iAtlantic

INTEGRATED ASSESSMENT OF ATLANTIC MARINE ECOSYSTEMS IN SPACE AND TIME

iAtlantic: The Results
Full Programme

5th iAtlantic General Assembly,

9-13 October 2023

Edinburgh, UK

Welcome to the Final iAtlantic Meeting

Welcome to iAtlantic's final meeting. After over four years of hard work, we are back in Edinburgh, where the project was launched in June 2019. It is remarkable to see how far we have come, and we are very excited to come together and share our results. We are delighted to have stakeholders and guests as the part of our final meeting – sharing the knowledge and integrating scientific evidence into the policy and management discussions has always been at the core of our approach, and we are looking forward to the stakeholder response panel discussions as the part of this meeting.

Please do read our 'Conference companion', which summarises iAtlantic's research highlights and will help to set the presentations in a broader context.

As well as our final meeting do make the most of our 2-day writing retreat at the end of the week. This is a unique opportunity for us to come together and focus on developing the many new research papers coming from iAtlantic.

Have a great General Assembly!

J Murray Roberts, iAtlantic Coordinator

Edinburgh, 2 October 2023

Contents

Social Media Policy

The iAtlantic project embraces wider dissemination, collaboration, and partnership and has established several social media channels to facilitate this.

During our General Assembly meeting, many of our speakers will be presenting exciting novel research that is not yet published. While iAtlantic has an active social media presence, **we respect the speakers' right to request that their work not be shared across social media**. The sharing of data or figures without the speakers' consent on publicly accessible platforms may prevent its subsequent publication in scientific journals and compromise their scientific progress. In light of this, we request that all meeting participants adhere to this social media policy.

During the 2023 General Assembly we ask all presenters to make it clear during their talks if any data, research plans or other information need to be kept confidential. This should be explained verbally and by inserting a graphic similar to the example below on the relevant PowerPoint slides.

Recording or reproducing audio or video of any content presented at the meeting is not allowed. However, please note, that some segments of this event will be recorded by the organisers and images and videos produced from the event may be publicly available on the iAtlantic website and in other outreach and dissemination activities. All participants have been asked for consent and offered an opportunity to contact the Project Office to make special arrangements during the registration process.

Provided there are no restrictions on dissemination, **we encourage participants at the iAtlantic General Assembly to share information through their social media accounts** using the hashtags and handles listed below. It is the responsibility of the General Assembly participants to acquire appropriate permission to publish any photographs that feature other participants.

Finally, we are committed to providing an enjoyable, inclusive, and safe space for all participants, and it goes without saying that **we ask all participants to uphold the values of intellectual collegiality and accuracy, and to respect context at all times to avoid misrepresentation and appropriation**.

#iAtlanticGA2023

X (Twitter): @iAtlanticEU

Facebook: @iAtlanticEU & #iAtlanticEU

Instagram: #iAtlanticEU

Programme Overview

6-7 October 2023	• Edinburgh 'High Seas Treaty' Symposium (co-organised by iAtlantic)
9-10 October 2023	• iAtlantic plenary sessions (open meeting)
11 October 2023	• Internal project meeting
12-13 October 2023	• iAtlantic writing retreat

9 October 2023 (Monday)

Day 1 – iAtlantic Research Highlights

- Venue: Pollock Estate, South Hall

Time (BST/UTC+1)	
08:00–09:00	Registration & Coffee
09:00–09:30	Welcome Address
09:30–10:00	Priority 1—Atlantic oceanography and ecosystem connectivity
10:00–10:30	Priority 2— Mapping Atlantic ecosystems
10:30-10:45	Q&A
10:45–11:15	Coffee break
11:15–11:45	Priority 3—Drivers of ecosystem change and tipping points
11:45–12:15	Priority 4—Impact of multiple stressors
12:15-12:30	Q&A
12:30–13:30	Panel Discussion 1 – Science Response
13:30–14:30	Lunch
14:30–15:00	Priority 5—Spatial and temporal management and protection
15:30–16:00	Priority 6—Capacity building, policy, stakeholder engagement and outreach
16:00-16:15	Q&A
16:15–17:15	Panel Discussion 2 – Policy Response
17:15–17:30	Close of the day remarks
17:30–19:30	Poster session / Welcome drinks reception

10 October 2023 (Tuesday)

Day 2 – iAtlantic Research Symposium

- Venue: Pollock Estate, South Hall

Time (BST/UTC+1)	
08:30-08:45	Arrival & Welcome coffee
08:45–09:50	Objective 1- Standardise South and North Atlantic Ocean observations to enable short, medium and long–term assessments of Atlantic Ocean circulation and its physico–biogeochemical environment
09:50–10:55	Objective 2- Map deep and open–ocean ecosystems at basin, regional and local scales
10:55–11:25	Coffee break
11:25–12:30	Objective 3- Assess the stability, vulnerability, and any tipping points of deep and open–ocean Atlantic ecosystems to changes in ocean circulation, and effects of single and multiple stressors
12:30–13:35	Objective 4- Align and enhance human, technological and data inter–operability capacities for cost–effective cooperation and planning across the Atlantic
13:35–14:35	Lunch
14:35–15:40	Objective 5- Define requirements for sustainable management with industry, regulatory and governmental stakeholders to reflect societal needs and inform policy developments that ensure and encourage a sustainable Blue Economy
15:40-16:00	iAtlantic Expedition Portfolio
16:00-16:15	iAtlantic Innovation & Exploitation Summary
16:15–16:45	Coffee break
16:45–17:30	All–Atlantic Sister Projects Session
17:30–17:45	Closing Remarks
18:30–23:00	Gala Dinner & iAtlantic Hero 2023 award – National Museum of Scotland

11 October 2023 (Wednesday)

Day 3 – Closed iAtlantic Sessions

- Venue: Pollock Estate, South Hall / St Leonard's Hall

Time (BST/UTC+1)		
08:30-09:00	Welcome coffee	
09:00–10:00	Wrap up & synthesis of the stakeholder response sessions	
10:00–10:30	iAtlantic Advisory Board & Science Council feedback session	
10:30–11:00	iAtlantic Special Session	
11:00-11:30	Coffee-break	
11:30-13:00	NACES task force (St Leonard's Hall)	Writing retreat planning
13:00–14:00	Lunch	iAtlantic Steering Committee (St Leonard's Hall)
14:00–18:00	Edinburgh Field Trip- Royal Botanic Garden	

- 12 October 2023 (Thursday) – Writing retreat Day 1
  - Venue: Pollock Estate, St Leonard's Hall

Time (BST/UTC+1)	
09:00–10:30	Writing papers in break-out groups
10:30–11:00	Coffee-break
11:00–13:00	Writing papers in break-out groups
13:00–14:00	Lunch
11:30–13:00	Writing papers in break-out groups
15:00–16:00	Coffee-break
16:00–18:00	Writing papers in break-out groups

- 13 October 2023 (Friday) – Writing retreat Day 2
  - Venue: Pollock Estate, St Leonard's Hall

Time (BST/UTC+1)	
09:00–10:30	Writing papers in break-out groups
10:30–11:00	Coffee-break
11:00–13:00	Writing papers in break-out groups
13:00–14:00	Lunch
14:00–15:00	Writing papers in break-out groups
15:00–16:00	Coffee-break
16:00–17:00	Writing papers in break-out groups

Zoom Details for Remote Participants

The first two days of iAtlantic General Assembly are open for remote participation to any **registered guests**!

To join the meeting – click on the link below (the link remains the same on Monday and Tuesday):
iAtlantic is inviting you to a scheduled Zoom meeting.

Topic: iAtlantic General Assembly

Join Zoom Meeting
https://us06web.zoom.us/j/83844520665?pwd=6d1qs8B3aOwHwmiZ2IknaFjfvmSoP1.1

Meeting ID: 838 4452 0665
Passcode: 460622

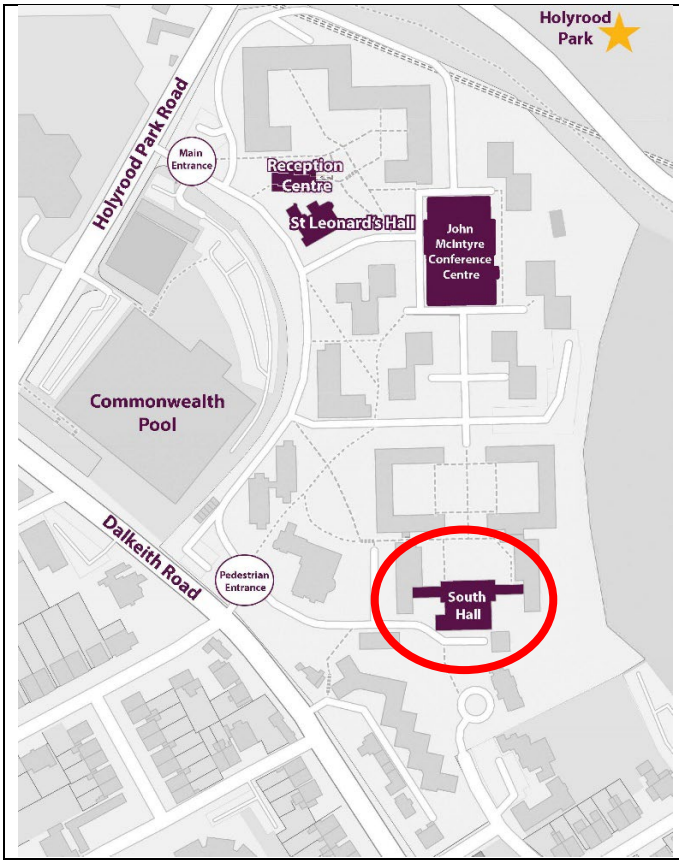
USE THIS QR CODE TO ACCESS THE ONLINE PROGRAMME, CONFERENCE COMPANION AND FEEDBACK FORM – WE WOULD LOVE TO HEAR FROM YOU!

HYPERLINK

Venue Details, Field Trip

South Hall

The main meeting venue is South Hall at the Pollock Halls Estate of the University of Edinburgh



Address:

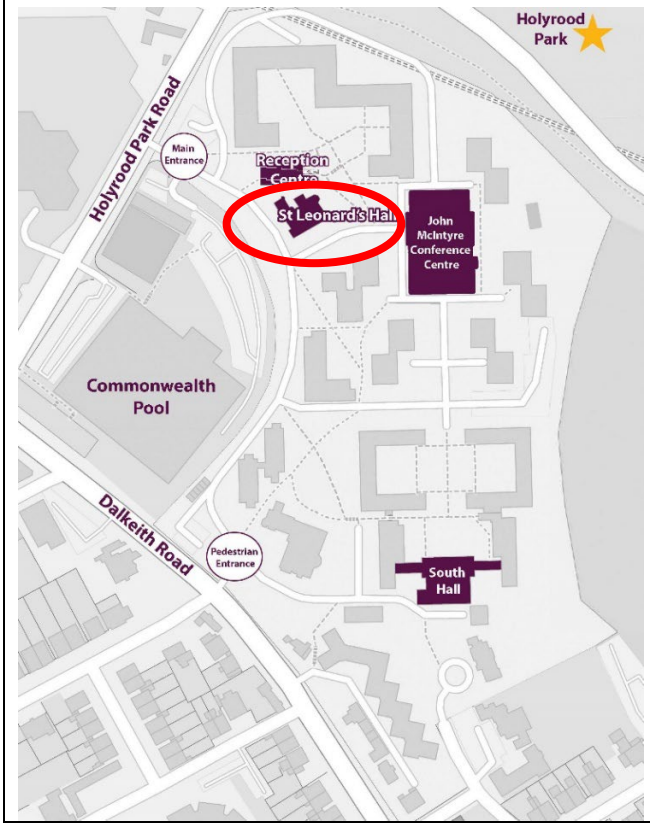
South Hall
Pollock Halls Estate
18 Holyrood Park Road
Edinburgh, UK, EH16 5AY

Website:

https://www.uoecollection.com/conferences-events/venue-hubs/pollock-estate/south-hall/

St Leonard's Hall

iAtlantic writing retreat will be in the beautiful 19-century built St Leonard's Hall, also located in the Pollock Halls Estate.



Address:

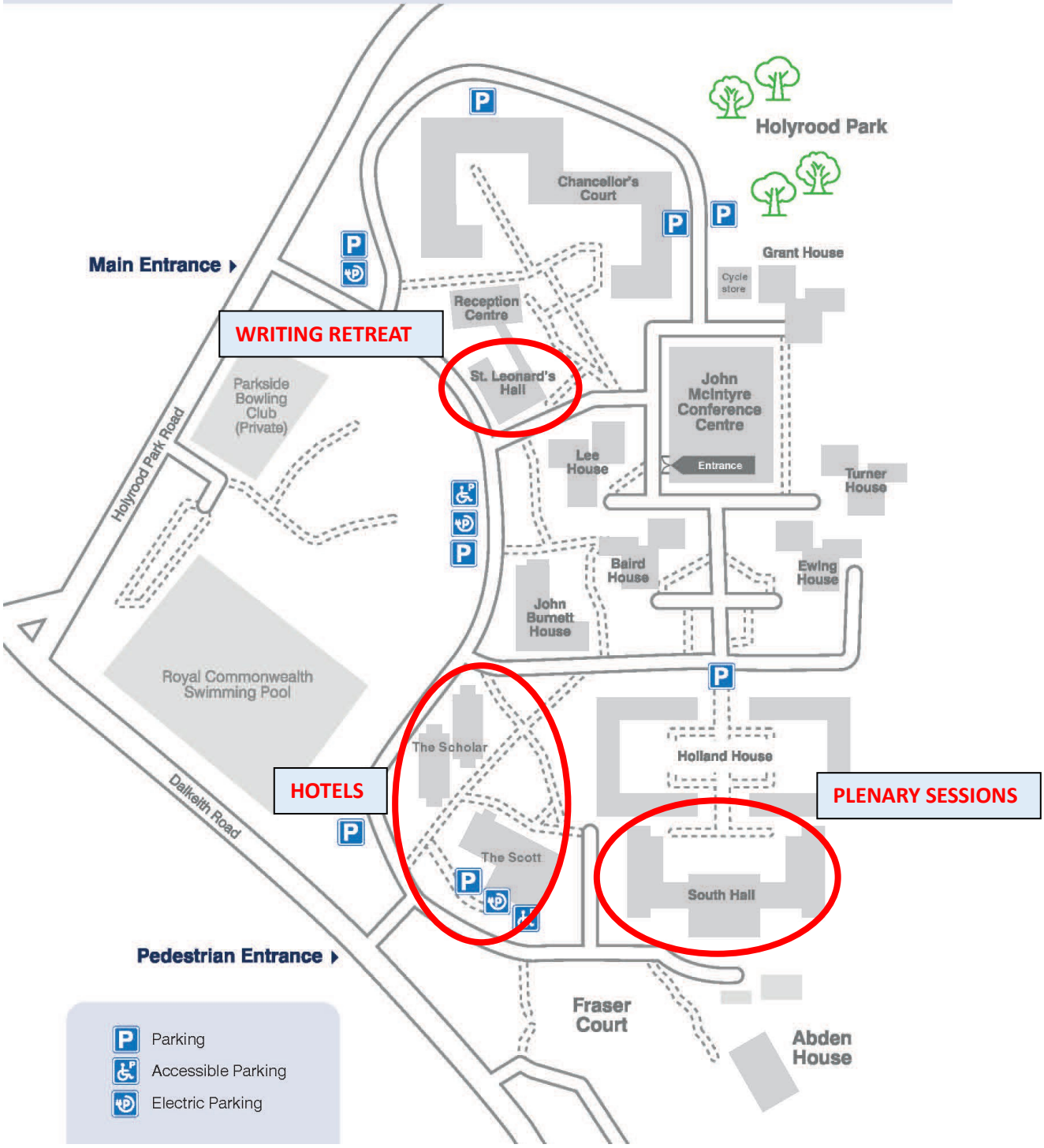
St Leonard's Hall
Pollock Halls Estate
18 Holyrood Park Road
Edinburgh, UK, EH16 5AY

Website:

https://www.uoecollection.com/conferences-events/venue-hubs/pollock-estate/st-leonards-hall/

Pollock Estate Map

THE UNIVERSITY of EDINBURGH
Hospitality & Events Collection



WiFi

Eduroam WiFi network is available everywhere at the Pollock Halls Estate. For non-eduroam guest WiFi access, individual login details will be available at the registration desk.

Royal Botanic Garden Edinburgh Walking Tour

Join us for a seasonal walk through the world renowned Royal Botanic Garden Edinburgh, a global centre for biodiversity science, horticulture and education. You will experience one of the richest botanical collections in the world, while being guided in small groups. The 90 minutes guided tour will cover the history of the garden, the seasonal plant highlights and an insight into the Royal Botanic Garden Edinburgh's science and conservation work. This special autumnal experience will give you the opportunity to escape the busy city into a nature retreat.

- The coach will be departing from the Pollock Estate on Wednesday 11 October after lunch.

Plenary Sessions – Detailed Programme

9 October 2023 (Monday)

Day 1 – iAtlantic Research Highlights

Time (BST / UTC+1)		Speakers
08:00–09:00	Registration & Coffee	
09:00–09:30	Welcome Address	
09:30–10:00	Priority 1—Atlantic oceanography and ecosystem connectivity	*Arne Biastoch and Didier Jollivet*
10:00–10:30	Priority 2— Mapping Atlantic ecosystems	*Colin Devey and Tabitha Pearman*
10:30-10:45	Q&A	
10:45–11:15	Coffee break	
11:15–11:45	Priority 3—Drivers of ecosystem change and tipping points	*Lea-Anne Henry and Marjorlaine Matabos*
11:45–12:15	Priority 4—Impact of multiple stressors	*Marina Carreiro-Silva and Andrew Sweetman*
12:15-12:30	Q&A	
12:30–13:30	Panel Discussion 1 – Science Response	Chair: *Murray Roberts* Panellists: 1. *Erica Head (DFO)* 2. *David Thornalley (UCL)* 3. *David Vousden (Chair GESAMP, Rhodes University)* 4. *Leo Chiloane (Curation Lead at SAEON)* 5. *Phil Williamson (University of East Anglia)*
13:30–14:30	Lunch	
14:30–15:00	Priority 5—Spatial and temporal management and protection	*Telmo Morato and Tim Collart*
15:30–16:00	Priority 6—Capacity building, policy, stakeholder engagement and outreach	*Vikki Gunn and Ben Boteler*
16:00-16:15	Q&A	
16:15–17:15	Panel Discussion 2 – Policy Response	Chair: *Matt Gianni* Panellists: 1. *John Mouat (Scottish Government)* 2. *David Freestone (Executive Secretary, Sargasso Sea Commission)* 3. *Kristina Gjerde (Senior High Seas Advisor, IUCN)* 4. *Jake Rice (DFO Chief Scientist – Ret.)*
17:15–17:30	Close of the day remarks	
17:30–19:30	Poster session / Welcome drinks reception	

10 October 2023 (Tuesday)

Day 2 – iAtlantic Research Symposium

Time:	
08:30-08:45	Arrival & Welcome coffee
08:45–09:50	Objective 1
09:50–10:55	Objective 2
10:55–11:25	Coffee break
11:25–12:30	Objective 3
12:30–13:35	Objective 4
13:35–14:35	Lunch
14:35–15:40	Objective 5
15:40-16:00	iAtlantic Expedition Portfolio
16:00-16:15	iAtlantic Innovation & Exploitation Summary
16:15–16:45	Coffee break
16:45–17:30	All–Atlantic Sister Projects Session
17:30–17:45	Closing Remarks
18:30–21:00	Gala Dinner & iAtlantic Hero 2023 award – National Museum of Scotland

Time:	
08:45–09:50	**Objective 1** Standardise South and North Atlantic Ocean observations to enable short, medium and long–term assessments of Atlantic Ocean circulation and its physico–biogeochemical environment

Session Chairs: Arne Biastoch and Kristin Burmeister

UK Time	Presenter	Title
08:45–08:50	Session opening by the Chairs	
08:50–09:05	Ángela Mosquera Giménez	iMirabilis2: oceanographic sketch of Cabo Verde
09:05–09:20	Christian Mohn	The role of hydrodynamics for shaping cold-water coral distribution in slope waters off Angola, Southeast Atlantic
09:20–09:35	Cyprien Lemaréchal	Properties of vertical plumes emanating from oceanic hydrothermal springs using LES
09:35-09:50	María Paz Chidichimo	Energetic overturning flows, dynamic interocean exchanges, and ocean warming observed in the South Atlantic

09:50–10:55	**Objective 2** Map deep and open–ocean ecosystems at basin, regional and local scales

Session Chairs: Colin Devey and Beatriz Vinha

UK Time	Presenter	Title
09:50–09:55	Session opening by the Chairs	
09:55–10:10	Rodrigo Sant'Ana	Effects of climate change on the spatial dominance of three deep-sea shrimp species observed on the Brazilian Meridional Margin (BMM)
10:10–10:25	Beatriz Vinha	Who are they, where do they live, and what do they eat? Discovering the cold-water coral communities of Cabo Verde on board the iMirabilis2 expedition
10:25–10:40	Adrien Tran Lu Y	Population genomics of two Cold-Water-Coral species, *Desmophyllum pertusum (Lophelia pertusa)* and *Madrepora oculata* in the Northeast Atlantic and Mediterranean Sea
10:40-10:55	Elodie Portanier	Genetic connectivity and demographic history of iconic hydrothermal vent species along the Mid-Atlantic Ridge: insights using next-generation sequencing and conservation implications

10:55–11:25	Coffee break
11:25–12:30	**Objective 3** Assess the stability, vulnerability, and any tipping points of deep and open–ocean Atlantic ecosystems to changes in ocean circulation, and effects of single and multiple stressors

Session Chairs: Lea-Anne Henry, Marina Carreiro-Silva & Danielle De Jonge

UK Time	Presenter	Title
11:25–11:30	Session opening by the Chairs	
11:30–11:45	Vanessa I. Stenvers	Experimental Mining Plumes and Ocean Warming Trigger Stress in a Deep Pelagic Jellyfish.
11:45–12:00	Cristina Gutiérrez-Zárate	Single and Multiple Impacts of Warming, Acidification and Deoxygenation on the Cold-Water Coral *Dendrophyllia cornigera*
12:00–12:15	Johanne Vad	Inter-Decadal Trends in Assemblage Composition on the Scotian Slope
12:15-12:30	Irene Perez	Palaeoceanographic variability recorded in a sediment core of Flemish Pass: comparing industrial era versus the last three millennia environmental changes

12:30–13:35	Objective 4 Align and enhance human, technological and data inter–operability capacities for cost–effective cooperation and planning across the Atlantic

Session Chairs: Malik Naumann and Leo Chiloane

UK Time	Presenter	Title
12:30–12:35	Session opening by the Chairs	
12:35–12:50	Malik Naumann	iAtlantic Data Management Summary
12:50–13:05	Vikki Gunn	Building capacity, sharing knowledge, supporting development
13:05–13:20	Leo Chiloane	Integration of the SAEON Data Infrastructure with the GEOSS Portal: Current Operational Framework and Lessons Learned from Stakeholder Engagement
13:20-13:35	Tim Collart	iAtlantic GeoNode – a portfolio of iAtlantic geospatial data

13:35–14:35	Lunch
14:35–15:40	Objective 5 Define requirements for sustainable management with industry, regulatory and governmental stakeholders to reflect societal needs and inform policy developments that ensure and encourage a sustainable Blue Economy

Session Chairs: Telmo Morato, Ben Boteler & Alvise Dabalà

UK Time	Presenter	Title
14:35–14:40	Session opening by the Chairs	
14:40–14:50	David Johnson	The changing tide of global ocean policy and management- and what it means for the Atlantic region
14:50–15:00	Catherine Hay	Assessing the Need for New Area-Based Management Tools for Cetacean Conservation in Bermuda: Evidence to Support the Designation of a Particularly Sensitive Sea Area
15:00–15:10	Jose Angel A. Perez	Historical Fishing Regimes and Geomorphology Reveal Potential Deep Sea Productivity Hotspots in the Brazilian Meridional Margin

15:10-15:20	Daniel Tha	The socio-economic effects of fauna tropicalization in the SW Atlantic: reshuffling economic and nutritional benefits
15:20-15:25	Christine Gaebel	Institutionalising marine science under a new agreement for marine biodiversity of areas beyond national jurisdiction (BBNJ)
15:25-15:40	Panel discussion	

15:40-16:00	**iAtlantic Expedition Portfolio** *Covadonga Orejas*
16:00-16:15	**iAtlantic Innovation & Exploitation Summary** *Andrew Carey*

iAtlantic has invested major efforts into advancing technologies that will make ecosystem mapping and assessment faster, cheaper, more accessible and more efficient. Our Innovation & Exploitation Manager, Andrew Carey (who took over from Theoni Massara in February 2023), will update the consortium on the progress of these technologies over the past year. He will also outline the project's approach to exploiting these outputs, ensuring there is a lasting legacy for iAtlantic as the project comes to a close. This talk will complement an exhibition stand at the venue throughout the General Assembly so that attendees can see at first hand the potential impact of each of these innovative technologies.

16:15–16:45	Coffee break
16:45–17:30	All–Atlantic Sister Projects Session

UK Time	Presenter	Title
16:45–16:50	Session opening by the Chair	
16:50–17:00	Cliff Jones, Rhodes University	AquaVitae – unlocking sustainable low trophic aquaculture into the future
17:00–17:10	Lennert Schepers, Flanders Marine Institute (VLIZ)	Mission Atlantic- data sharing and management to support Atlantic Integrated Ecosystem Assessments
17:10–17:20	Bruna Guterres (Federal University of Rio Grande)	ASTRAL - All Atlantic ocean sustainable, profitable and resilient aquaculture
17:20-17:30	Panel discussion	

17:30–17:45	Closing Remarks
18:30–23:00	Gala Dinner & iAtlantic Hero 2023 award – National Museum of Scotland

List of Posters

Author	Title
Daniela Yepes Gaurisas	Impact of increased temperature and altered POC quality on Cabo Verde bathyal soft-sediment ecosystems
Johanne Vad	Temporal Shifts in Plankton Community Composition and Phenology from the Bermuda Atlantic Time-Series (BATS)
Carolin Uhlir	Adding pieces to the puzzle: insights into diversity and distribution patterns of Cumacea (Crustacea: Peracarida) from the deep North Atlantic to the Arctic Ocean
Eirini Papachristopoulou	Investigating the impact of the 8.2 kyr event on North Atlantic deep-sea ecosystems
Isabelle Ansorge	South Africa's Floating University SEAmester- An example of a successful ship-based education programme
Isabelle Ansorge	Mooring observations of the Agulhas Leakage- SAMOC-SA's contribution to iAtlantic
Angel Perez	Exploring Benthic Habitats on the Sedimentary Slopes of Santos Basin, SW Atlantic
Angel Perez and Lukas Gavazzoni	HSM predictions reveal the potential role of submarine canyons as reservoirs of deep-sea shrimp *Aristaeopsis edwardsiana* (Johnson, J. Y., 1868) stocks, in the Brazilian Meridional Margin
gel Perez and Natali I. P. Piccolo	Is the SW Atlantic Hotspot the Catalyst for a EBM Climate Framework-Treaty? A warm approach for regional cooperation
Sonia Romero-Romero	Assessing the Trophic Plasticity of the Cold Water Coral *Desmophyllum pertusum* (*Lophelia pertusa*)
David Thornalley	Response of deep-sea benthic foraminifera in the subtropical NW Atlantic to past abrupt climate change events
Björn Fiedler	FUTURO- An All-Season Multiscale Research Campaign on the Future Evolution of the Coastal Upwelling System off West Africa
Björn Fiedler	Enhancing Capacity for Sustainable Management of Near-Coastal Marine Resources in Cabo Verde
Alvise Dabalà	Area-based management for a changing Atlantic Ocean: systematic conservation planning, international cooperation, and climate change
Loic Van Audenhaege	Spatial distribution of hydrothermal and non-vent assemblages at the Lucky Strike hydrothermal vent field
Kristina Beck	Physiological response and skeletal dissolution of the cold-water coral *Desmophyllum pertusum* (*Lophelia pertusa*) to multiple environmental stressors
Felix Butschek	Do Cold-Water Coral Mounds Act as Breakwaters for Internal Waves?
Anaïs Sire de Vilar	Effects of various abiotic stressors on the early life stages of the cold-water coral (CWC) *Desmophyllum pertusum* (*Lophelia pertusa*)
Elham Kamyab	Comparison of eDNA and Whole Community Metabarcoding Methodologies for Analysing the Distribution and Diversity of Deep Sea Meiofauna: A Case Study in the North-West Atlantic Ocean
Irene Perez Rodrigues	Changes in the development of the Guinea Dome off Cabo Verde during the Holocene
Jenny Neuhaus	The ecological enigma of *Ledella ultima* (E. A. Smith, 1885): An in-depth assessment of genetic diversity and population structure in an abyssal protobranch

Kristin Burmeister	Tropical Atlantic current variability in model simulations and observations
Ana Colaço	Cumulative impact of low oxygen and SMS particles on the vent fauna
Danielle S.W. de Jonge	Insights into Abyssal Benthic Ecosystem Functioning Under Reduced POC Flux Through *In Situ* Incubations and Linear Inverse Modelling

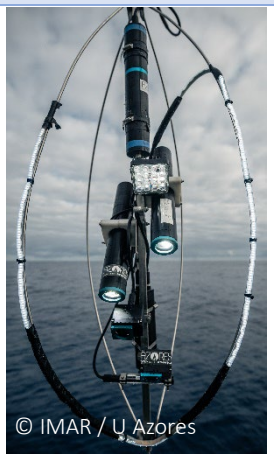
I&E Exhibition Stand

At this year's iAtlantic General Assembly, we are delighted to showcase an exhibition stand dedicated to the project's innovative technological outputs. Here, you will find out more about the equipment at first-hand from those who have been directly involved in their development, including not just how they work, but how they are already making a difference in the marine research landscape. The following technologies will be on display:


© IEO-CSIC

We are pleased to have at this year's General Assembly the 3D reconstruction system developed by the team at the Spanish Institute of Oceanography and shipped from the Aquarium Finisterrae in Galicia, Spain especially for this event. This is a low-cost tool that can very efficiently capture high quality photos on several angles over 360 degrees around a coral under aquaria conditions. It can be used to monitor tissue regeneration or retraction as well as changes in the structure of the tissue or the proportion of exposed skeleton.

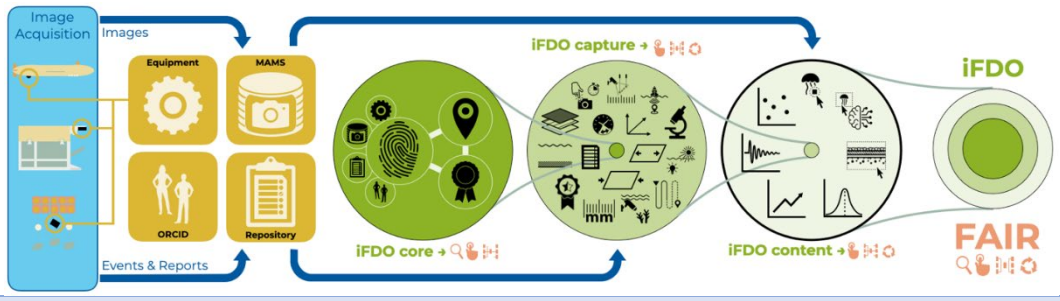
We will also have on display a version of the 'Azor drift-cam', which is a low-cost user-friendly underwater video system to rapidly survey deep-sea bent hic habitats to 1km depth – it has been fully demonstrated and successfully tested during several cruises. There are currently attempts underway to recreate this in both Brazil and South Africa following training workshops delivered in summer 2023.


© IMAR / U Azores

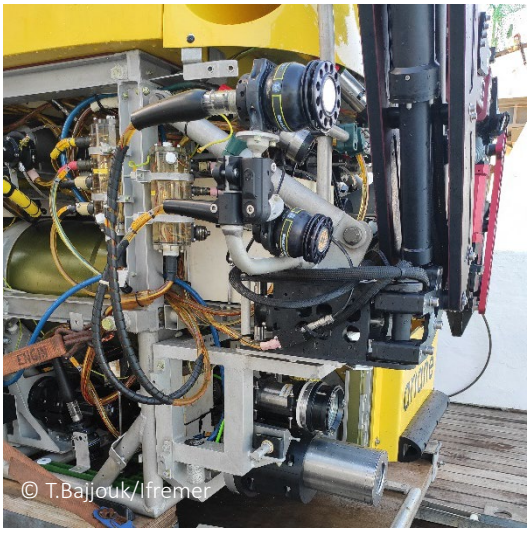

© iMirabilis2/NOC

The UK National Oceanography Centre has developed the Robotic Cartridge Sampling Instrument (RoCSI) environmental DNA (eDNA) sampler. This can characterise biological communities with high sensitivity and species-level accuracy without disturbing organisms in the environment and will help us to understand the natural state of marine ecosystems that are often challenging to sample. The team will show videos from their recent expeditions and provide updates since the technology was acquired by McLane Research Laboratories.

The latest work on Findable, Accessible, Interoperable, and Reusable (FAIR) image Digital Objects (iFDOs) to process seafloor imagery will also be presented. These have been designed to be applied to all types of marine image data (in-situ or ex-situ, video or stills, single images or datasets of thousands of photographs), and will enable users to address all necessary requirements of data FAIRness in a structured and coherent way.

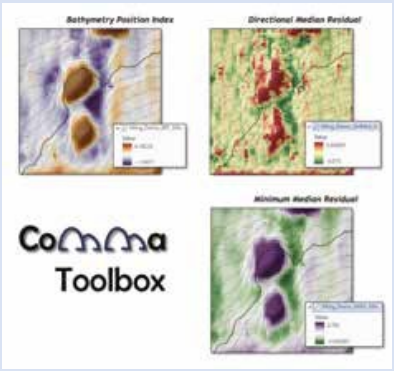


The IFREMER team has been working on the use of 3D high-resolution imaging techniques to investigate scale patterns of faunal dynamics at deep-sea vents will be sharing their experience. They have studied the temporal evolution of vent communities on the central Mid-Atlantic Ridge at the Lucky Strike hydrothermal vent field through repeated 3D mapping of the 11-m high “Eiffel Tower” edifice. We are pleased to have the IFREMER headsets with us at the General Assembly to enable attendees to see for themselves the great work they have done on this.



While hyperspectral cameras are a proven technology, their implementation in deep-water marine robotics is new, opening up new perspectives for ecosystem mapping and assessment. We have seen the first tests of hyperspectral imaging in the deep sea, aimed at the identification of benthic habitats and assessment of habitat ecological status, and initial results have shown different hyperspectral signatures for different cold-water coral species, and for live and dead coral framework. The team at IFREMER will show recent video footage of their work on this.

Finally, the Confined Morphologies Mapping ArcPro (CoMMa) toolbox to semi-automatically map and characterise cold-water coral mounds will be highlighting its results. We will be joined by Joana Gafeira from the British Geological Survey who led the development of this with an iAtlantic research team base d at the University of Edinburgh. The team will be showing what they are currently doing to maximise the potential of this equipment.



Objective 1. Standardise South and North Atlantic Ocean observations to enable short, medium and long-term assessments of Atlantic Ocean circulation and its physico-biogeochemical environment

1. iMirabilis2: oceanographic sketch of Cabo Verde

Ángela Mosquera Giménez[1], Pedro Vélez-Belchí[1], Iván Mouzo Bellino[2], Pablo Rodríguez Fornes[2], Veerle Ann Ida Huvenne[3] and Covadonga Orejas[4]

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In order to study the area of Cabo Verde, the multidisciplinary iMirabilis2 expedition took place form the 31st of July to the 30th of August 2021. Thanks to this expedition it was possible to establish the huge importance of this area as place of study and conservation, specially Cadamosto seamount, so pristine and rich in biodiversity. Cabo Verde Islands are located between the North Equatorial Current (NEC) and the North Equatorial Counter Current (NECC). When the NECC reaches Africa, it splits in two currents, an eastward and a northward flow. This later flow joints the NEC forming a front known as the Cabo Verde Frontal Zone, that acts as a barrier between the North Atlantic Central Waters (NACW) and the South Atlantic Central Waters (SACW). In addition, this northward flow produces a cyclonic circulation in the region of Cabo Verde, called the Guinea Dome, and therefore an upwelling in this area. During the iMirabilis2 expedition 22 CTD cast and several ADCP transect were carried out in order to characterize the hydrographic conditions and to determine the water mass distribution in the area of Cabo Verde. These hydrographical data showed the particular circulation of this area, composed mainly by cyclonic and anticyclonic gyres. The incorporation of data from drifters and remote sensors allowed to increment both the spatial and temporal range of the study improving our understanding of the changes that occur in the Cabo Verde region along the different seasons.

2. The role of hydrodynamics for shaping cold-water coral distribution in slope waters of Angola, Southeast Atlantic

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We investigate hydrodynamic framework conditions for cold-water coral distribution and food supply along the Angolan margin in the Southeast Atlantic combining basin-scale and high-resolution nested hydrodynamic models. The coral mounds of the Angolan margin have recently been described as an area of high population density of the cold-water corals *Lophelia pertusa* and *Madrepora oculata*. Although exposed to hypoxic conditions and high temperatures, especially *M. oculata* forms unexpectedly large colonies. Recent findings suggest that a combination of adaptation strategies, sufficient food supply and coral physiology contribute to coral growth. We use dynamic downscaling of high-resolution implementations of the ROMS-AGRIF model across two levels of nested grids from 300 m to 100 m spatial resolution applied at the Angola margin (iAtlantic study area 8) following the approach adopted in iAtlantic Work Package 1 (task 1.3) along the Walvis Ridge (study area 9) to address iAtlantic Objective 1 (short-, medium- and long-term assessments of Atlantic Ocean circulation and its physico-biogeochemical environment). The models use existing high-resolution local bathymetry, basin-scale lateral forcing from the INALT20 model and tidal forcing, as well as in-situ measurements of water mass properties and currents for model validation. Our model simulations for the Angola margin provide a detailed three-dimensional picture of the fine-scale physical processes and properties, which potentially drive a continuous food supply to the coral communities and enable us to develop new functional proxies for implementation in habitat suitability models thereby contributing to iAtlantic Objective 2 (mapping deep and open-ocean ecosystems at basin, regional and local scales).

3. Properties of vertical plumes emanating from oceanic hydrothermal springs using LES

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Buoyant plumes rising from hydrothermal sources play an important role for the mixing and transport of biological and chemical tracers in the deep ocean, at multiple scales ranging from the vent exit to the neutral buoyancy level. In this study, we perform Large Eddy Simulation (LES) using the Basilisk code and its adaptive grid technique to investigate the different existing conditions of hydrothermal plumes at very high-resolution, reaching the centimetre scale. To capture the extreme and highly unstable behaviour of the 300°C seawater injection, we reconstruct a non-linear equation of state, based on measurements, which helps to provide an estimate of the heat flux and reduce uncertainties. We show that these non-linearities are crucial for representing the plume dynamics. They help to induce a braking effect on the plume, as well as a higher level of turbulence, enhancing the vertical mixing. Furthermore, we show that the fully turbulent state observed at the vent exit is primarily driven by the energy produced by the subsurface circulation, and the corresponding turbulent kinetic energy injected at the seafloor is determined. Moreover, key plume parameters are retrieved from in-situ observations, including the buoyancy flux, by comparing the plume width and its transition zone from forced plume to fully buoyant plume with the results obtained from the LES. Overall, our study provides a comprehensive understanding of hydrothermal plumes and their behaviours.

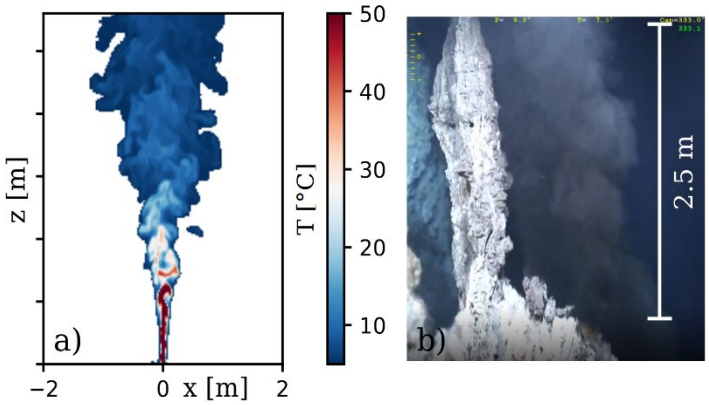

Figure: (a) Fully turbulent plume in LES. (b) On-site video capture.

4. Energetic overturning flows, dynamic interocean exchanges, and ocean warming observed in the South Atlantic

María Paz Chidichimo[1*], Renellys C. Perez[2], Sabrina Speich[3], Marion Kersalé[4]; Janet Sprintall[5], Shenfu Dong[2], Tarron Lamont[6], Olga T. Sato[7], Teresa K. Chereskin[5], Rebecca Hummels[8]; Claudia Schmid[2] (with contributions from the SAMOC/SAMBA-west team)

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Since the inception of the international South Atlantic Meridional Overturning Circulation (SAMOC) initiative in the 21st century, substantial advances have been made in observing and understanding the Southern Hemisphere component of the Atlantic Meridional Overturning Circulation (AMOC). Here we synthesize insights gained into overturning flows, interocean exchanges, and water mass distributions and pathways in the South Atlantic. The overturning circulation in the South Atlantic uniquely carries heat equatorward and exports freshwater poleward and consists of two strong overturning cells. Density and pressure gradients, winds, eddies, boundary currents, and interocean exchanges create an energetic circulation in the subtropical and tropical South Atlantic Ocean. The relative importance of these drivers varies with the observed latitude and time scale. AMOC, interocean exchanges, and climate changes drive ocean warming at all depths, upper ocean salinification, and freshening in the deep and abyssal ocean in the South Atlantic. Long-term sustained observations are critical to detect and understand these changes and their impacts. During this presentation I will also discuss recent expansions in the SAMOC observing system, notably the new mooring array enhancements funded by iAtlantic in the western portion of the South Atlantic MOC Basin-wide Array (SAMBA) in the southwest South Atlantic at 34.5°S (SAMBA-west).

Objective 2. Map deep and open-ocean ecosystems at basin, regional and local scales

1. Effects of climate change on the spatial dominance of three deep-sea shrimp species observed on the Brazilian Meridional Margin (BMM)

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Anthropogenic actions have contributed substantially to the warming of the oceans, especially in areas shallower than 700 m depths. The Southwest Atlantic Ocean is one of the world's most important hotspot of ocean warming, as promoted by changes in circulation patterns in the region, including the increase in the Agulhas leakage, the transport increase and southward migration of the bifurcation of the South Equatorial Current, the southward expansion of the Brazil Current and displacement of the Brazil-Malvinas Confluence. Such changes may have affected species latitudinal and bathymetric distribution, leading to alterations in the present and future structure of communities. Habitat suitability models were implemented to assess current spatial patterns of three deep-sea shrimp species (*Aristeopsis edwardsiana*, *Aristaemorpha foliacea* and *Aristeus antillensis*) and understand which characteristics influence the most on their distribution in the BMM. Additionally, predictions, based on greenhouse gas emissions scenarios in the next 80 years, were also implemented to understand the possible changes on slope habitats and their main effects on the species spatial patterns. Changes in the occurrence of the three species were observed when spatial distributions were projected for 2100. The distribution of *Aristeopsis edwardsiana*, the dominant species in the area, shifted to more southern portions of this area, while the smaller species, which in the current conditions were more frequent in the northern portions of the area, began to occupy areas previously dominated by the former species. The effects of climate change condition not only the displacement towards high latitudes, but also in competition patterns among them.

2. Who are they, where do they live, and what do they eat? Discovering the cold-water coral communities of Cabo Verde on board the iMirabilis2 Expedition

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The iAtlantic multidisciplinary expedition iMirabilis2 took place in July and August 2021 on board the Spanish R/V *Sarmiento de Gamboa* (UTM-CSIC). For the first time, bathyal and abyssal deep-sea benthic ecosystems at the SW of Cabo Verde (NW Africa) were explored. In the expedition, Cadamosto seamount (SW of Brava Island) and the slopes of Fogo and Brava islands were surveyed, from 2100 to 1450 m depth, with the Remotely Operated Vehicle (ROV) Luso (EMEPC) to collect video data and samples for the characterization of the hard-bottom benthic communities of the study area. In this study, we investigated the spatial patterns and functional ecology of the deep-sea benthic communities of Cabo Verde. For this, we (1) applied multivariate statistical community analyses to identify the different benthic assemblages of the explored area and their environmental setting; (2) used stable carbon and nitrogen isotopes ($\delta^{13}C$ and $\delta^{15}N$) and lipid analyses to examine the trophic structure of the benthic habitat and the main food sources available to benthic communities, and (3) applied an ensemble species distribution modelling approach to predict the presence of the most conspicuous cold-water coral (CWC) taxa in five unexplored seamounts of Cabo Verde. Our results revealed a well-preserved habitat, without any sign of anthropogenic activities, composed of diverse benthic communities with Vulnerable Marine Ecosystems (VME) indicator species, thriving in a volcanic geological environment. Substrate type and terrain features drive the distribution of different assemblages, and the benthic trophic web is fueled by organic matter originated from surface phytoplanktonic activity. Model outputs predicted the presence of VME taxa in other seamounts of Cabo Verde, with Nola and Senghor as the areas with the highest predicted suitability. Our work delivers fundamental information to drive future expeditions in this largely unexplored Atlantic region and to inform stakeholders for future conservation plans.

3. Population genomics of two cold-water-coral species, *Desmophyllum pertusum (Lophelia pertusa)* and *Madrepora oculata* in the Northeast Atlantic and Mediterranean Sea

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Ecosystems and organisms, including deep-sea species, are threatened by ongoing anthropogenic activities and climate change. Deep-water coral reefs built by cold-water stony corals are important ecosystems that provide habitat for many species and are widely distributed. Despite their significance, they remain understudied compared to their shallow tropical counterparts due to their remote location. In the Atlantic Ocean, these reefs are mainly composed of *Desmophyllum pertusum (*formerly *Lophelia pertusa)*, *Madrepora oculata*, and *Solenosmilia variabilis,* forming dense mixed formations that support many species, including commercial ones. However, understanding population connectivity of these species remains a challenging task. Recent genetic study, with microsatellites markers, has shown a partitioning into two large lineages for *D. pertusum* and *M. oculata* in the Northeast Atlantic and Mediterranean Sea. Nevertheless, a unclear signals remain in the Atlantic populations. To address these knowledge gaps, we generated reference genomes and conducted population genomics studies with 100 whole-genome re-sequencing samples for each species from the Mediterranean Sea and Northeast Atlantic. Additionally, through international collaboration allowed by iAtlantic, we included samples from the Western and Southern Atlantic regions, enabling us to gain an initial understanding of the pan-Atlantic biogeography and diversity for these species. Our work, at the European region scale, revealed surprising results. First, we found out that *D. pertusum* is separated in several lineages, with subtle genetic structure associated with water masses changes. Strikingly, results for *M. oculata*, revealed very divergence lineages across Atlantic and Mediterranean Sea, suggesting more a complex of cryptic species than populations, with a least one Madrepora species in the Mediterranean Sea. Furthermore, our whole-genome analysis strongly supports that clonal reproduction may be predominant in these species. Theses genomic approach have and continue to provide very valuable insight into the understanding of biology, distribution and management of these important deep-water coral reefs in the face of climate change and human activities.

4. Genetic connectivity and demographic history of iconic hydrothermal vent species along the Mid-Atlantic Ridge: insights using next-generation sequencing and conservation implications

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Hydrothermal vents are vulnerable ecosystems that ensure numerous services and are threaten by climate change and mining activities. In these remote areas, connectivity is essential for resilience and understanding it is crucial for the definition of biologically informed networks of marine protected areas. Indirect approaches to study it, such as the study of genetic connectivity, represent valuable tools to better understand larval and gene flow at large spatial scales. We used a next-generation sequencing approach (ddRAD-seq) to genotype 540 individuals from four species inhabiting hydrothermal vents along the mid-Atlantic ridge (MAR) at the genome level. *Rimicaris* shrimp species displayed no spatial genetic structure on their whole distribution range (5°S to 37°N) as expected from previous studies. On the opposite, for gastropods, significant spatial genetic structures were detected, as was previously observed for vent mussels. For *P. smaragdina* a contact zone in the area of the Rainbow vent field was detected while genetic differentiation was higher for *L. atlanticus*, with no detected contact zone between clusters. In *L. atlanticus* some degree of reproductive isolation may exist. Differences between species may result from differences in dispersal abilities, depths of dispersal, sensitivity to physical barriers or adaptation to depth. For gastropod species, we investigated the demographic history of MAR populations in order to estimate current migration rates and the time of divergence between genetic groups. Results will be discussed in the context of population conservation in response to mining activities, especially regarding the ISA authorization for exploration in the TAG/Snake-Pit vent fields.

Objective 3. Assess the stability, vulnerability, and any tipping points of deep and open-ocean Atlantic ecosystems to changes in ocean circulation, and effects of single and multiple stressors

1. Experimental mining plumes and ocean warming trigger stress in a deep pelagic jellyfish

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While the deep pelagic ocean remains largely unexplored, it is becoming increasingly apparent that the inhabitants of this vast realm are under growing threats from human activities. Here, we investigate the effects of global warming and sediment plumes that will be produced during deep-sea mining on the mesopelagic jellyfish *Periphylla periphylla*. Through a series of *ex situ* experiments, testing increasing temperatures (in situ, +2°C, +4°C) and abyssal sediment concentrations (0, 16.7, 33.3, 166.7, 333.3 mg·L-1), we measured the metabolic response (ammonium excretion and respiration), expression of

stress related RNA transcripts and changes in microbial community composition. Both warming and sediment plume exposure increased metabolic activity in *P. periphylla*. Oxygen consumption was nearly doubled following a temperature increase of 4°C. Exposure to sediment appeared to have the strongest physical and metabolic effect on *P. periphylla*, resulting in the production of excess mucus, increased ammonium production, and expression of genes related to processes such as wound repair. In addition, the highest sediment load resulted in a similar doubling of respiration rates as the most extreme temperature treatment. *P. periphylla*'s microbiome of the outer bell was not affected, and mucus production proved to be an efficient strategy to maintain microbial community composition in response to sediment smothering. Given current climate projections and the imminent plans for commercial mining of the deep-seabed, *P. periphylla*'s response to suspended sediment warrants the greatest concern in the short-term. In addition to causing physical stress, the observed increase in metabolism will impact energy homeostasis, as *P. periphylla* are adapted to a slow metabolic pace in an environment where food is scarce. If our results are representative for other midwater fauna, future plans for mining need to consider these effects, as our results indicate worrisome consequences of seafloor disturbance on deep pelagic communities.

2. Single and multiple impacts of warming, acidification and deoxygenation on the cold-water coral *Dendrophyllia cornigera*

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The currently available knowledge on the consequences of the ongoing global change for Cold-Water Coral (CWC) dominated ecosystems is still very limited. Global change projections show these ecosystems will be exposed to warming, acidification and deoxygenation. These stressors will act simultaneously but their possible interactions remain largely unknown. Hence, there is a need to investigate the combined effects of these stressors to achieve a better understanding of the effects of global change on the structure and functioning of deep-benthic ecosystems. Here we present the results of a long-term experiment within WP4.3 to assess the single and combined effects of warming, acidification and deoxygenation on the CWC *Dendrophyllia cornigera* in a two-level full factorial design. Coral nubbins were exposed to eight experimental treatments, based on the current *in situ* conditions and the IPCC RCP 8.5 projections for the North Atlantic. Throughout the experimental time (May 2022 - February 2023), several key ecophysiological traits (survival, skeletal growth, tissue coverage, respiration and excretion) were regularly monitored. In addition, at the end of the experiment, the composition and biodiversity of the microbiome and the tissue biochemical composition (total lipids, proteins and carbohydrates) were determined. Taken together, this study will provide important and

novel insights into the ecophysiological response of this CWC species to different climate scenarios, as well as its vulnerability and resilience to global change.

3. Inter-decadal trends in assemblage composition on the Scotian Slope

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Understanding how ecosystems respond to environmental variation is key to predicting the consequences of climate change. Here, we analysed time series of assemblage composition of zooplankton (55 taxa; from annual spring and fall surveys, 1998–2019) and demersal fish and invertebrates (32 taxa; from annual surveys, 1982–2019) on the eastern Scotian Slope. The study area is influenced by complex oceanographic interactions between warmer, north-eastward flowing waters derived from the Gulf Stream and colder south-westward flowing waters from the Labrador Current and Gulf of St. Lawrence. Currently, there is only limited fishing but the area was subject to intense bottom trawling until 1993. Here, multivariate statistical analyses were applied to each data set to assess temporal trends. Outputs from the Bedford Institute of Oceanography North Atlantic Model (BNAM) were also examined to link assemblage changes identified to shifts in oceanographic conditions. The zooplankton displayed a single linear trend, common to both seasonal datasets. Generally, warmer-water, southern species such as *Oithona atlantica* became more prevalent in the later part of the time-series, while colder-water, northern species (e.g. *Calanus glacialis*) appeared to decrease in abundance. The demersal assemblage underwent two periods of significant change. First, a sharp increase in one third of the taxa was identified between 1996 and 2000. Second, there was a decrease in the abundances of eighteen fish after 2000, while a few taxa, including the squid *Illex illecebrosus*, displayed strong increases in biomass towards the end of the time series. Confirming previous studies, analysis of BNAM outputs revealed that surface and subsurface temperatures along the Scotian Slope have recently increased, as the prevalence of Warm Slope Water has grown.

4. Palaeoceanographic variability recorded in a sediment core of Flemish Pass: comparing industrial era versus the last three millennia environmental changes

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A multi-proxy palaeoceanographic reconstruction from a sediment core recovered from the northern rim of the Flemish Pass (east off Newfoundland) is in progress. This research aims to enhance our understanding of the environmental variations that this region, under the influence of the Labrador

Current, has experienced over the past millennia, with a special focus on the industrial era. The results presented here are based on abundance counts of planktonic and benthic foraminifera, in addition to the quantitative analyses of ice rafted debris (IRD). The sediments cover an age range from approximately 800 years BCE to recent times, as determined by our age-depth model established on radiocarbon (^{14}C) datings, as well as ^{210}Pb, ^{137}Cs and ^{241}Am radionuclides. The palaeoceanographic proxy analyses demonstrate a significant oceanographic variability within the last decades. Specifically, planktonic/benthic ratio and benthic foraminifera associations experienced outstanding shifts from 1,965 to recent times. Furthermore, the IRD characterization shows important fluctuations in the studied interval: the values of lithic grains per gram of sediment slightly increased from 1,840 and rapidly rose from 1,965. In contrast, planktonic foraminifera associations, which are almost fully dominated by the polar species *Neogloboquadrina pachyderma*, remained relatively constant throughout the core. According to our results, the changes observed in recent decades are the most prominent in the last 3,000 years. The increase in IRD over the past decades suggests a significant growth in the number of icebergs melting in the region, which could lead to variations in food supply to the deep-sea, consequently affecting the benthic foraminifera assemblages. Our results are associated with shifts in the environmental conditions of the Labrador Current, a key element of the global climate system, due to its linkage with the North Atlantic Subpolar Gyre and the formation of deep waters at the high latitudes of this Ocean.

Objective 4. Align and enhance human, technological and data inter-operability capacities for cost-effective cooperation and planning across the Atlantic

1. iAtlantic data management summary

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Our work in Work Package 7 is focused on providing iAtlantic consortium partners with a state-of-the-art workflow for data processing and publishing in line with the H2020 Open Research Data Pilot. This commitment includes managing research outputs in accordance with FAIR and Open Science principles and is reflected in all aspects of data management in iAtlantic. The data generated by the project and published through the World Data Centre PANGAEA will be widely and long-term disseminated through EMODnet and the European Atlas of the Seas, and made available to all Atlantic stakeholders, including those in the Northwest and South Atlantic. Besides PANGAEA, we are meanwhile working together with a few other trusted data repositories fulfilling our FAIR and Open Data requirements, e.g. SAEON, BODC and SEANOE. We are also focused on growing the international data community around Atlantic Ocean observations through a thematic GEOSS interface (All-Atlantic Community Portal) and through EMODnet. iAtlantic fellows have had the opportunity to gain expertise in data processing and analysis in training workshops run by WP7 partners ("Big Data" workshops). In this presentation, the key results of the Work Package 7 tasks and our ongoing activities are presented.

2. Building capacity, sharing knowledge, supporting development

Vikki Gunn[1] and the iAtlantic capacity building team
(of which there are many members across the consortium!)

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In recognition of the importance of human and technical capacity in underpinning a truly collaborative and inclusive approach to basin-scale marine science, iAtlantic placed capacity building at the core of its mission from the outset. A comprehensive programme, managed by the WP6 team and implemented hand-in-hand with iAtlantic's technical work packages, aimed to share knowledge, infrastructure, equipment and expertise across the project partnership. These activities encompassed hands-on training at sea and in the laboratory, through formal instruction, workshops and training events, as well as through more informal individual coaching and mentoring approaches, online learning opportunities and an inclusive approach to the research process – including the transfer of knowledge to end users. Central to the programme's activities was the establishment of the iAtlantic Fellowship, comprising the cohort of 50+ early career researchers who really provided the scientific horsepower in iAtlantic's engine. Inclusion of the Fellows in all aspects of the project is central to the project's approach and underpinned its ambition to produce the next generation of marine science leaders. However, learning opportunities were open to researchers at all career levels and – wherever possible – opened to suitable participants from the wider Atlantic research community. Capacity development in iAtlantic included more than training and teaching. Sharing of infrastructure and equipment, creating access to facilities, data and know-how, and providing opportunities for researcher mobility between partner institutions were championed in recognition of their importance in achieving a fully inclusive approach to the research questions iAtlantic set out to tackle. This presentation reflects on the breadth of iAtlantic's capacity development activities, celebrates successes, casts an objective eye over challenges and barriers, and identifies some lessons to be learned for future programmes.

3. Integration of the SAEON data infrastructure with the GEOSS portal: current operational framework and lessons learned from stakeholder engagement

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The South African Environmental Observation Network (SAEON) hosts and develops open data systems and applications distributed on an Open Data Platform (ODP). The ODP allows for the publication of earth observation and environmental data. The infrastructure is based on standardised metadata and discovery tools, with Findable, Accessible, Interoperable, and Reusable (FAIR) data principles embedded into the systems and data curation procedures. To address data interoperability with other research data infrastructures, SAEON exposes a catalogue Application Programming Interface (API) endpoint for harvesting published metadata in several technical standards. The endpoint is accessible to authorised clients - including internal SAEON data systems and external data infrastructures, such as the GEOSS

All-Atlantic Ocean Data community portal. Successful implementation and interoperability of the SAEON data platform with other data infrastructures depend on technical aspects and governance processes. For example, negotiating agreements is necessary, and the compilation of documentation, such as data policies, is critical. The third aspect which needs to be recognised is human interaction. A data centre should aim to gain stakeholders' trust, and this trust needs to be built through communication and extensive stakeholder engagement. Issues such as lack of data sharing by stakeholders, lack of understanding of the necessity for good data management practices or the benefits of Open Science, or how to manage data all impede data being deposited into a data centre. Awareness and understanding can be created through meetings, training and workshops. As part of its current involvement in the iAtlantic consortium, SAEON has been engaging with PANGAEA to try and streamline processes for integrating South Atlantic data with the GEOSS All-Atlantic Ocean Data community portal. This presentation will discuss the current scope of activities in integrating SAEON's data infrastructure with GEOSS and lessons learned from interactions with stakeholders contributing to Work Package 7 of iAtlantic.

4. iAtlantic GeoNode – a portfolio of iAtlantic geospatial data

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In Task 5.2, Seascape Belgium has developed an advanced web-based Geographic Information System (GIS) known as the iAtlantic GeoNode[1] (D5.1). At time of writing, the iAtlantic GeoNode hosts over 356 data layers. These includes a wide array of pre-existing geospatial datasets from various sources (e.g. EMODnet, Ifremer, GEOMAR, CMEMS, Global Fishing Watch, H2020 Atlas) covering biological, environmental, biogeographic, and human-related information regarding use, management, and conservation of the Atlantic Ocean. Additionally, the GeoNode is publishing geospatial data outputs derived from iAtlantic research, archived in PANGAEA and other data repositories. The data layers can be explored using search engine technology, visualized through an interactive web map, downloaded in various geospatial data formats, and shared with stakeholders in various ways. Through these functionalities, the iAtlantic GeoNode aims to support the delivery of iAtlantic research and enhance the utilization and impact of iAtlantic research outputs among a broad range of stakeholders. During this presentation, we will provide an overview of the extensive data portfolio available in the iAtlantic GeoNode, explore the functionalities and demonstrate how it can assist you in visualizing and sharing your work.

[1] https://www.geonode.iatlantic.eu/

Objective 5. Define requirements for sustainable management with industry, regulatory and governmental stakeholders to reflect societal needs and inform policy developments that ensure and encourage a sustainable Blue Economy

1. The changing tide of global ocean policy and management - and what it means for the Atlantic region

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It is often said that in the policy world, the tides of change turn slowly. Whilst this is generally true, there are points in history when circumstance, evidence and swell of opinion coalesce to effect a sea change. During the lifetime of iAtlantic (2019-2023), despite the two-year standstill brought about by the Covid-19 pandemic, much has changed in global ocean policy: international biodiversity targets have come and gone and been replaced by new ambitions; the ocean-climate debate has intensified; more urgent pressures emerged to drive forward the regulation of seabed mining – and also triggered a growing cohort of countries to call for a moratorium or precautionary pause on deep-sea mining activity; reviews of existing bottom fisheries regulation resulted in calls for more stringent assessment of impacts on vulnerable marine ecosystems, and a new global treaty to protect biodiversity in the high seas was eventually adopted after a 20-year process of debate and negotiation. But how do these global processes impact the Atlantic region? In the past four years, we have seen the identification of 17 ecologically or biologically significant areas (EBSAs) in the North-East Atlantic; the designation of a new high seas MPA and its subsequent extension to include the seabed; the submission and debate over a Regional Environmental Management Plan for sulphide mining on the northern portion of the Mid-Atlantic Ridge; and the OSPAR Commission released its Quality Status Review 2023 – a 10-year assessment of the environmental status of the North East Atlantic. In this presentation we reflect on what iAtlantic set out to do in terms of bringing new science and data to support sustainable management of ocean resources, how the ocean policy field and goalposts have moved during the lifetime of the project, how iAtlantic has interacted with stakeholders to share new science, and what lasting impact iAtlantic will leave as policymakers and regulators face the significant task of responsibly managing ocean resources in an era of increasingly rapid and unpredictable environmental change.

2. Assessing the need for new area-based management tools for cetacean conservation in Bermuda: evidence to support the designation of a particularly sensitive sea area

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Cetaceans are negatively impacted by a multitude of human activities including the shipping, fishing, and whale-watching industry. Bermuda, a small oceanic archipelago with high cetacean biodiversity, is seeking to expand its Blue Economy in an ambitious Marine Spatial Plan which may increase the threats to cetaceans. Despite the protection of all cetacean species in Bermuda's Marine Mammal Sanctuary, limited protective measures and area-based management tools (ABMTs) have been implemented to support their conservation. This study assesses whether cetacean focussed ABMTs are required in Bermuda by mapping the overlap of human activities and cetacean habitats, assessing the effectiveness of current cetacean conservation measures, and examining whether a Particularly Sensitive Sea Area (PSSA) may be justified. A geodatabase of layers was created to demonstrate the current and predicted human use of Bermuda's nearshore waters (focussing on the shipping, fishing, and tourism industries). Novel baseline data on cetacean distribution was generated using a participatory Geographic Information System (GIS) platform, where local experts created maps showing the key areas utilised by various cetacean species. Semi-structured interviews from those in the IMO, Bermudan Government, tourism industry and research institutes highlighted the effectiveness of conservation measures and the feasibility of a PSSA designation in Bermuda. The results of the study demonstrate that shipping likely creates the largest population level pressure on cetaceans, with the misconduct of recreational boat users harassing humpback whales (*Megaptera novaeangliae*) causing smaller-scale issues. Two nearshore seamounts were highlighted as being key feeding grounds for multiple cetacean species as well as an important stopover for migrating humpback whales. Designating a PSSA is therefore highly recommended in this area which may be likely through adjusting an existing IMO measure in the region; an Area to be Avoided. However, long-term monitoring and a detailed evidence base is first required.

3. Historical fishing regimes and geomorphology reveal potential deep sea productivity hotspots in the Brazilian Meridional Margin

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Conservation strategies for marine ecosystems often include space-based measures to protect biodiversity 'hotspots', defined as areas where diversity is particularly rich, rare or endemic. Adding a 'productivity hotspot' definition among criteria used to guide space-based conservation strategies in the deep sea, however, seems particularly useful considering that ocean basins tend to be oligotrophic, except for localized regions where topography, circulation and biological processes may promote trophic-wide productivity, and sustain dense concentrations of consumers and top predators, some of them targets of commercial fisheries. This study explores the premise that historical records of concentrated fishing operations in association with geomorphological features are effective surrogates for productivity hotspots distribution in the Brazilian Meridional Margin (BMM- SW Atlantic- 18°S- 35°S; 200 – 3300 m), potentially guiding space-based conservation strategies. We analysed catch data of the monkfish (*Lophius gastrophysus*), the royal crab (*Chaceon ramosae*), red crab (*Chaceon notialis*) and the aristeid shrimps *Aristaeopsis edwardsiana*, *Aristeus antillensis* and *Aristeomorpha foliacea* obtained from over 23,000 fishing tows conducted in BMM by vessels operating bottom trawls, gillnets and pots. Spatial variability of catches was analysed for the effect of geoforms as delimited by terrain modelling. Nearly 80% of the catches were obtained on three geoforms that jointly covered 48% of the slope area. A 'moderate slope' (mean slope = 2.0°) feature covering 19.2% of the total area sustained over 40% of

the catches of all species combined. Important concentrations of the commercial species were explored within embayments of Santos and Pelotas Basins. Spatial GLM models were used to test the effects of different geoforms on catch rates of different species. We discuss the potential of historical fishing data as surrogates to delineate productivity hotspots and to guide future research activities and conservation strategies in the wider South Atlantic Ocean.

4. The socio-economic effects of fauna tropicalization in the SW Atlantic: reshuffling economic and nutritional benefits

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The Brazilian Meridional Margin (BMM) in the Southwest Atlantic Ocean (SWAO) (~20°S–34°S), is influenced by the Brazil Current and the Brazil–Malvinas Confluence, where ocean-shelf interactions suggest global warming-induced changes can potentially alter species habitats and affect fauna diversity. The 'mean temperature of the demersal catches' (MTC) monitored between 2000 and 2019 in the BMM increased by 0.41°C year^{-1} from 2013 to 2019, as determined by the continuous increases in bottom temperatures after 2012 (0.077°C year^{-1}). This process has reshuffled the availability of traditional and non-traditional fishing targets in the region. Comparing two similar periods (P1 = 2000-2002 and P2 = 2017-2019) in terms of total mean demersal catches (21.15 and 19.00 thousand tons, respectively), P1 was defined by 15 main species with affinities for cold waters, while P2 had 8 species with affinities predominantly for warm waters. These changes were reflected in the contribution of the protein content offered to society from the demersal blue foods: *Micropogonias furnieri*, associated with warm waters, was the predominant species in P1 and P2, but increased its representation from 35.5% to 43.9%, adding 1.6 thousand tons of edible protein and R$ 22.0 (~USD 4.6) million in first sale revenue. The same happened with *Penaeus brasiliensis*, the warm water shrimp that fetches the highest sale value amongst the demersal species: in P1, it represented 0.6% of the catches, increasing to 1.7% in P2; it added a modest 118 tons in protein content, but a R$ 17.0 (~USD 3.5) million in market value. On the losing end, however, cold water species such as *Merluccius hubbsi*, *Lophius gastrophysus*, *Illex argentinus* and *Genypterus brasiliensis* together subtracted 705 thousand tons of protein and R$ 17 million. A more complete balance of these repercussions will soon be completed, as well as its implications for society, fisheries, and fishing management regimes, especially given that the SWAO is a warming hotspot and the tropicalization trend is expected to continue.

5. Institutionalising marine science under a new agreement for marine biodiversity of areas beyond national jurisdiction (BBNJ)

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Areas beyond national jurisdiction (the seabed, subsoil, and water column outside coastal state jurisdiction) account for over two-thirds of the global ocean and are home to diverse and unique marine biodiversity. In response to global concern for BBNJ, a new international agreement for the conservation and sustainable use of BBNJ (BBNJ Agreement) was negotiated between 2018 and 2023, with the Agreement being formally adopted at the United Nations in June 2023. Within the Agreement, the undertaking and application of marine science is emphasised as fundamental to the success of its implementation. This provides a window of opportunity for deep-sea science to inform and support decision-making for over two-thirds of the global ocean. However, science-policy exchanges are complex and challenging. To provide insights on opportunities and barriers for integrating marine science into BBNJ decision-making, semi-structured interviews were conducted with key stakeholders. Findings from this research underscore the importance of fit-for-purpose institutional arrangements, including an effective Scientific and Technical Body, and suggest that in order to fulfil the unique requirements set out in the BBNJ Agreement, a step-change is needed regarding the design of this new body. Key findings will be integrated with observations drawn from the BBNJ negotiations, to highlight opportunities to integrate marine science, including research coming out of iAtlantic, to support the science-based decision-making under the BBNJ Agreement.

Posters

1. Impact of increased temperature and altered POC quality on Cabo Verde bathyal soft-sediment ecosystems

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Deep-sea benthic ecosystems are notably characterized by severe organic limitation, depending mainly on the slow, limited, and inconstant export of surface primary production to the seafloor. These ecosystems are essential for regulating the climate and the cycle of matter and energy on Earth. However, despite their apparent vastness and resilience, human pressures coupled with climate change effects have intensified in recent decades and are expected to greatly affect deep ecosystems in the Atlantic Ocean, with a decline in the particulate organic carbon (POC) flux along with warmer temperatures for the next century. These effects will be more drastic in equatorial upwelling zones, leading to decrease in macrofaunal biomass, benthic respiration, and bioturbation intensity. To assess and quantify the potential effects of climate change stressors on benthic assemblages in the equatorial Atlantic, we examined the macrofaunal community composition from Cabo Verde Basin (CVB) and evaluated the short-term response of benthic organisms (Sediment Community Oxygen Consumption (SCOC) and Dissolved Inorganic Carbon (DIC) rates) to climate change stressors. During the iMirabilis2 expedition in August 2021, ex-situ enrichment experiments with ^{13}C and ^{15}N labelled diatoms were

conducted by incubating soft-sediments testing climate projections (temperature/POC quality) for next century in the CVB. Annelids dominated the sediment in CVB in terms of abundance (47%), biomass (57%), and composition (18 families), followed by nematodes. Our experiments suggest that benthic respiration rates can increase by over 80% with +2°C, independently of the POC quality. The increase in respiration was not followed by changes in macrofaunal abundance or biomass, but bacterial biomass nearly doubled with an increased temperature. Our work revealed important implications of higher seafloor temperatures for sediment community respiration rates and organic matter processing in the bathyal depths of the central Atlantic Ocean, supporting expected potential negative consequences of climate change for deep ecosystems in next century.

2. Temporal shifts in plankton community composition and phenology from the Bermuda Atlantic Time-Series (BATS)

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Understanding how plankton communities respond to environmental variation is critical to predicting the consequences of climate change for open-ocean ecosystems. Here we analysed the time-series of plankton community composition and size structure from the Bermuda Atlantic Time-series Study (BATS). Univariate statistical analysis of yearly phenological indices was combined with multivariate approaches such as redundancy analysis and trajectory analysis to identify shifts in plankton composition and annual cycling between 1993 and 2019. We found that phytoplanktonic community composition changed significantly since the early 1990s, with larger phytoplankton groups such as diatoms and cryptophytes decreasing in abundance over time and smaller groups such as *Synechococcus* and *Prochlorococcus* increasing in prevalence. In addition, the biomass of small zooplankton fractions (200 µm to 500 µm) significantly declined between 2006 and 2012, while larger zooplankton taxa (2,000 µm) increased in prevalence during the same period. This contributed to a shift in total zooplankton biomass, which increased until 2012 and then decreased until 2019. Analysis of phytoplankton and zooplankton phenology revealed high inter-annual variability in the timing of annual blooms. Despite this considerable level of natural variability, shortened lag times between spring and winter planktonic blooms were identified in recent years of the BATS time-series. These shifts in phytoplankton and zooplankton community composition and phenology were related to changes in environmental conditions, such as temperature, salinity, dissolved oxygen, inorganic carbon and nutrient concentrations. Indeed, conditions in the Sargasso Sea are known to have changed in the last decades due to climate change, with temperature and salinity increasing by 0.85°C and 0.12, respectively and dissolved oxygen concentrations declining by 17.76 µmol/kg since 1983.

3. Adding pieces to the puzzle: insights into diversity and distribution patterns of Cumacea (Crustacea: Peracarida) from the deep North Atlantic to the Arctic Ocean

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The Nordic Seas have one of the highest water-mass diversity in the world, yet large knowledge gaps exist in biodiversity structure and biogeographical distribution patterns of the deep macrobenthic fauna. This study focuses on the marine bottom-dwelling peracarid crustacean taxon Cumacea from northern waters, using a combined approach of morphological and molecular techniques to present insights into genetic variability of this taxon. In total, 947 specimens were assigned to 77 morphologically differing species, representing all seven known families. Out of these, 131 specimens were successfully included in 16S rRNA gene amplification and subsequent analyses. For 60 species, morphological and molecular-genetic delimitation was fully congruent, highlighting the overall success and high quality of both approaches. Differences were due to eight instances resulting in either morphologically variable species or morphologically cryptic species, uncovering hidden diversity e.g. in the taxon group *Leptostylis* (Figure 1). An interspecific genetic distance of at least 8 % was observed as a realistic distance with a clear barcoding gap for molecular delimitation of cumacean species. Data from public databases and specimens collected during different international expeditions revealed a change in the composition of taxa from a Northern Atlantic-boreal to an Arctic community. A closer investigation on species level revealed occurrences across multiple ecoregions or patchy distributions within defined ecoregions. Looking ahead, the results of this study provide an additional data set for this year's ArcWatch1 expedition (PS138, Aug-Sept 2023), which addresses, among other questions, to what extent there are visible changes in the benthic community composition in the Arctic deep sea over the last 10 years.

4. Investigating the impact of the 8.2 kyr event on North Atlantic deep-sea ecosystems

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The 8.2 kyr event is an abrupt climate perturbation that occurred about 8200 years before the present, which interrupted the relatively stable climate of the Holocene period. The event has been associated with an episode of massive freshwater release into the North Atlantic that is proposed to have led to a slowdown of the Atlantic Meridional Overturning Circulation (AMOC) and in turn to reduction of the northward heat transport to the Atlantic Ocean and thus cooling of the Northern Hemisphere. The 8.2ky event provides a useful scenario with which to examine how marine ecosystems may respond to changes in North Atlantic circulation and possibly AMOC weakening. This is of particular value given recent concerns about ongoing changes in the North Atlantic that may be linked to a weakening AMOC, and emerging evidence for their impact of marine ecosystems. In order to assess the deep-sea ecosystem response to oceanographic changes during the 8.2ky event, here we present a 2500-year (~6.8-9.2 ka BP), high-resolution benthic foraminiferal assemblage record, alongside planktic foraminiferal assemblages, sediment grain size (sortable silt) and benthic d13C data from North Atlantic site RAPiD-17-5P, located south of Iceland and under the main flow of Iceland-Scotland Overflow Water (ISOW). Relatively muted changes are observed across the 8.2 kyr event, which stand in contrast to the large changes reported for the recent industrial era. To enable a broader understanding on the likely controls on benthic foraminiferal changes during the 8.2 kyr event, we also present similar, new, records from other cores located at key sites throughout the subpolar North Atlantic and NW Atlantic. We compare our results to our previous work examining the industrial era and consistent with these findings, large shifts in surface ocean conditions appear to be a primary driver for benthic assemblage change.

5. South Africa's Floating University SEAmester- An example of a successful ship-based education programme.

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iAtlantic WP 6 places capacity building at the core of its mission and calls for programmes that improve scientific knowledge, develop research capacities and transfer marine technology information and expertise across generations. In South Africa, the Department of Science and Innovation's (DSI) has

already taken a significant step forward in such training measures. The current DSI Global Change Grand Challenge programme calls for platforms that "*attract young researchers and retain them by exciting their interest in aspects of global change, while developing their capacity and professional skills in the relevant fields of investigation*". To meet these challenges, SEAmester – South Africa's Floating University and a joint initiative between Government and Universities was started in 2016. The strength of SEAmester is that South African postgraduate students combine theoretical classroom learning with the application of this knowledge through ship-based, and more importantly, hands-on research through the Agulhas System Climate Array (ASCA) programme. Now into its 9th year, SEAmester has already made significant progress in ship-based training with over 241 students from 26 South African universities participating in these training cruises. This poster examines the development of this programme, its success and most importantly, what has become of the past SEAmester students.

6. Mooring observations of the Agulhas Leakage- SAMOC-SA's contribution to iAtlantic

Isabelle Ansorge[1], Tarron Lamont[1,2], Marcel van den Berg[2], Stuart A. Cunningham[3] and the wider SAMOC community

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Schiermeier's 2013 Nature article *"Oceans under Surveillance"* in Nature highlighted the international need for an extensive array of continuous measurements across both the northern and southern Atlantic, as well as its neighbouring basins. The call for these observations is due to the ocean's Meridional Overturning Circulation (MOC), a global reaching system of ocean currents. It is the primary mechanism for the transport and storage of heat, freshwater, oxygen and carbon between ocean basins. Climate models have shown that past changes in the strength of the MOC were linked to climate variations, with future predictions hinting that the MOC will continue to modulate climate change scenarios on timescales from decades to centuries. Recognition of the critical importance of the MOC in this region led to the creation of an international community initiative on the South Atlantic Meridional Overturning Circulation (SAMOC). The local branch of this initiative SAMOC-SA, underway since 2013, consists of several South African observational platforms aimed at monitoring long-term physical-chemical changes within the ocean current systems around South Africa, as well as their impact on local climate. Over the past decade the SAMOC array has consisted of an extensive array of tall moorings, CPIES, full depth CTD stations, Argo deployments, as well as a multitude of underway and surface measurements extending across the Greater Agulhas Current system and its inter-basin Leakage. This poster highlights the involvement of iAtlantic in SAMOC-SA and the results obtained from the oxygen sensors attached to moorings M9 and M10. M9 was deployed at a depth of 3016m at 34°30.1948'S and 17°07.4625'E and M10 was deployed in a depth of 4500m at 34°29.99'S and 14°42.21'E in October 2020. Over the two-year programme the large deviations in the pressure indicate blowdowns suffered by the moorings during the passage of large Agulhas Rings, which are typically associated current speeds between 1–1.5 ms^{-1}. Dissolved oxygen variability during the two-year period was generally concomitant with temperature and salinity changes, indicating the highly variable nature of water mass intrusions and mixing in the Cape Basin.

7. Exploring benthic habitats on the sedimentary slopes of Santos Basin, SW Atlantic

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In December 2022, the first iAtlantic expedition in the South Atlantic was set to study benthic ecosystems of the Santos Basin slope region (200 – 1000 m depths). The 17-day 'iAtlantic_BR10-Petrobras' cruise was conducted on board the research vessel NPqHOc Vital de Oliveira (Brazilian Navy) and included (a) water column structure characterization, (b) mapping seafloor morphology, (c) characterizing benthic habitats and communities through seafloor imagery and biological/ geological sampling, and (d) assessing sedimentary ecosystems functioning and responses to climate-related environmental changes. Multibeam echo sounding was conducted along 1,046 NM-long track lines and covered an area of 2,565 km^2. Seafloor was characterized by sedimentary terraces with pockmarks particularly concentrated in two depth zones (450- 500 m and 600- 800 m). Two prominent 4 – 11 km-long geological features were described, possibly formed by large salt diapirs or carbonate mounds. Box corer samples taken on the surface of these structures and of ridges between pockmarks suggest they were covered by fragments of stony corals (*Desmophyllum pertusum*, *Madrepora* sp., *Solenosmilia variabilis*, and *Enallopsammia rostrata*) as well as living colonies of black corals (*Bathypathes* sp.). Video footage, obtained by a towcam system in the vicinity of pockmark rims (~800 m-deep), exhibited a sedimentary seascape with intense current flow and concentrations of fish (mostly macrourids) and shrimps. Benthic habitats were under the influence of the South Atlantic Central Waters (200 – 800 m depths) and their interface with Antarctic Intermediate Waters at 700 – 800 m depths. Turbidity increased at these depths and at 200 – 300 m coinciding with deep-sea catch concentrations. Additional efforts are largely needed to improve our understanding of Santos Basin deep ecosystems. The baseline data collected and derived interpretations, nonetheless, were important steps in those directions and were valuable contributions to plan future expeditions in the region.

8. HSM predictions reveal the potential role of submarine canyons as reservoirs of deep-sea shrimp *Aristaeopsis edwardsiana* (Johnson, J. Y., 1868) stocks, in the Brazilian Meridional Margin

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Aristeid shrimps are valuable deep-sea resources in the Brazilian Meridional Margin (BMM). For seven years (2002 – 2009) three species were heavily exploited by slope trawlers in a narrow depth zone of the slope (700 - 800 m), resulting in important stock reductions and further ecosystem impacts. Limited

scientific records indicated, however, that these species occurred in much deeper zones (up to 2000 m) mostly unavailable to the trawl fisheries. We modelled the spatial distribution and projected the probability of suitable habitats of *Aristaeopsis edwardsiana*, in the northern sector of the BMM. The region encompassed slope areas of Campos and Espírito Santo basins, which is characterized by numerous cross-slope blind canyons. The analysis was based on the species occurrence in 3,431 trawls conducted between 2004 and 2007. Explanatory environmental variables were extracted from a Digital Bathymetric Model produced by Petrobras in the context of oil and gas production licensing process, and from the high-resolution circulation model INALT20. An ensemble habitat suitability model (HSM) was built considering the results produced by three applied HSMs: GLM, Maxent and Random Forest. Water mass structure variables (bottom temperature and salinity), current speed and seafloor aspect (easterness) tended to exhibit a high explanatory role in all models. In general, suitable habitats included water masses mixture zones with reduced bottom flow dynamics. These habitats were most likely to occur between 200 and 800 m depths throughout the entire study area, and particularly within canyon systems where suitable habitats likely extend to over 1800 m depths. These are unreported distribution areas that could represent (a) important reservoirs inaccessible to the trawl fisheries and/or (b) pathways to mid-slope fishing areas. Because nearly all catches were formed by mature individuals, these canyons may provide important connections between spawning and pre-reproductive areas in the northern BMM.

9. Is the SW Atlantic Hotspot the Catalyst for a EBM Climate Framework-Treaty? A warm approach for regional cooperation

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Southwest Atlantic Ocean (SWAO) comprises one of the most extensive and intense warming hotspots in the global ocean, directly affecting coastal states in SE South America. This impact will manifest as marine biodiversity loss and ecosystem shifts, leading to repercussions on the availability of blue food resources and the efficiency of the blue economy. The evidenced tropicalization of demersal megafauna in Brazil adds complexity to the challenge´s that public leaders may face to sustainably manage shared stocks for a climate-resilient fisheries and ecosystems in SWAO amid an uncertain future. Addressing climate change demands multidimensional responses to intricate problems. Established regional organizations and international bidding agreements discussions demonstrate awareness of climate change, yet are struggling to translate adaptation and mitigation concepts to management actions in a timely fashion. In this emerging context we intend explore, based on iAtlantic outcomes, whether a climate change-driven ocean hotspot can be perceived, not as stressor in the policy approach, but instead a natural feature upon which an adaptive regional cooperation framework could be developed in the SWAO, that would play a pivotal role in informing dynamic policies through collaborative governance. A SWAO climate-change induced treaty can harness the capacity of flags States to introduce adaptive management strategies geared towards climate resilience. This, in turn, can help mitigate the adverse effects of climate change on ecosystems and biodiversity, because it may integrate spatial and temporal effects informed by science with socioeconomic responses across all phases of the

policy cycle. The benefits of this dynamic framework may extend beyond climate change and can as a platform, synergistically address the overlapping objectives of international treaties related to Climate Change, Ocean Conservation and Fishing to deliver commitments and actions to facilitate more effective responses.

10. Assessing the trophic plasticity of the cold water coral *Desmophyllum pertusum (Lophelia pertusa)*

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Cold water coral (CWC) reefs form hotspots of biodiversity in the deep-sea. One of the most abundant and widely distributed reef builders, *Desmophyllum pertusum,* relies on a wide array of heterotrophic carbon sources like dissolved or particulate organic matter, bacteria, phytoplankton, and pico to mesozooplanktonic preys. As a result, the functional role of *D. pertusum* within the food web remains enigmatic since they can have trophic identities consistent with primary consumers or carnivores. We used compound-specific nitrogen isotope ratios of amino acids to estimate the trophic position of *D. pertusum* collected at six geographically distinct sites across the Atlantic basin, spanning a depth range from 150 to 1200 m. Our results suggest that *D. pertusum* is mostly a primary consumer of phytodetritus although zooplankton can be an important part of their diet, which is more consumed at deeper sites. Based on $\delta^{13}C$ values of essential amino acids, we found that *D. pertusum* derive essential amino acids from microalgal sources at all sites. However, results of multivariate statistical analyses reveal differences among sites based on $\delta^{15}N$ patterns of specific amino acids that typically change with trophic transfer, pointing to distinct strategies in the synthesis and metabolism of these amino acids. Overall, we found that *D. pertusum* has primarily a role as primary consumer within the food web although the differences among sites show its trophic plasticity, which allows them to thrive in the resource-limited deep ocean.

11. Response of deep-sea benthic foraminifera in the subtropical NW Atlantic to past abrupt climate change events

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Paleoclimate records have revealed intervals of past abrupt climate change, which have been associated with changes in the Atlantic Meridional Overturning Circulation (AMOC). There are ongoing concerns about a current and/or future weakening of the AMOC. Previous studies suggest changes in AMOC may impact marine productivity, and paleo-data suggest that AMOC-related changes in surface circulation can impact the food supply to the deep sea and thus the benthic ecosystem. Here we investigate past benthic ecosystem responses to abrupt climate changes during the last 90,000 years at Bermuda Rise - an extensively studied site that has been used to reconstruct past abrupt climate and AMOC changes – to constrain past variability and its likely control(s). We have generated high resolution records of benthic foraminifera species assemblage (percent and flux). We couple these faunal data with multiple new proxy records for ODP Site 1063: mean grain size of sortable silt (SS) to examine the vigour of bottom water currents at the site; planktic fragmentation percentage (PF%) as an indicator of the corrosivity of bottom waters; counts of ice rafted debris (IRD) to indicate the presence of icebergs; and quantitative and qualitative assessments of the amount of biogenic silica. These are used alongside existing published datasets of Pa/Th, eNd, opal, and benthic carbon isotopes. Our results reveal millennial-scale variability in the abundance and composition of benthic foraminifera, which are coupled to abrupt climate change events. We also identify prominent abundance peaks in the benthic foram, *Epistominella exigua* – a seasonal productivity indicator - that typically occur during Heinrich stadial periods. We interpret the results in terms of changes in subtropical surface ocean productivity during stadial intervals.

12.FUTURO - an all-season multiscale research campaign on the future evolution of the coastal upwelling system off West Africa

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Tropical upwelling regions such as the upwelling system off Senegal and Mauritania play an active role in climate and oceanic biogeochemical cycles as well as supporting the most productive ocean food chains. They support the largest fisheries of the world and are home to a biodiverse marine environment. Anthropogenic impacts in these regions will therefore have disproportionately large consequences for human society by putting livelihood and well-being of large parts of the regional population at risk. However, despite intense research activities in the past, oceanographic, biogeochemical and ecological process understanding in upwelling regions remains poor. This is because (i) physical, chemical and biological components of the system have not been studied in a synergistic and mechanistic way, and (ii) existing observational campaigns have largely been snapshots in space and time within systems that are highly dynamic on multiple spatio-temporal scales. Ultimately, this uncertainty threatens adequate adaptation of legal and economic regimes for the sustainable use and management of upwelling systems. To address these shortcomings, a yearlong large-scale observational campaign in the West African upwelling system has been proposed and is now planned for the time frame 2027-2029 to overcome this situation. During the so-called FUTURO campaign one or more international research vessels are expected to operate throughout the campaign off West Africa executing a sequence of coordinated and concerted multidisciplinary surveys and experiments. A graduation program is envisioned to flank the FUTURO campaign to directly benefit Early Career Ocean Professionals from the region. Design, planning and execution of the FUTURO campaign should be done

in close coordination with regional partners and stakeholders to assure an impactful study design that is tailored to regional socio-economic priorities. With this poster, we provide an overview of FUTURO at this early stage to scientists and organizations who might be interested to actively participate in this effort.

13. Enhancing capacity for sustainable management of near-coastal marine resources in Cabo Verde

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The archipelago of Cabo Verde, a Small Island Developing State (SIDS) located about 350 NMi off the west coast of Africa in the tropical North Atlantic, heavily relies on the wellbeing of the marine ecosystem surrounding it. In contrast, the level of exploration of these ecosystems is relatively low and mostly based on classical methods such as scuba-diving campaigns. The management of local fish stocks is mostly based on fish landings statistics at a few landing sites. To support Cabo Verde in improving its ecosystem monitoring capacities, a technical training workshop was held in 2022 at the Ocean Science Centre Mindelo (OSCM) which involved scientists, technicians and students from 12 West African countries. During the workshop theoretical and practical sessions about hydroacoustics for biomass assessments were held. As a result of this workshop, technicians from Cabo Verde carried out their first own biomass survey and investigated the near-coastal distribution of fish in a nature reserve at the neighbouring island. More regular campaigns are being planned for the future in order to establish a monitoring of local marine resources. The workshop also facilitated the exchange between experts in hydroacoustics from the West African region and Cabo Verde has been invited to join a subregional FAO working group on hydroacoustics for biomass surveys.

14. Area-based management for a changing Atlantic Ocean: systematic conservation planning, international cooperation, and climate change

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Anthropogenic activities are impacting the provisioning of ecosystem services and causing biodiversity loss in the ocean. Fishing, seabed mining, climate change and other activities are heavily affecting deep sea and open ocean environments and the many vulnerable and long-lived species that inhabit them. The iAtlantic research project seeks to develop information on the deep and open-ocean Atlantic marine ecosystems and assess their stability, vulnerability and tipping points through a basin-wide multidisciplinary approach. Consequently, the iAtlantic project results can help industry, regulatory and governmental stakeholders develop sustainable management and protection of the Atlantic marine environment. Although systematic conservation planning tools can help identify priority areas for achieving management and conservation goals, they often have little relevance for large-scale marine systems, as they tend to neglect local realities due to data limitations. In this study, we develop strategies to overcome some challenges that curb systematic conservation planning tools in large-scale marine systems. In particular, we show how these tools can aid in selecting priority areas in data-poor regions for conservation and restoration, reveal the value of collaboration between nations or international organisations, and incorporate climate change into marine spatial planning processes. After generating prioritizations using the *prioritizr* R package, which selects priority areas for reaching specific conservation goals while minimising the cost, we found that: biogeographic information can be valuable for deep sea conservation planning, international collaboration leads to more efficient plans, and climate change carries uncertainty in selecting protected areas. Since the input objectives drive the prioritisation results, there is a need for dialogue between stakeholders and scientists to develop feasible and effective conservation plans. Our findings highlight the need for increased scientific knowledge on the deep sea to reduce uncertainty and show that existing scientific knowledge is sufficient to help inform area-based management in the Atlantic Ocean.

15.Spatial distribution of hydrothermal and non-vent assemblages at the Lucky Strike hydrothermal vent field

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The continuous improvement of underwater platforms and optical technologies have provided access to images of the deep seabed enabling the mapping of habitats and large epibenthic organisms. Despite extensive survey efforts, distribution of vent and non-vent species have been rarely resolved over vent field scales. To assess the sphere of influence of hydrothermal activity with spatial distribution, we mapped the habitat and associated biological and microbial assemblages at and around four active vent edifices of the Lucky Strike vent field with parallel transects of seabed images covering a total surface of ~23340 m². Edifices in the South-East harboured large mussel assemblages associated with zoanthid

assemblages. The low cover of mussels and the absence of zoanthids at the south-central edifices suggest the importance of mature edifices to host extensive cover of vent assemblages at more mature edifices in the South-East. In addition to "white material" associated with vent activity, we observed the wide distribution of orange deposits, testifying of another source of primary productivity endorsed by iron-oxidising mats suggesting their geochemical significance. A few morphospecies dominated the non-vent communities. Near venting areas, morphospecific distribution was driven either by affinity or avoidance to active venting and/or the presence of hard substratum. Our study highlighted the potential of seabed image acquisition to better apprehend the different mechanisms responsible for the hydrothermal influence over 10s of meter around vent exits. This study identifies new research perspectives to characterise the trophic influence of the vent habitat on epibenthic megafauna for which a targeted sampling can now be designed.

16. Physiological response and skeletal dissolution of the cold-water coral *Desmophyllum pertusum (Lophelia pertusa)* to multiple environmental stressors

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The cold-water coral (CWC) *Desmophyllum pertusum (Lophelia pertusa)* is an important ecosystem engineer, forming complex three-dimensional reefs in the deep sea. These reefs consist of both live corals and dead skeletal parts and are associated with high biodiversity. However, CWCs are threatened by various environmental stressors due to climate change. Previous laboratory studies mainly focused on the effects of individual environmental factors, especially elevated temperatures and reduced pH. So far, little is known about the effects of reduced oxygen concentration and food availability on CWCs and the combined effect of all these stressors. Therefore, we are conducting a long-term aquarium experiment with *D. pertusum* under end-of-century conditions. We are investigating the combined effect of increasing pCO_2 (400 and 1000 ppm), elevated temperature (9 and 12 °C), reduced oxygen concentration (80 % and 100 %) and reduced food supply (25 and 50 mg C m^{-2} d^{-1}) on coral mortality, calcification, respiration, and energy reserves over one year. In a parallel experiment, we are also examining dissolution rates of live and dead skeletons at different pCO_2 levels (750, 1000 and 1250 ppm) using buoyant weighing and computed tomography (CT) scans to better predict how ocean acidification will affect the structural integrity of CWC reefs in the future. Here we will present preliminary data collected after six months of the experiment. After three months, calcification rates were lowest in the multiple stressor treatment with reduced food availability. The dissolution rate of dead coral skeletons was highest at lowest seawater pH. We hypothesise that live corals are able to cope with projected environmental changes over short time periods, but not over one year. In the long-term, we predict the combination of all four factors will negatively impact the physiology of *D. pertusum*, mainly driven by warming and reduced food availability.

17. Do cold-water coral mounds act as breakwaters for internal waves?

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Internal or baroclinic tides are common forms of internal gravity waves in the ocean, generated by surface tides as they travel over rough seabed and carrying an estimated 1TW (10^{12} Watt) of energy into the deep ocean. Previous studies suggest that that submarine canyons have a focusing effect on internal tides. Like surface waves on a shallow reef or beach, internal waves may break over rough topography. Breaking of internal waves leads to energy conversion, increased mixing, sediment resuspension and current intensification. Whether internal waves break depends on their angular velocity, latitude, the slope of the seabed and 'buoyancy frequency', a seawater property that describes the restoring force acting on internal oscillations. Consequently, high resolution surveys of the seabed as well as accurate oceanographic measurements are required to understand the interaction of internal waves with coral mounds. In this study of the upper Porcupine Bank Canyon (PBC), west of Ireland, an array of seven Acoustic Current Doppler Profilers (ADCPs), over 30 CTD casts and 25-m resolution bathymetry are used to identify and map natural seabed features that form breakwaters for internal waves at various tidal frequencies. While previous research has focused on diurnal (M1) or semidiurnal (M2) frequencies, this study suggests that higher frequency lunar overtides (M4/M6) are most likely to break at the slope of cold-water coral mounds in the upper PBC. This may have facilitative effects such as the formation of a goldilocks zone for suspension feeders and other organisms, adding an additional potential explanation for increased beta diversity in the periphery of coral mounds.

18. Effects of various abiotic stressors on the early life stages of the cold-water coral (CWC) *Lophelia pertusa*

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Lophelia pertusa is increasingly endangered due to climate change and human impacts. Although the impacts of these threats on the adults are well-documented, there is a significant knowledge gap regarding their early life stages. Therefore, the aim of this study was to investigate the combined impacts of ocean acidification (OA) and sediment plumes from bottom trawling, as well as the potential consequences of microplastic (MP) pollution on the early life stages of *Lophelia pertusa*. The cumulative effect of (OA) and bottom trawling was studied through experimental treatments consisting of two scenarios of OA (ambient and elevated pCO2 levels projected for the end of the century) and natural

benthic sediments (0 and 5 mg/mL). Embryos at the 2-4 cell stage and 12-day-old larvae were subjected to these treatments for 48 hours and one week, respectively and their survival rates, embryo development, and larval swimming speed were measured. The results showed no significant effects of high pCO2 and sediment plumes on the survival of embryos and larvae, and no significant variation in embryo size. However, after one week, larvae exposed to high pCO2 and sediment plumes, both individually and in combination, exhibited a notable decrease in swimming speed. This decline might have adverse effects on larval dispersal, connectivity, and predator susceptibility. The impact of microplastic pollution was assessed using 6 µM fluorescent polystyrene microbeads. Four-week-old larvae were exposed to three treatments: no MP, 1000 pristine MP/mL, and 1000 biofouled MP/mL. Survival rates and ingestion behaviour were examined after 24 hours. The larvae's feeding behaviour on MP was also investigated during a 15-minute exposure, comparing the effects of pristine MP with and without the presence of food (fine fraction of copepods). The results revealed high survival rates (>70%) across all microplastic treatments after 24 hours with no significant differences. Furthermore, microplastic ingestion occurred exclusively in the presence of food, yet the larvae promptly expelled the particles within 15 minutes, indicating efficient mechanisms for recognizing and rejecting non-edible materials. The larvae's simple digestive system could prevent microplastic retention, may potentially explain their rapid expulsion. Results will be discussed in the context of the potential consequences on the dispersal potential and connectivity among *L. pertusa* populations.

19.Comparison of eDNA and whole community metabarcoding methodologies for analysing the distribution and diversity of deep sea meiofauna: a case study in the North-West Atlantic Ocean

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Studying the diversity of remote environments such as deep-sea ecosystems is challenging. Compare to classical morpho-taxonomic methods, high throughput sequencing of environmental DNA (eDNA) and/or whole community metabarcoding (WCM) offer a rapid promising alternative to assess the biodiversity. However, still handling and processing of the samples that meets the standard quality for benthic monitoring of oligotrophic ecosystems remains to be tested. Hence, besides completing the map of meiofauna biodiversity, the two main aims of this project were to 1. explore the diversity of deep-sea meiofauna communities, and 2. compare the precision and competence of two methodologies of WCM with two sample sizes (BulkMeta, and MiniMeta), and eDNA analysis of a small sub-sample from overlaying water and sediment (eDNA-W and eDNA-S) of the same ecosystem in particular for monitoring of deep sea meiofauna. Therefore, during IceDivA2 expedition, we collected samples from four areas (including 7 stations) located in abyssal plains at west of the Mid-Atlantic Ridge. Using MiSeq platform, sequencing reads have been produced for the two hyper variable region (V1V2) of 18S rDNA. A total of 1104 meiofauna species (ASVs clustered by 3% cut off threshold) from 6 phylum dominated by Nematoda, Arthropoda (mainly Harpacticoid copepods) and platyhelminths were obtained. Both types of WCM samples revealed significantly higher diversity compared to the eDNA

samples, in which BulkMeta showed the highest diversity of detected meiofauna. Furthermore, analyses of the meiofauna community structure demonstrated that stations close to Azores have the most unique meiofauna community (289 exclusive species) followed by Labrador Sea, Sea Mounts and 52-39, respectively, while only 73 species were common in all areas. This study demonstrated that compare to eDNA analysis, WCM is more accurate tool for exploration and monitoring of meiofauna deep sea biodiversity and there is a positive correlation between the sample sizes, and detected meiofauna species.

20.Changes in the development of the Guinea Dome off Cabo Verde during the Holocene

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A sediment core recovered from 4,394m depth southwest off Cabo Verde, has been studied in order to reconstruct the past Guinea Dome dynamics. According to our age-depth model based on 3 Accelerator Mass Spectrometry (AMS) radiocarbon (^{14}C) datings, the sediments cover an age range from 11.18 to 1.26 (ka BP). The sedimentation rates vary between 1.2 and 2.8 cm/kyr. We studied the following palaeoceanographic proxies: 1) planktonic foraminifera assemblages, 2) joint Mg/Ca ratio and stable carbon and oxygen isotope ($\delta^{13}C$ and $\delta^{18}O$) analyses performed on specimens of the surface-dwelling planktonic foraminifera *Globigerinoides ruber* and the sub-thermocline dwelling *Globorotalia truncatulinoides*, and 3) X-ray fluorescence scans of the sediment cores. The proxy data demonstrate a significant oceanographic variability within the study area. We distinguish three periods between 1.26-2.02, 2.66-3.36 and 9.99-11.18 ka BP, which are characterized by sub-thermocline conditions that were on average 2°C cooler, compared to the remaining Holocene. In contrast, sea surface conditions remained rather constant. The subsurface cooler events coincide with a lowered planktonic foraminifera biodiversity and a decreased salinity gradient between sea surface and sub-thermocline. Our results are interpreted in terms of temporal variations in the intensity of the Guinea Dome, which is characterized by the local uplift of isotherms caused by the regional cyclonic circulation. Accordingly, the sub-thermocline waters experienced cooling during intervals of more intense doming, while no significant change at sea surface occurred. The strengthening of the doming would further result in the loss of some surface/intermediate dwelling foraminifera species leading to a lowered biodiversity, as observed in our data. By characterizing the changes in the open ocean during the Holocene, we enhance our

understanding of the significant environmental shifts that impacted the low latitudes during this time period, as evidenced by the green-to-desert Sahara transition at the end of the African Humid Period.

21. The ecological enigma of *Ledella ultima* (E. A. Smith, 1885): An in-depth assessment of genetic diversity and population structure in an abyssal protobranch

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The abyssal plains of the Atlantic Ocean are inhabited by a highly diverse protobranch bivalve fauna. *Ledella ultima* represents the most common species of its genus in the Atlantic and occurs below 3000 m depth on a pan-Atlantic scale. Despite the circumscribed distribution of *L. ultima*, its population structure and genetic diversity have been found to be remarkably low, suggesting a highly connected population. Additionally, other species of *Ledella* Verrill & K. J. Bush, 1897 have broadly overlapping distributions and depict a highly conservative morphology, seemingly co-occupying ecological niches. These patterns make their inter- and intraspecies diversity puzzling. In this study, we explore this ecological enigma by examining the morphology, proteomic fingerprint, phylogenetics, and population structures of our pan-Atlantic *L. ultima* samples. Using novel mitochondrial sequences (COI: 124, 16S: 128), we discovered two distinct haplotype clusters within *L. ultima*, as well as three differentiated clusters. However, further analysis of morphology revealed no recognisable dissimilarities between them and previously considered indicative morphological characters are present in multiple groups. Similarly, these groups are indistinguishable from their proteomic fingerprint. We further explore both the population structure within *L. ultima*, as well as its relation to cohabitating sister-species. Our results highlight remarkable patterns of geographic distribution, population structure, and speciation. Deeper and broader understanding of the processes that drive these patterns are vital to our understanding of the abyssal ecosystem and the deep-sea as a whole.

22. Tropical Atlantic current variability in model simulations and observations

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The upper wind-driven circulation in the tropical Atlantic Ocean plays a key role in the basin wide distribution of water mass properties and affects the transport of heat, freshwater, and biogeochemical tracers such as oxygen or nutrients. It is crucial to improve our understanding of its long-term variability which largely relies on model simulations due to sparse observational data coverage especially before the mid-2000s. We applied two different forcing products to a high-resolution ocean model which resolves the complex zonal current field in the tropical Atlantic. Where possible, we compared the simulated results to long-term observations. We found that in simulations the strength of the wind stress curl above the upwelling regions of the eastern tropical North Atlantic is important to set the mean strength of the off-equatorial surface and subsurface currents north of the equator. Too strong wind stress curl above the upwelling regions seems to overestimate the subsurface currents resulting in unrealistic seasonal variability. The simulated decadal to multidecadal variability of the tropical Atlantic current field can, to a large extent, be explained by changes in the Sverdrup dynamics. The combination of both simulations and observations reveals that the recent strengthening of the EUC can be indeed interpreted as a recovery from a weak phase the current experienced since the late 1990s. Where it has become common place for models to explain processes behind ocean observations, we postulate that long-term observations, once they have reached a critical length, can be used to test the quality of wind-driven simulations. This study presents a comprehensive overview of tropical Atlantic current variability from seasonal to multidecadal timescales.

23. Cumulative impact of low oxygen and SMS particles on the vent fauna

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Deep-sea mineral resource extraction potential mining activities can impact deep-sea biota through the generation of sediment plumes dispersing across vast areas of the ocean by accident or by continuous discharging. Suspended sediments can affect the fauna and their physiology. This activity will happen with an already going climate change. This will be an added stressor to the communities. The deep-sea hydrothermal vents, despite a large environmental variability in what regards pH, oxygen concentration, temperature, and primary productivity, will also be affected by climate change, since the large majority of the hydrothermal vent chemistry are oxidative processes, that depend on the oxygen concentrations in the water column. We report the results of an aquaria-based experiment testing the effects of low oxygen and suspended particles generated during a potential mining activity accident on the juveniles of the vent mussel *Bathymodiolus azoricus*. Mussels were collected from the Lucky Strike hydrothermal vent field (Azores, NE Atlantic) at 1700 meters depth in 2021. Mussels were maintained in 1-L aquaria and exposed to four experimental treatments for a period of two weeks at the DeepSeaLab aquaria facilities (Okeanos-University of the Azores): (1) control conditions (no added sediments and normal seawater oxygen); (2) low oxygen (a differential of 30 micromol from the normal oxygen concentration) (3) suspended polymetallic sulphide (PMS) particles; (4) Low oxygen +suspended polymetallic sulphide (PMS) particles. PMS particles were obtained by grinding PMS inactive chimney rocks collected at the hydrothermal vent field Lucky Strike. Particle types were delivered 420 mg L-1 on day 8 and day 11. The putative effects of low oxygen, PMS particles, and the cumulative effect were evaluated through measurements of the mussel physiological responses at the levels of the organism (oxygen consumption, ammonium excretion), tissue (stable isotopes and elemental analyses).

24. Insights into Abyssal Benthic Ecosystem Functioning Under Reduced POC Flux Through In Situ Incubations and Linear Inverse Modelling.

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Abyssal benthic ecosystems are heavily dependent on Particulate Organic Carbon (POC) reaching the seafloor. Under future climate scenarios, the quantity and quality of seafloor POC will change, with a reduction predicted for most of the global deep seafloor. A mechanistic understanding of how POC influx regulates abyssal ecosystem functioning is necessary to help predict how other parallel stressors may behave against a backdrop of reduced POC flux. In a space-for-time substitution experiment, we compared C cycling through specific ecosystem pathways under contrasting trophic regimes: the Porcupine Abyssal Plain (PAP) with a relatively high POC influx, and the Cabo Verde Abyssal Plain (CVAP) with a relatively low POC influx. A Benthic Respirometer Lander was deployed five times at the CVAP during the *iMirabilis2* research expedition to perform stable isotope tracer experiments and study Sediment Community Oxygen Consumption (SCOC), DIC production, and biomass and C turnover of bacteria, meiofauna, and macrofauna. These measures of ecosystem functioning were compared to PAP where a previous study employed similar methodology to the same level of food-web detail. A linear inverse model (LIM) of the food web was constructed for both CVAP and PAP to study C pathways that could not be measured *in situ*. Both our *in situ* experiments and the LIMs showed reduced C cycling, remineralization, and secondary production rates, with a shift to smaller unicellular and multicellular organisms dominating C cycling under reduced seafloor POC flux. Closer analysis of the LIM shows the CVAP network has been organized to increase cycling efficiency and deal with persistent low C input, with a particularly important and neglected role of Foraminifera. In contrast, the more eutrophic PAP network has not developed food-web structures to cope with low food availability and may be more vulnerable to climate change than already food-limited abyssal systems.

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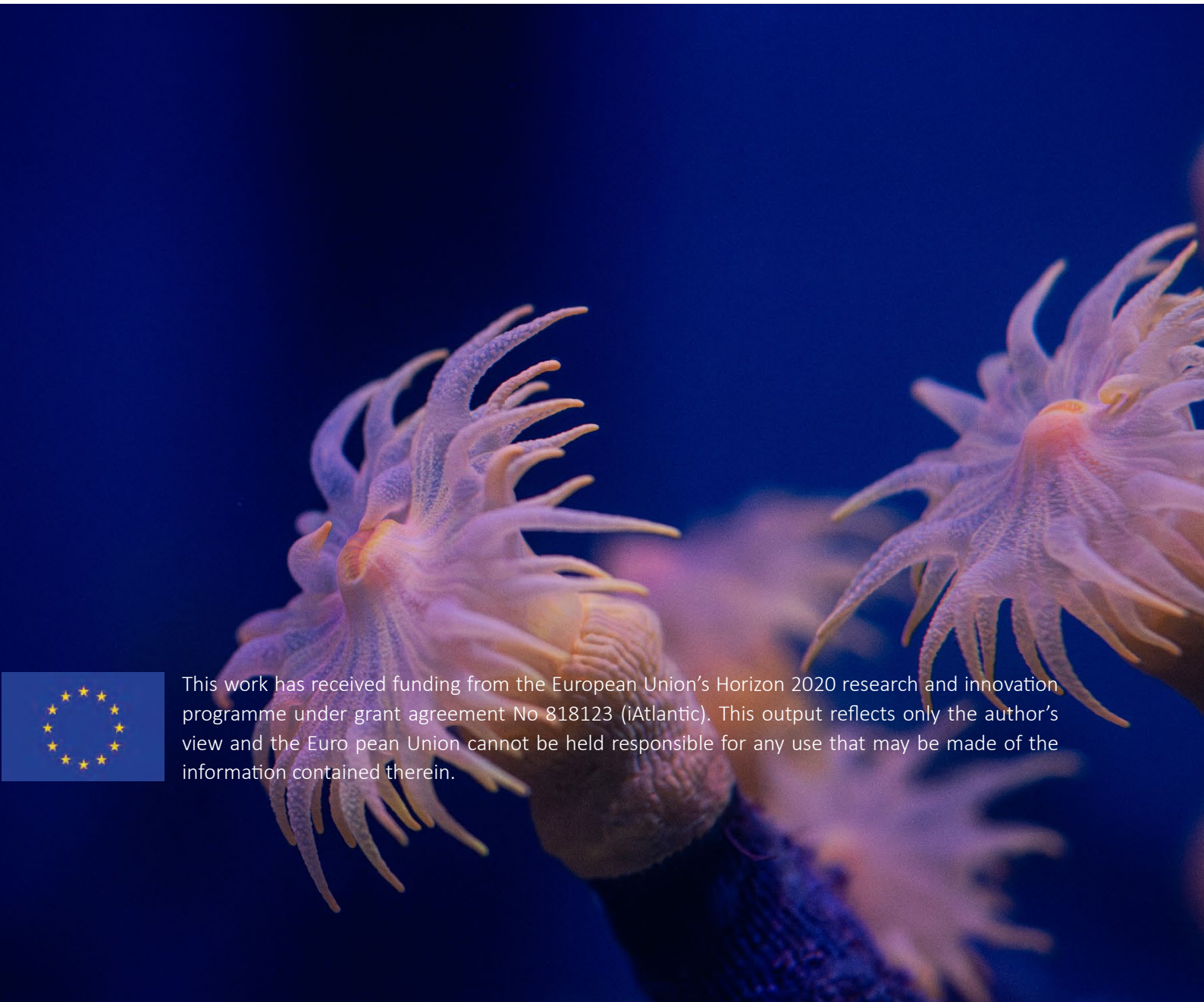

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