

NGOs. Two papers were presented at a virtual conference, and the team hosted a session as part of the Ocean Best Practices System Workshop IV in Oct 22.

4. Introduction of new/emerging initiatives by members (Chair: Nick Owens)

Later on Day 1, POGO members had the opportunity to introduce new/emerging initiatives taking place at their institutions. This included interventions by **Edgar Pavia (CICESE, Mexico)** on “CANEK: An intensive observational and modelling project of the Gulf of Mexico and Mexican Caribbean”; by **Ed Hill (NOC, UK)** on “UK sustained scientific observation priorities”; by **Mike Smit (OFI, Canada)** on “Transforming climate action: Addressing the missing ocean”; and by **Marco Marcelli (CMCC, Italy)** on observational and modelling activities at CMCC.

In addition, **Margaret Leinen** and **Ed Hill** presented an idea for POGO to strengthen its advocacy role by preparing statements for submission to targeted stakeholders (e.g. UN bodies, individual governments, etc). It was agreed that this proposal would be fleshed out by a sub-group of members and presented at the AGM on Thursday. Finally, POGO alumna/NANO member **Fernanda Matos**, currently a PhD student at AWI, addressed the members and urged them to think about why early-career ocean professionals are currently “fleeing” science, and what could be done to address this issue.

5. Introduction of new/selected members and partners (Chair: Nubi Olubunmi Ayoola)

Olivier Pringault gave a presentation on the *Institut de Recherche pour le Développement (IRD, France)*, the newest POGO member. IRD contributes to French scientific diplomacy and policies on aid for development through an equitable partnership model with countries in the “Global South”. 26% of IRD employees are located abroad and 60% of publications are co-authored with scientists from the Global South. IRD has over 150 “young associated teams”. It has 5 scientific departments (preserving biodiversity, improving health, understanding societies, managing oceanic resources sustainably, and understanding global change). Oceans and coasts are one of the 9 global challenges. IRD invests in tomorrow’s scientists, through training, strengthening scientific groups, and support for academic/research institutions (joint laboratories). In terms of ocean research, IRD focusses on climate change, ecosystems, reconciling resource exploitation with biodiversity conservation, and studying the impact of pollution.

Yuntao Wang (remote) gave a presentation on a proposal being submitted by the *Second Institute of Oceanography (China)* to the UN Decade of Ocean Science for Sustainable Development. Digital Deep-sea Typical Habitats (Digital DEPTH) is proposed to address the lack of scientific knowledge to support the management of deep sea and to assess its response to climate change and human activities. It will focus on discovery, connectivity, prediction and capacity building. Focus on typical deep-sea habitats, such as seamounts, mid-ocean ridges, abyssal plains and continental slopes, and their connectivity. It will develop key technologies for intelligent observation and numerical modelling, and generate a digital deep-sea habitats atlas and area-based management tools. A couple of joint international cruises will be organised in the first 3 years.

Marco Marcelli presented the *RENOVATE project (a holistic approach to marine ecosystem restoration) of the Euro-Mediterranean Centre for Climate Change (CMCC, Italy)*. He presented the

impacts of coastal development on sensitive/protected marine habitats such a *Posidonia oceanica* seagrass meadows. RENOVAE is a 10-year project is a partnership between 5 universities, CMCC, OGS, CNR and other stakeholders. Objectives are (1) to establish environment compensation actions towards ecosystem services restoration, and (2) develop an early-warning system for extreme natural events, dredging and pollution impacts. This requires development and implementation of an integrated observing system and operational modelling at regional scale, supported/validated by in situ data -working towards the development of a digital twin of the coastal ocean.

Finally, **Toste Tanhua** (GEOMAR, Germany) gave an update on the **Global Ocean Observing system (GOOS)** and its cooperation with POGO. GOOS includes 84 countries, 8,700 + observing platforms, and 13 global networks (see www.ocean-ops.org/reportcard2022). GOOS is the infrastructure that coordinates the global system. GOOS has developed 34 Essential Ocean Variables (EOVs) – a new one has recently been accepted on Ocean Bottom Pressure, related to the Smart Cables network also recently adopted by GOOS. Toste highlighted the statement of intent to strengthen collaboration between POGO and GOOS, produced one year ago, and posed the question of how to bring this to life. He suggested mapping this to the Roadmap for the Implementation of the GOOS 2030 Strategy. POGO and GOOS mission/vision statements are very similar. The 3 pillars of POGO map very clearly to 3 of the strategic objectives of GOOS (support innovation, capacity development, and advocacy/communication). A series of industry dialogues was recently concluded between GOOS and the Marine Technology Society (MTS). The Observing Together programme of GOOS offers the opportunity to cooperate with POGO on capacity development. Engagement across the UN is another opportunity for GOOS and POGO to co-create messages to strengthen their collective voice.

6. Thematic sessions

A total of 4 thematic sessions were held over the 2 days, on **(1) Deep Ocean Observations for Science, Conservation and Management, (2) Societal Applications of Digital Twins, (3) Coastal Ocean Observations, and (4) POGO member involvement in the Ocean Biomolecular Observing Network (OBON)**. Session leaders reported back at the AGM on Day 3 and the POGO members discussed plans for follow-up actions.

6.1. *Deep Ocean Observations for Science, Conservation and Management (Co-Chairs Jozee Sarrazin and Takeshi Kawano)*

The session consisted of 8 presentations on different aspects of deep ocean observing, and a selection of French, European and international programmes.

Denis Bailly (University of Brest, France) presented on **“Data needs for conservation in the high seas under the BBNJ regime”**. He introduced two projects focussing on emblematic ecosystems of critical importance beyond national jurisdiction (Sargasso Sea and Thermal Dome/Central East Pacific), where they are testing a methodology for ecosystem diagnosis and analysis. Both EBSAs, they are experimental in anticipating the shift from a scientific recognition to setting a governance framework under the auspices of BBNJ treaty. They have started identifying the kinds of data needed to have these sites recognised as “protected areas of international value and concern under BBNJ”, and the data needed to negotiate restrictions on activities such as shipping, fishing and seabed mining. Science is needed to inform causal chain relations in a policy context (e.g. DPSIR model). He highlighted the

gaps in monitoring the effectiveness of policy implementation, but also positive changes in the observation capacity and volume of data generated, the efficiency of observation technologies (including cost reduction), and the diversity of interests and financial sources mobilised. There is a need to shift towards a need and demand-driven observing system.

Damien Desbruyeres (Ifremer, France, *remote*) gave a presentation on **“Global and full-depth ocean monitoring: the Deep-Argo array”**. There are 3 main scientific gaps justifying the need for Deep Argo: (1) energy and sea-level budgets (resolving uncertainty in estimate of heat absorption by the deep ocean, i.e. below 2,000m depth), (2) abyssal circulation, and (3) validating, evaluating and constraining numerical models. The plan is to deploy 300 deep Argos floats per year to reach a total of 1200 floats. 350 have been deployed over the last 10 years, 180 of which are operational today. Deep Argo is making a step change in monitoring of Antarctic Bottom Water (warming) and N. Atlantic Deep Water (cooling). He introduced the “PIANO” and “Argo-2030” projects, which are dedicated to the development and deployment of the first European 6000m deep Argo float, respectively.

Laurent Coppola (CNRS/EMSO France) presented on **“EMSO France -the French contribution to the ERIC EMSO”**. The research infrastructure consists of 4 sites (3 open sea and 1 coastal), supported jointly by CNRS and Ifremer. Various technologies have been developed for deployment at these sites (e.g. benthic robot, Ocean Bottom System) and data acquisition is both real-time and delayed mode, following the FAIR data principles. He presented examples of research applications for each of the sites (climate/carbon, seismology).

Pierre-Marie Sarradin (Ifremer, France) presented **“An overview of 12 years of deep ocean observation, example of the EMSO Azores observatory”**. The observatory is located on the mid-Atlantic Ridge, at the Lucky Strike hydrothermal vent. Two nodes are connected to a surface buoy that communicates the data back to shore every 6h. It is an integrated study site with OBS array, temperature probe arrays, physical oceanographic monitoring and during maintenance cruises a sampling strategy for rocks, fluids and organisms. The observatory has served as a technology development platform over the years. Data can be accessed directly on the EMSO-Azores web portal. Research examples included hydrothermal circulation/fluid chemistry, and biological rhythms of mussels (linked with tidal periodicity). He also introduced some ocean literacy projects linked to the observatory. Future work will include underwater noise and image analysis, as well as reducing the environmental impact of the site.

Takeshi Kawano (JAMSTEC, Japan) gave a presentation on **“Recent deep ocean studies at JAMSTEC”**. The first topic presented was deep water warming and change in deep ocean circulation from the repeat hydrography programme GO-SHIP. Warming in Southern Ocean was found to propagate rapidly to the northern N. Pacific. JAMSTEC developed “Deep Ninja” to measure warming in deep waters of the Pacific Ocean. The second topic was observation of single-use plastics and food packaging on N. Pacific deep ocean floor using submersible Shinkai 6500. Density of plastic debris was 2 orders of magnitude higher than previously recorded number. Need 8,000m-class AUV to be able to cover entire area of Japan’s EEZ. New URASHIMA being designed for this, to be launched in 2025. Finally he introduced the New Caledonia observatory project between JAMSTEC and Ifremer to deploy a pilot line mooring and deep ocean observatory on the seamount slope.

Jim Edson (WHOI, USA) presented on **“Global and full-depth ocean measurements from the Ocean Observatories Initiative”**. OOI operates and maintains sophisticated instrumentation in demanding location, providing real-time data (freely available) from surface to seafloor, from more than 800 instruments on 80 platforms at 5 arrays. OOI has a 30-year lifetime starting in 2016 and is a UN Decade Action attached to the OASIS programme. OOI provides research-quality data to the user community. One example of cabled array research application was using bottom pressure measurements to forecast volcanic eruptions. Sensor replacement and “tech refresh” are required of all instruments. Biogeochemical sensors and gliders take more time and effort to keep up and running. Actively looking for new sensors that are more robust and reliable and welcome collaborations. A question was asked about the Southern Ocean site, which Jim responded that he is working on getting back into service. Another question was asked on benthic cameras. Jim replied that most of the data volume is imagery and acoustic data. The imagery is being used a lot by students.

Benoit Pirene (ONC, Canada, *remote*) gave a presentation on **“Ocean Networks Canada: a Research Infrastructure with a Societal Mandate”**. ONC offers continuous, real-time data about the ocean, measuring essential ocean variables; supports experiments through on-shore and offshore infrastructure; and encourages multi-disciplinary and trans-disciplinary research. Observing air-water exchange, benthos and geology in addition to “whales and water”. ONC operates cabled systems as well as mobile devices (starting very soon deployment of 18 deep BGC floats). They provide data products to support decision making for government and industry, and support indigenous communities by empowering them: They have developed earthquake and tsunami early warning systems, surface current maps and marine protected area monitoring. Community fishers programme provides CTDs to indigenous fishers, where data transferred wirelessly to a tablet then uploaded to Oceans 3.0 data management system for QC and made available to indigenous communities and public at large. Ocean-based climate mitigation strategies -going from the lab to the field, e.g. ocean alkalinity enhancements, sinking of kelp and geological storage. He finished by introducing a CDR project called “Solid Carbon”. A question was asked about plans by ONC to deploy a neutrino telescope (“P-ONE”). The project has many international partners, some tests have been performed and first set of moorings planned for 2024.

Leslie Smith (DOOS, USA) presented the **Deep Ocean Observing Strategy (DOOS)**, a GOOS project since 2014, recently funded as AccelNet project by NSF and that has been endorsed by the UN Ocean Decade. DOOS seeks to bring together groups working on the same challenges, particularly across different disciplines. DOOS focusses on key connection points (e.g. observes/modellers, science/policy, surface/deep, etc) with a strong focus on early-career researchers. She highlighted the potential synergies between DOOS across the 3 pillars of POGO. She introduced the [2022 Global Deep-Sea Capacity Assessment](#), a survey of 186 geographical areas spanning the globe to assess the capacity of these areas for deep-sea research and exploration. The Ocean Discovery League is a key partner of DOOS, working together to address the needs highlighted by the report: Mentoring of ECRs in developing countries, data training and low-cost sensor development.

6.2. *Societal Applications of Digital Twins (Co-Chairs Martin Visbeck & Gilles Lericolais)*

Martin Visbeck (participating remotely) introduced the session. He introduced briefly the concept of Digital Twins, as a virtual representation of the real ocean that have a 2-way connection with it (feedback between ocean observations and the twin). DTs are a great opportunity to answer the “what if?” questions. Although a relatively new concept for the ocean, DTs have been around for over 30 years in engineering. An “International Digital Twin of the Ocean Summit” was held in London last May, which was also the launch of the UN Decade programme DITTO. DITTO started around 1 year ago and has established several Working Groups. Organisations can become formal partners by applying through the DITTO website and signing an MoU.

Alain Arnaud (Mercator Ocean International) gave a presentation on **“Digital Twin Ocean, the European Perspective”**. He stressed that digital twins will build on, rather than reinventing, what we already have as a result of many years of observations and modelling. MOI is hosting the Ocean Prediction Ocean Decade Collaborative Centre. What we need is user-driven, powerful tools, fit for the digital age, connecting a wide range of data and models with cloud infrastructure, HPC, AI and services. The EDITO (EU-funded) project is creating an interoperability layer. A data lake will provide seamless access to EMODNet and CMEMS (and others), while a processing engine will provide computing capabilities for data processing (AI etc). The Core DTO is formed by all existing and collaborating projects and fosters the co-development of local or regional DTOs.

John Siddorn (NOC, UK, *remote*) gave a presentation on **“Applying Digital Twin techniques to the natural environment”**. He introduced that the added value to ocean observations comes from modelling, data sciences and integration with knowledge systems. He highlighted the importance of user interactivity and decision tool integration for the forecast improvement. He defined digital twins as “a tool to improve decisions” and the main differences with traditional modelling as (1) improved coupling between the real-world and the digital representation, and (2) an interface that enables interaction with the twin for decision making from many different domains or specialisms. There needs to be a cascade from local through regional to global scale. He gave an example of an environmental DT information management framework for Marine Protected Areas and the complexity involved in setting these up. He also mentioned DTs for capacity development and the potential for democratising data and tools. In this example, seabed imagery can be used to monitor and predict changes in biodiversity under different climate change scenarios as well as other pressures like fisheries, pollution etc to inform policy in a timely manner.

Fei Chai (Xiamen University, China) gave a presentation on **“Digital Twin Ocean and its applications for Xiamen Bay and Changjiang Estuary”**. He introduced the “Coastal SOS” project, which has been endorsed by the UN Decade. It is focussing on 4 coastal sites in China, 1 in Malaysia and 1 in Thailand, looking at pressures such as warming, OA, hypoxia and HABs. The project involved NGOs and industry partners for co-design together with the users. Xiamen Bay has a well-established observing system (remote sensing, microsattellites, air drones, sensors on navigation buoys and in aquaculture farms, etc) and modelling. Model applications include (1) forecasting trajectories of marine debris for collection by municipal workers, and (2) physical-biological forecasting for

eutrophication/HAB/hypoxia. DTO has a huge potential for marine CDR, using observations and models to test different CDR methods.

Anne Cohen (WHOI, USA, *remote*) presented **“A coral reef digital twin”**. The platform being developed is “Digital Reefs”, funded by NSF Convergence Accelerator Programme. The users are the estimated 1 billion people around the world who rely on coral reefs for their livelihoods. The project team started by talking to a variety of stakeholders, who all responded that they were unable to use the wealth of data that is out there. Applications include assessment of health of coral reef islands, location of MPAs in relation to larval dispersal, and restoration of an atoll to its pristine state. Users can save and share visualisations performed with different “what-if” scenarios. Another component is the development of visualisations as holograms for educational/entertainment purposes. The plan is to develop the first prototype and trial it over the next 2 years.

The discussion focussed on quality control for the data lake. For the EDITO platform, a sponsor institute will need to take responsibility for the submitted dataset. It is an important problem when several datasets are being federated, and although there is no solution currently for this, it is an area that is being worked on (perhaps AI can be used in future). There was also a question about sustainability and funding of digital twins. What is the business model? There is a variety of actors interested in DTs -some commercial, others altruistic and others scientific. Some companies will want to build DTs for their own purposes and will charge clients for their use. Government agencies using them for management purposes may use a combination of public and private funding. There will definitely be a combination of different business models for different DTs. The Digital Reefs project team is expecting that the cost will be borne by the countries using them, but in the case of developing countries this may be problematic. In China, the initial funding is provided by the government, but they are currently engaging with IT/gaming companies. There followed some discussion about POGO’s possible role in supporting DTs. Helping to make data and DTs available to developing countries through training/capacity development, making use of POGO’s extensive network, was the main role envisaged for POGO. Perhaps also support with interoperability/standards. Communicating uncertainty of models/forecasts was also highlighted as an important issue that POGO could help with.

6.3. Coastal Ocean Observations (Chair Francisco Arias)

Francisco Arias Isaza introduced the session by highlighting the importance of “small-scale”, coastal observation programmes and how the foster collaborations between countries at the regional scale.

Ana Carolina Ruiz-Fernández (National Autonomous University of Mexico) gave a presentation on **“The Research Network of Marine-Coastal Stressors in Latin America and the Caribbean (REMARCO)”**. REMARCO is the result of 15 years of cooperation between Latin American/Caribbean countries in the context of the International Atomic Energy Agency (IAEA) Technical Cooperation Projects. The network makes use of nuclear and isotopic techniques. REMARCO includes 18 countries and focusses on marine pollution, ocean acidification, HABs, microplastics and eutrophication. Training courses (in Spanish) have been developed with the Ocean Teacher Global Academy. Several countries are reporting data to SDG indicator 14.3.1 on ocean acidification as a result of the training courses provided within REMARCO. Common protocols for HAB monitoring have been agreed and published on-line, in Spanish and English. They are working to improve the capability of laboratories for reporting on indicator 14.1.1(a) on coastal eutrophication. Marine pollution monitoring has been

conducted since 2007. They are producing manual and e-learning courses and developing regional surveys with harmonised methods to ensure comparable results. Microplastics monitoring is being implemented, through kits for microplastic sampling and acquisition of equipment for microplastic analysis (e.g. FTIR) with IAEA funding.

Karen Ibarra (INVEMAR, Colombia) then presented a national cooperation perspective, focussing on the *“The Surveillance Network for Conservation and Protection of Marine and Coastal Waters of Colombia (REDCAM)”*. She introduced the Marine Environmental Quality Program at INVEMAR, and the range of coastal ecosystems in Colombia (seagrasses, mangroves, coral reefs). REDCAM is an inter-institutional network that coordinates the collection of marine/coastal water/sediment quality in Colombia. It has been going for 22 years, includes 350 stations in the Caribbean and Pacific, and has run 14 training courses. Laboratory analyses focus on physico-chemical parameters, pesticides, microbiology, heavy metals and hydrocarbons. A water quality index has been developed (ICAM) jointly with other countries in the region. A robust database is used, with data visualisation to deliver the data to the users. Ocean acidification monitoring is contributing to SDG 14.3.1 through the IOC data portal. Harmful Algal Blooms and microplastics are also monitored regularly at a number of stations.

Laurent Delauney (Ifremer, France) followed with an *“Update on European coastal observation network JERICO”*. The Joint European Research Infrastructure for Coastal Observatories (JERICO) has the vision to become by 2030 the European gateway to long-term scientific observations and related services for European coastal marine systems. It includes 19 European nations, with continental, atmospheric and open ocean Research Infrastructures (RI). Key scientific challenges are (1) assessing/predicting changes in marine systems, (2) assessing impact of extreme events on those changes, and (3) unravel the impacts of natural/anthropogenic drivers of climate change. JERICO includes over 500 platforms (HR radars, Ferrybox, gliders, profilers, etc) run by 40 partners. The long-term plan is to become an ERIC, integrated with the European Ocean Observing System (EOOS) and EuroGOOS. JERICO-RI is endorsing the full data life-cycle from production to delivery enabling high quality-controlled data. The JERICO-CORE (being developed) is the unified hub of JERICO-RI to discover, access, manage and interact with JERICO-RI resources (e.g. datasets, software, best practices, publications, equipment, training etc). AA-COASTNET (All Atlantic COASTal observing and technology NETwork) has been working to develop a network dedicated to marine coastal observations, including Brazil, Argentina, South Africa, West Africa, Cabo Verde and Europe).

Toste Tanhua made a comment about the need to/challenges of integrating coastal and open ocean observations. Laurent responded that most observing systems are driven by local/regional needs. JERICO tries to simplify the interface and communications, and we need these entities (also EOOS) to support the communications and integration/federation. Zacharie Souhou made a comment about the PROPAO network in Benin/Cote d’Ivoire and asked how JERICO could contribute to this network. Laurent responded that they could help with sharing best practices, and also that in some countries (e.g. Argentina) DIY systems are being developed very successfully. Zacharie added that they are developing low-cost systems using Arduino in Benin, but they are facing issues with battery power.

Willie Wilson asked about the challenge of data standardisation for eDNA and phytoplankton imaging. In JERICO they have published some methods for imaging and flow cytometry in the Ocean Best

Practices System. EOOS has established a biology working group to address this topic. Ana Carolina said that in REMARCO they started with the harmonisation of methods for collection and analysis. They ran intercalibration exercises and training, so the data are very comparable. Francisco Arias concluded that coastal observations are being made at a variety of different scales and need to be “on-line” for decision-makers (e.g. for HABs, pollution etc). The other issue is that citizen science and high-tech observations need to be complementary. Finally, he highlighted the importance of cooperation (i.e., “the new leadership”).

6.4. *POGO member involvement in the Ocean Biomolecular Observing Network (OBON) (Co-Chairs Margaret Leinen & Francisco Chavez)*

Margaret Leinen (Scripps Institution of Oceanography, USA) introduced the session and the OBON programme. She explained that OBON was a product of POGO, endorsed by the UN Decade of Ocean Science for Sustainable Development. It aims to establish a network for biological observations, specifically using biomolecular techniques. OBON’s goal for the Decade is to have a variety of techniques and platforms (moored, drifting...) measuring biomolecules in the ocean. Several years ago, POGO established a Biological Observations WG and received funding, through POGO, from the Lounsbery Foundation, to run a virtual international workshop on eDNA, which resulted in the OBON proposal. OBON’s objectives are to (1) build a coastal-to-open ocean multi-omics biodiversity observing system and develop autonomous sampling and analysis capability; (2) enhance marine “omics” data systems and enhance ecosystem models by adding biomolecular components, (3) partner with marine conservation and management specialists, policymakers, private sector to address sustainable development, and (4) develop and transfer capacity through training programmes combined with funded equipment supported by development/aid agencies and philanthropy. Margaret invited POGO members to let her know of people in their institutions working on biomolecular analyses. She introduced the OBON WGs (technology, data and capacity development) and the OBON Decade-endorsed projects. She highlighted the locations (mostly coastal) where OBON projects are sampling, which will form the backbone of the coastal biomolecular observing network. Members are also invited to inform OBON about research cruises where biomolecular analyses are being made. A workshop will take place this year focussing on technology development. OBON is also looking at sampling kits for citizen science, and at ways to enhance marine “omics” data systems for combining biomolecular data with physical and biogeochemical data. A User Advisory Group will be established in 2023, and a philanthropic organisation is committed to helping establish that group by first holding a workshop on eDNA for marine ecosystem management. OBON has participated in several calls for projects and filling gaps by targeting our calls for projects (e.g. polar, open ocean, data systems).

Francisco Chavez (Monterey Bay Aquarium Research Institute, USA) gave a presentation on the ***“Scientific and societal applications of eDNA and other biomolecular observations”***. He discussed the need for near real-time, globally-distributed, multi-disciplinary information to be able to tell if life in the sea is changing and why. This new set of requirements requires a new model, and eDNA is an emerging technology that can respond to these needs. He highlighted the need to collect and sequence specimens to increase our genome libraries. He presented vertical profiles of different organisms, from phytoplankton to fish, based on eDNA collected from single samples taken at various depths. We can also go back in time and analyses preserved samples and look at changes in

communities over time in relation to climate change (regime shift). MBARI is working with John Hopkins University to automate DNA sample preparation and sequencing in situ (through miniaturisation). His group set up a demo in Peru where samples were collected by local scientists and the group analysed the samples and presented the results by the end of the week. He highlighted the limitations of eDNA and reliance on sequence libraries for correct identification of species. A 2nd national (USA) workshop on marine eDNA was held in Sept 2022, on the incorporation of eDNA science into environmental management. The conclusions were that the science is beyond “does it work?”, and has been used in biodiversity surveys, detection of invasive species, management of threatened and endangered species, and stock assessments. Next steps include better engagement of the management community, standardisation of methods, and development of a national strategy. The infrastructure required for global eDNA collection is equivalent to a satellite mission (approx. 1 billion dollars), but it is a hard “sell”.

Willie Wilson (Marine Biological Association, UK) gave a presentation on ***“Understanding the technical challenges to develop eDNA science using autonomous vehicles – introducing WCO-BON”***. He introduced the Marine Research Plymouth association, and the “triple-helix” partnership between academia, industry and government in the Plymouth area, as well as a cluster for marine autonomy. Marine Science Plymouth works collaboratively on Smart Sound Plymouth – the UK’s platform for proving, validating and demonstrating advanced marine autonomy, technology and digitalisation, building on a century of observations in the English Channel. Smart Sound is a test bed for new technologies, including 4G/5G communications networks and marine autonomy. Plymouth also has long-term biological monitoring programme (Western Channel Observatory and Continuous Plankton Recorder Survey), with a 17-year molecular time-series of fungal diversity at L4 (WCO). The WCO Biodiversity Observation Network (WCO-BON) will support applications such as biodiversity forecasting, fisheries/aquaculture, pathogen detection, MPA management etc. An Ocean Biomolecular Observation Instrumentation Workshop is being organised to develop a series of documents and/or recommendations around the current technology state of the art, barriers and challenges to autonomous eDNA instrument development, instrumentation and autonomous platform integration standardisation, and identification of specific autonomous technology use cases for future implementation. The idea is that it will become a series of workshop, as this is an area that will be actively developed over the next decade.

Katie Pitz (Monterey Bay Aquarium Research Institute, USA) gave a presentation on ***“Better Biomolecular Ocean Practices (BeBOP)”***. She introduced that BeBOP was initiated to help those who are starting out in eDNA research and are not sure which protocols to use, as well as finding out which protocols have been used to create datasets that they want to use. Protocol templates have been created using “Markdown” (a machine readable format) for specific tasks within the work flow, which can be used and updated in a modular fashion (e.g. protocols for field sampling, DNA extraction, amplification, sequencing, bioinformatics, etc). The second component is the Minimum Information about an Omics Protocol (MIOP). This allows searching/filtering of protocols according to methodology category, study goals, environmental context, etc. A Github repository has been created for the Markdown files. Protocols can be downloaded as pdfs, which will allow them to be deposited with the Ocean Best Practices System. BeBOP wants to focus on protocols that are generally given less attention, such as permitting, data management and sample storage/curation. One of the next

priorities is to map omics protocols and data workflows of OBON projects, using these projects as test cases to improve protocol and data sharing methods.

Toste Tanhua asked a question about the quantitative aspects of eDNA. Francisco Chavez responded that currently most people consider eDNA as presence/absence data, but as shown in some of his graphs there is also potential for eDNA to provide quantitative data, and this will improve over time. Jesse Ausubel (on-line) added that traditional methods (e.g. nets) have many weaknesses, so the “gold standard” that eDNA is being compared to is not very high. Omics approaches offer many opportunities, and papers are being published every week with new results. He fully expects that eDNA results will be at least as good as traditional methods, if not better, within about 5 years. He also mentioned the issue of reducing the footprint of ocean observing, and that omics and acoustics may offer a good solution to the net zero issue for GOOS. He suggested that it may be a good topic for the next POGO Meeting.

Joseph Nkwoji commented that he was very excited about OBON, and had noticed that the African continent was missing from the map of OBON stations. He expressed that his University and country need OBON greatly for capacity building. Margaret responded that South Africa was involved, and capacity building was being conducted through the AtlantECO project, but she would be very interested in talking to Joseph and getting West African countries involved.

Nick Owens asked about the time frame for eDNA. Francisco Chavez responded that some experiments have been done on this, and the time it takes for DNA to decay in seawater depends on the temperature, but it is of the order 2-3 days. Jesse Ausubel added that, for quantitative studies, eDNA relates better to surface area rather than biomass. It is also easier to obtain quantitative data for more common species (but this is the case for all types of studies).

Ed Hill commented that the NOC was responsible for producing a [report on net zero oceanography](#), and that autonomous systems will be an important component of the strategy. They also considered the transition to net zero, and the issues around green fuels being much lower density, therefore introducing the issue of needing to trade berths for fuel space, and therefore the need for more automation on-board ships as well.

Fei Chai commented on the need to integrate physics and modelling to determine where organisms have come from that are detected by eDNA. He also mentioned gene expression, to which Willie Wilson responded that OBON is not just going to be about eDNA, but this is the starting point. The intention is that as methods are further developed for transcriptomics and for analyses of other biomolecules, these will also be included in OBON.

At the end of the session, Richard Sempéré made an intervention on the need to further develop biodiversity monitoring that is integrated with physical and chemical monitoring (which is currently done in some countries but not all). His second point was the need to focus on contaminants (also in relation to biodiversity), including demonstrating to policymakers the impacts of contaminants on marine organisms and on ecosystem functioning. This issue is currently not well covered by observing programmes. Nick Owens added that this could be a topic for the members to discuss during the AGM.

POGO Annual General Meeting

The Plenary Meeting was followed by the Annual General Meeting (AGM) of the POGO Charitable Incorporate Organisation. One new trustee was elected: Carmen Paniagua (CICESE, Mexico), as host of then next annual meeting; Francisco Arias Isaza (INVEMAR, Colombia) was re-elected for a second 2-year term. The POGO trustees and Secretariat would like to extend a warm welcome to the new trustees, and express their gratitude towards retiring trustee Gilles Lericolais (Ifremer, France) for his several years of service on the Board and significant contributions towards POGO's success.

During the AGM, POGO members discussed POGO business, finances, activities, new projects and partnerships. The members discussed POGO's priorities for the coming year, in particular plans to follow up on the four thematic sessions held during the Plenary. The minutes of the AGM have been written separately and circulated to the POGO members.