August 2024

Challenger Wave

Monthly newsletter of the Challenger Society for Marine Science (CSMS)

NEWS

2023 had highest annual mean sea level on record

National Oceanography Centre (NOC) scientists Dr Andy Matthews, Dr Jo Williams and Dr Svetlana Jevrejeva collaborated on the latest Met Office 'State of the UK Climate' report released on the 25th July 2024. Data from the tide gauge at Newlyn, one of the longest available records around the UK, continues to show that sea level is rising, with 2023 the highest year on record for annual mean sea level since records began. Raising awareness and education around sea level rise is key for NOC as it can have devastating consequences for coastal communities.

A section of the report authored by the National Oceanography Centre (NOC) assesses sea level change around the UK. Data from the tide gauge at Newlyn, one of the longest available records around the UK, continues to show that sea level is rising, with 2023 the highest year on record for annual mean sea level since records began. Ongoing problems with observations mean an accurate assessment for the whole of the UK cannot be produced, but other sites around the UK also had their highest or second highest year on record. The rate of sea level rise at Newlyn also continues to increase, with most recent trends estimating a rise of 4.6 ± 0.9 mm per year (1993-2023). For more information visit the NOC news article.

Dr Svetlana Jevrejeva is a sea level scientist at NOC, she said: "Tide gauge records provide robust observational evidence that sea level around the UK continues to rise due to increased rate of ice loss from the Greenland and Antarctic ice sheets, as well as continued glacier mass loss and warming of the ocean. The sea level record from Newlyn, one of our longest records starting in 1915, showed exceptionally high periods in 2023 especially in the second half of the year, which could lead to the greater impacts from storm surges observed during Autumn/Winter. In 2023 there were 16 extreme storm surge events, affecting coastal communities and infrastructure."

Weakening of the Atlantic Meridional Overturning Circulation abyssal limb in the North Atlantic

The abyssal limb of the global Meridional Overturning Circulation redistributes heat and carbon as it carries Antarctic Bottom Water from the Southern Ocean towards the Northern Hemisphere. Using mooring observations and hydrographic data from multiple sources in the North Atlantic, Biló et al. (2024) show that northward-flowing Antarctic Bottom Water is constrained below 4,500 m with a mean volume transport of 2.40 ± 0.25 Sv at 16° N.

The authors find that during 2000–2020, the Antarctic Bottom Water northward transport weakened by approximately 0.35 ± 0.13 Sv (1 Sverdrup = 10^6 m^3 s^{-1}), corresponding to a 12 ± 5% decrease. The weakening of the Atlantic Meridional Overturning Circulation abyssal cell is a probable response to reduced Antarctic Bottom Water formation rates over the past several decades and is associated with abyssal warming observed throughout the western Atlantic Ocean.

The authors estimate that the warming of the Antarctic Bottom Water layer in the subtropical North Atlantic is, on average, 1 m°C per year in the last two decades due to the downward heaving of abyssal isopycnals, contributing to the increase of abyssal heat content and, hence, sea-level rise in the region (1 m°C = 0.001 °C).

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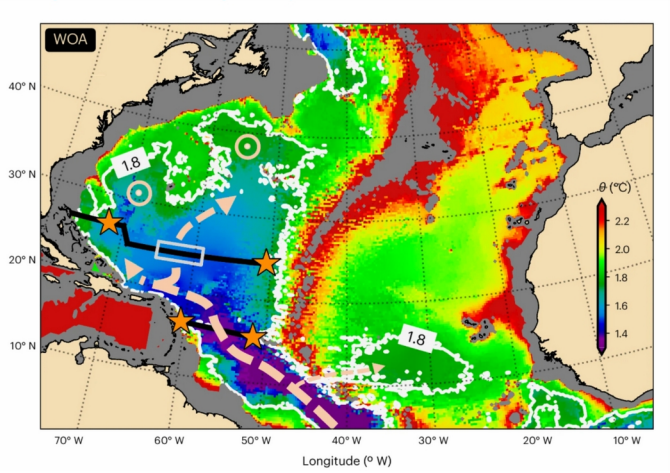
This warming trend is approximately half of the Antarctic Bottom Water warming trend observed in the South Atlantic and parts of the Southern Ocean, indicating a dilution of the signal as the Antarctic Bottom Water crosses the Equator.



The Antarctic Bottom Water (AABW) distribution and its primary pathways in the North Atlantic. World Ocean Atlas (WOA) potential temperature θ values closest to the bottom of the North Atlantic tropical and subtropical regions overlayed with the AABW flow (that is, θ < 1.8 °C) direction and deep upwelling areas based on (dashed arrows and circles, respectively). The stars indicate the mooring locations from the Meridional Overturning Variability Experiment (MOVE, 16° N), Rapid Climate Change Meridional Overturning Circulation (RAPID, 24.5° N) and Western Boundary Current Time Series (WBTS, 26.5° N) programmes. The black line along 16° N represents the CTD transects from the MOVE programme and where the Guyana Abyssal Gyre Experiment (GAGE) moorings were also located. The black line farther north is the approximate location of the World Ocean Circulation Experiment-International Global Ocean Ship-Based Hydrography Investigations Program (WOCE-GOSHIP) CTD transects (that is, A05 line). The grey box bounds the mid-basin area where Deep Argo profiles are present along 24.5° N (65° W–59° W). Areas shallower than 3,000 m have been masked in grey. Click to see all the figures and read the paper.

PML led Transatlantic Research Project Endorsed as an Ocean Decade Action

The Atlantic Meridional Transect (AMT), a flagship UK government National Capability programme led and coordinated by Plymouth Marine Laboratory (PML), has been officially endorsed by the UN Decade of Ocean Science for Sustainable Development 2021-2030 ('Ocean Decade') as a Decade Action as part of the Biomolecular Ocean Observing Network (OBON).

The endorsement is a significant recognition of AMT's vital role in advancing oceanographic science and supporting international marine and climate policy. The AMT programme, established in 1995 and coordinated by PML, conducts an annual voyage from the UK to the South Atlantic. Covering a wide range of latitudes, including the rarely sampled North and South Atlantic gyres, AMT provides crucial in-situ measurements to validate satellite observations, with the high-quality data collected helping to inform policy decisions and national and international legislation. The programme's sampling approach includes open ocean, coastal waters, and a wide range of ocean conditions, capturing the Atlantic Ocean's diversity and complexity.

AMT is being endorsed by the Ocean Decade as part of OBON, which is designed to develop best practice for using eDNA and other biomolecular measurements for next-generation ocean observation. OBON is led by the Partnership for Observation of the Global Ocean, the global forum to promote and advance ocean observations (which has its secretariat based at PML), with partners all working together to make molecular datasets more accessible.

Under OBON, a new project, called "AMT-omics", is bringing together a variety of partners alongside PML, including the Marine Biological Association (MBA), the University of Southern California, St Francis Xavier University, The University of California (Irvine) and the University of Stellenbosch. This aims to:

- Collate all AMT molecular data to make it easy to find, access, use, and share
- Integrate molecular data from various methods to create valuable long-term data sets for the entire Atlantic Ocean.

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- Compare traditional and molecular data to ensure consistent long-term data as part of the transition towards increased automated sampling (for which molecular data will become the main source)
- Support the training of Early Career Researchers (ERC) molecular and bioinformatics skills through a POGO-sponsored fellowship.

Julian Barbière, Global Coordinator of the Ocean Decade and Head of the Marine Policy and Regional Coordination Section of UNESCO's Intergovernmental Oceanographic Commission (UNESCO-IOC), said: "We are proud to count the AMT program as part of the Ocean Decade. Ensuring accessible, timely, and actionable data and information to all ocean users is at the heart of our mission. It is the focus of the Decade Challenge 8, which aims to expand the global ocean observing system. But observations and data also underpin all other Decade Challenges. Programs such as AMT play an indispensable role in providing the data needed to support decision-making processes on complex ocean-related issues, and are essential to achieving the objectives of the Ocean Decade."

PML's Professor Andy Rees, project lead for AMT, said: "Long-term, sustained ocean observations are critical to our understanding of the ocean's role in the global climate system and the changes taking place within it. We're delighted that AMT has been endorsed as an Ocean Decade Action, which recognises the vital and unique role it plays in furthering biological, chemical, and physical oceanographic research while helping to develop the next generation of scientists and scientific methods."

Hydrothermal vents on the seafloor may help the Southern Ocean store carbon

Research from the National Oceanography Centre (NOC), University of Plymouth, University of Southampton and the British Antarctic Survey has found that hydrothermal vents could provide a vital source of nutrients for phytoplankton, tiny plants that help store carbon from the atmosphere in the Southern Ocean. The paper published in Nature Communications Earth & Environment shows that the nutrients iron and manganese, are released in boiling water ejected from hydrothermal vents deep underwater and can reach the ocean surface where phytoplankton live. These metals boost a critical component of the Earth's carbon cycle called the biological carbon pump, as phytoplankton use carbon dioxide from the atmosphere to grow which is then trapped within the ocean.

Example of a hydrothermal vent which are commonly found on the seafloor along mid-ocean ridges

The remote Southern Ocean is known to have a critical shortage of these nutrients, suppressing the rate at which phytoplankton can use and store carbon dioxide. It has been known for a long time that a primary source of the metals in the Southern Ocean is from land dust. However, when studying water samples collected in December 2019 to January 2020 from the surface to the Southern Ocean's seafloor kilometres below, scientists discovered an underwater plume of iron and manganese-rich water. Using state-of-the-art computer simulations, the team of scientists tracked the plume back to a source in the volcanic ridges crossing the Southern Ocean's floor. Chemical processes can gradually strip the metals out of the plume, but the simulations also allowed the team to show that it rises sufficiently rapidly to the surface to fertilise the Southern Ocean. Understanding the natural sources of these metals is vital for assessing the impact of proposed climate interventions such as artificial ocean fertilisation.

Dr. Chelsey Baker, Ocean Biogeochemical Model Analyst at the National Oceanography Centre and joint lead author said: "To avoid the worst outcomes of climate change, solutions

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have been proposed to enhance the oceans natural processes that remove carbon dioxide from the atmosphere. One suggestion is to fertilise places like the Southern Ocean with extra iron. However, we don't fully understand the consequences of this for the ocean's ecosystem. Knowing the natural sources of metals and how they support the biological carbon pump is crucial when assessing how effective such a direct climate intervention would be."

Dr Antony Birchill Marine Biogeochemist at the University of Plymouth University and joint lead author said: "To find evidence for a new source of these metal nutrients in the Southern Ocean is very exciting. We already know that hydrothermal systems could be important from studies elsewhere but to find evidence for one deep in one of the most remote places on earth, a place which we also know is important for the biological carbon pump, is a major breakthrough."

The research is part of the NOC led and NERC funded, CUSTARD (Carbon Uptake and Seasonal Traits in Antarctic Remineralisation Depth) project looking at how marine life influences the uptake and storage of carbon in the Southern Ocean. The CUSTARD project is part of the UK NERC Role of the Southern Ocean in the Earth System programme. To find out more, visit: https://roses.ac.uk/about/.

Opportunity for Early Career Researchers in Marine Science: Royal Society workshop on Contaminant Mixtures, 15 October 2024

I'm writing with details of an opportunity to participate in a Royal Society workshop relevant to marine science. The Royal Society is leading a policy project exploring the effects of contaminant mixtures in UK waters. This work is being steered by two of our Fellows, Professor Louise Heathwaite FRS and Professor Mike Depledge FRS, and spans both freshwater and coastal marine environments.

A key component of this project is a workshop on Tuesday 15th October, which will convene an interdisciplinary group of scientists with a range of government stakeholders. The workshop will explore what is and is not known about how contaminants (for example, heavy metals, pesticides, PCBs, etc.) interact and the effects of these interactions on riverine, estuarine and coastal ecosystems. As part of this, we will consider advances in monitoring, and regulatory challenges relating to the effects of contaminant mixtures.

We are looking for interested early- to mid-career researchers who might like to participate in this workshop. Specifically, we are keen to hear from researchers with expertise in marine ecology with a focus on pollution impacts, ecotoxicology, environmental modelling, water quality research and/or related fields.

Please feel free to circulate this invitation to your network. To register your interest, or with any questions, please contact science.policy@royalsociety.org with a short statement outlining your relevant expertise***:- Beatrice Widell, Programme Coordinator, Science in Public Life***

CIESM Science Council Elections Ahead

The time has come to call for dynamic, sharp candidates to the role of Chairs of the CIESM Scientific Committees during the next triennium. As members of the CIESM Science Council, the elected Chairs will work closely with the Director General to define the scientific strategic agenda and promote cooperation across the Mediterranean and Black Sea Basins. Researchers with international visibility and a strong taste for multi-lateral research are invited to apply. Women applications are particularly welcome.

The call is now open and will be closed on the 31st August. Information for applicants can be downloaded here. Chairs will be elected by secret ballot by Congress participants, between the 15th and 17th October at the Congress Reception Desk. More precisely, the selection process will unfold as follows:

(i) Candidacy (deadline 31st August);

(ii) Pre-selection of the most suitable candidates by the Advisory Board (deadline Mid-September);

(iii) Self-presentation of candidates to the electors at the CIESM Congress (15th October);

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(iv) Voting by Congress participants (between 15th and 17th October);

(v) Official nomination of newly elected Chairs at the CIESM Congress (18th October).

The CIESM Team is willing to help should you need more information.

The 2024 Challenger Society Sea Ice Special Interest Group workshop
This will take place on Monday 23rd September and Tuesday 24th September as an in-person event at The National Oceanography Centre, Southampton. The workshop is open to all, particularly early career scientists, with an informal atmosphere for talks or posters. Topics covered include polar atmosphere, ocean and cryosphere with an emphasis on sea ice modelling, processes and observations.

Presentations will be streamed online for those unable to participate in person. There is no registration fee for the meeting but, if you intend to participate, please fill in and submit the online registration form (UK Sea Ice Group Meeting 2024 | NOC Events (noc-events.co.uk) by 1st September at the latest. Further details of the agenda and timings will follow shortly.

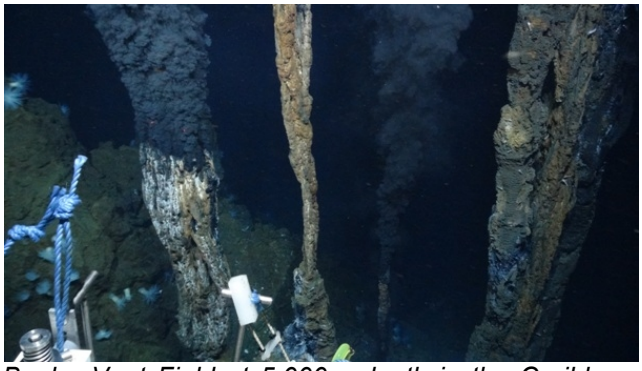
Please feel free to forward this announcement to colleagues or to relevant mailing lists. We look forward to seeing you at UK Sea Ice 2024. If you are looking to stay in hotels in Southampton please click here for further information; local organiser - ***Dr Yevgeny Aksenov, Marine Systems Modelling, National Oceanography Centre Southampton***

Marine Data Management, Governance and the MEDIN toolset
The Marine Environmental Data and Information Network (MEDIN) and OceanWise are delighted to invite you to attend our popular free online training workshop: 'Marine Data Management, Governance and the MEDIN toolset' on the 2nd - 6th of September 2024. Enrol now at: https://classroom.oceanteacher.org/course/view.php?id=1001 using enrolment key: MEDIN092024.

This training course is suitable for anyone responsible for collecting or managing marine environmental data, Including researchers, technicians, undergraduates or post-graduates. Prior knowledge or practical experience of data management is not required. The course features interactive training and discussion sessions, quizzes, and assignments to help attendees. The training is split into manageable pieces and spread over five days with live lessons in the morning and independent learning in the afternoons, which can be completed flexibly around your other work commitments. See the MEDIN website for more information on the workshops, or contact Roseanna Wright, if you have any questions.

The NOC Association AGM 2024
Video links and presentations from the annual meeting are now on-line.

How the UK stores marine rock samples, and how you can help
Marine rock samples collected by dredge or remotely operated vehicles (ROV) are an exceptional resource of immense scientific value which help inform geoscience research and contribute to the Natural Environment Research Council's (NERC) research areas including Earth resources, mantle and core processes, physics & chemistry of Earth materials and volcanic processes.



Beebe Vent Field at 5,000m depth in the Caribbean Sea. Image taken, February 2013, using the UK's remotely operated vehicle Isis, NERC, UK.

Currently, there is no repository for marine rock samples collected by UK Research and Innovation (UKRI) funded scientists and research ships so a Rock Store Working Group, involving the National Oceanography Centre (NOC), the British Geological Survey, the British Antarctic Survey and the Universities of Southampton, Strathclyde, Edinburgh and Manchester, is inviting the UK's marine science community to complete a survey which will help define the future requirements for marine dredge rock and ROV rock samples facilities. Results will be

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provided to the NOC Association of Marine Science National Capability Beneficiaries to consider next steps. The survey is open to UKRI-NERC funded scientists and the closing date for responses is 18 December 2024.

National Marine Facilities 2023/24 Technology Roadmap

The National Oceanography Centre has released the National Marine Facilities (NMF) Technology Roadmap 2023–24. The roadmap explains how NMF is developing the National Marine Equipment Pool (NMEP), ship-fitted instrumentation and supporting infrastructure. Through NERC national capability funding, these capabilities support marine science, large-scale research infrastructure, and enable the UK to contribute to the Global Ocean Observing System.

The 2023/24 roadmap considers how some recommendations from the Net Zero Oceanographic Capability (NZOC) summary report might be implemented over the next five years.

The UK National Decade Committee

The UK's National Decade Committee (NDC) was established to support UK contributions to the UN Ocean Decade. With government representatives and members from across a breadth of disciplines, the NDC includes researchers and early career professionals coming together to champion the UN Ocean Decade. Reports, meeting minutes and the terms of reference are available on the NDC website's Reports & ToR page. Please feel free to contact the secretariat if you would like to share ideas or have any questions about the UN Ocean Decade or the work of the UK NDC.

VIEWS

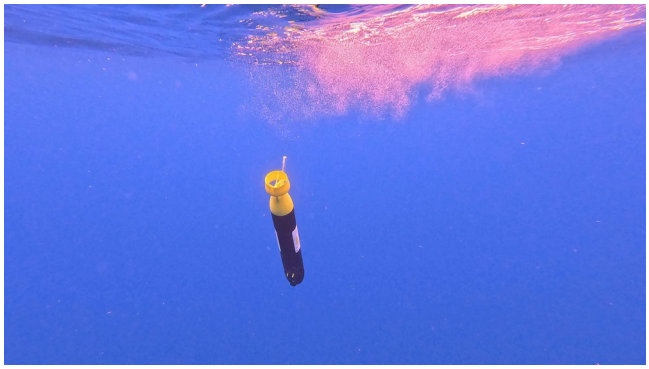
UK Meteorological Office CCRA4 call for evidence

The Met Office have put out a call for evidence for the 4th UK Climate Change Risk Assessment. The initial call will close at the end of September 2024, and encourages submissions from across the UK coastal and marine climate change community. The link is here Climate Change Risk Assessment Independent Assessment (CCRA4-IA) Technical Report - Met Office. The form is straightforward, with a series of tick box questions about the sectors or cross-cutting themes your evidence relates to. There isn't a specific marine or aquatic sector, but lots of categories related to things like nature and infrastructure, and a lot of interest in coastal issues. The Met Office have specifically asked for more marine-based evidence for this CCRA.

Evidence can be in the form of academic papers, project reports and other grey literature. It can be submitted via live links, uploads (up to 5 mB per file) or even freeform text. They are looking for anything published after June 2020. Please consider if you have evidence to submit and send on to your teams / colleagues. ***- Paul Buckley, MCCIP Programme manager***

EcoSUB AUV dives to new depths

During a recent deep water trials campaign in Madeira, an ecoSUBm25-Science Autonomous Underwater Vehicle (AUV) was launched and successfully completed a spiral behaviour to provide vertical profiling of the water column down to 2,000 m depth, and back again.



The ecoSUBm25-Science AUV is a disruptive technology, based on the extremely affordable ecoSUBm series AUV platform, it weighs just 12kg and is depth rated to 2,500m. Whilst most

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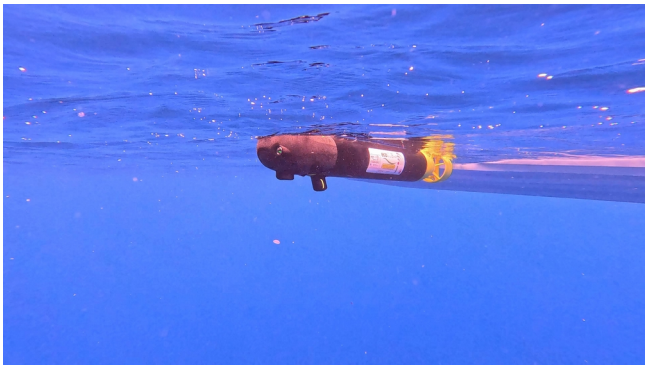
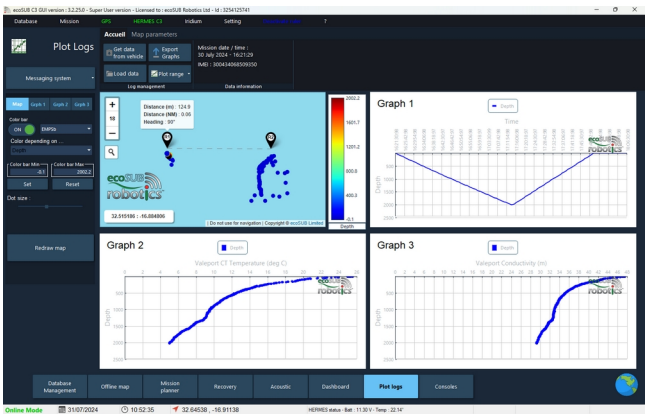
deep rated AUV technology is based on large and expensive platforms, costing millions of dollars, the ecoSUB platform is in the tens of thousands, providing a step-change in accessibility to autonomous ocean data collection for the marine science community and others.



The ecoSUBm25-Science AUV was equipped with a CTD and a Chelsea Technologies TriLux sensor, providing measurements of Conductivity, Temperature, Chlorophyll, Turbidity and Phycoerythrin. The m25 platform is also capable of hosting sensors to measure Dissolved Oxygen, CDOM, pH, Oil in Water, as well as navigation sensors such as altimeters and DVL, along with acoustic coms for underwater communications.

The 2,000m depth mission was completed on 30 July 2024. Launch and recovery was from Observatorio 1, a fast RIB research vessel, kindly provided by the Oceanic Observatory of Madeira, who generously supported the trials providing workshop and vessel support. This mission marks a world-AUV-first, industry leading 2,000m deployment for a micro-AUV system, proving real world technology to aid ocean data collection.

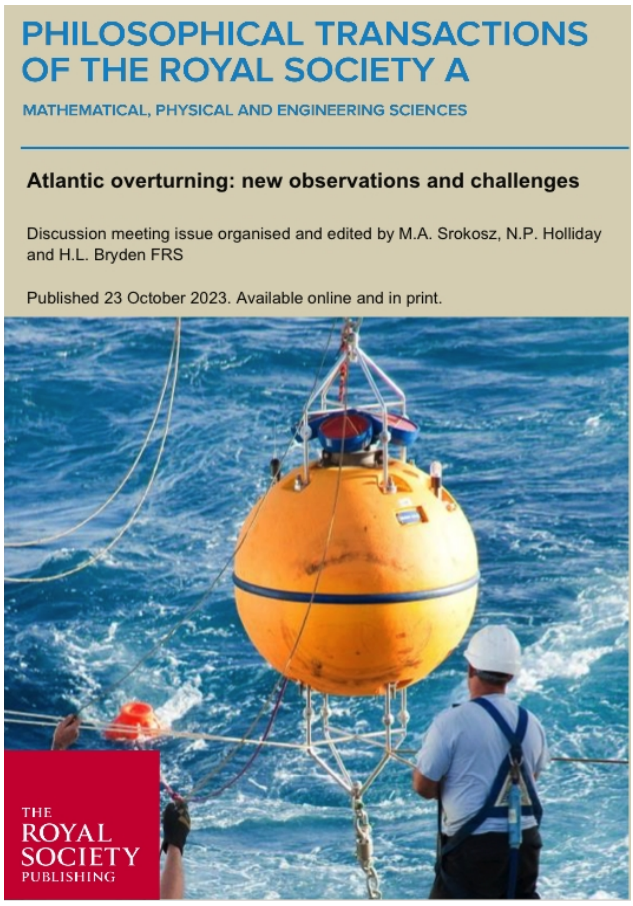


Furthermore, on board navigation and mission parameters maintained a launch point and recovery point separation of just 125 meters, demonstrating the systems ability to maintain a straight down and straight up capability. Total mission length was 1h 40m. Maximum depth recorded was 2,002 meters.

For more information about the ecoSUB family of affordable AUV systems please visit and contact us via www.ecosub.uk. View a short video of the mission here https://www.youtube.com/watch?v=c4K7T8Ij7KM.

Royal Society Special Issue

Published in October last year, **Atlantic overturning: new observations and challenges** organised and edited by M A Srokosz, N P Holliday and H L Bryden FRS, is now one of our most widely read issues of the Royal Society Publishing *Philosophical Transactions A.* The articles are available at www.bit.ly/ TransA2262.



The print issue can be purchased at the reduced price of £40 per issue by contacting sales@royalsociety.org.

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SALTS

RRS Discovery expedition marked 10th anniversary of crucial AMOC observations

Scientists from the National Oceanography Centre (NOC) and the Scottish Association for Marine Science (SAMS) have returned on the RRS *Discovery* from the DY181 expedition, marking a decade of ongoing observations of a crucial part of the Atlantic Meridional Overturning Circulation (AMOC). The expedition, part of the Overturning in the Subpolar North Atlantic Program (OSNAP) studies the AMOC component that flows through the Rockall Trough and Iceland Basin.

2024 marks the 10th anniversary of the OSNAP array data, which provides vital insights into changes in the AMOC through an international effort involving several scientists from multiple countries. The expedition was also the first conducted under the recently announced AtlantiS programme (Atlantic Climate and Environment Strategic Science), which is exploring the ocean's role in mitigating climate change.

The AMOC is a complex system of ocean currents that carries heat northwards towards the Arctic Ocean. It sustains mild temperature conditions in Europe compared to similar latitudes in North America. On the way north, these warm waters lose heat to the atmosphere and sink into deeper depths, carrying cold, freshwater, nutrients and anthropogenic (human-caused) carbon South.

The RRS *Discovery* set sail from Aberdeen, Scotland, on the 3rd of July and docked in Reykjavik, Iceland, on the 28th of July. During the expedition, scientists, technicians and crew recovered dozens of moored instruments that have been in the ocean for the last two years measuring ocean properties (such as temperature, salinity, oxygen and pH) and currents in depths between 50m and 2800m. Scientists downloaded the data before returning the instruments to the water for another two years. During DY181, nutrients, dissolved inorganic carbon, total alkalinity and oxygen were measured at different depths in the ocean to give a better view of the changes in the chemical properties of the ocean.

New technologies, including lab-on-chip sensors were used in collaboration with the CHALKY project and telemetry installed in the moorings was tested in collaboration with RAPID-Evolution. Lab-on-chip aims to automate water sampling for surface carbon chemistry parameters. Telemetry on moorings will allow scientists to collect data remotely using autonomous vehicles or ships of opportunities in between mooring turnarounds, which marks an important step toward near-real-time deep ocean data and reduces the risk of data loss if the mooring cannot be recovered. Read more news at https://www.o-snap.org/news-events/blog/.

Can the twilight zone be fished responsibly ?

When exploring anything new, particularly an area of scientific enquiry, it helps to consult the experts who already know the subject inside and out. So that's what Ciara Willis, an MIT-WHOI Joint Program Ph.D. student, did. In her case, the experts were tuna and swordfish who spend their summers in the Northwest Atlantic, diving between the surface waters and the mesopelagic or ocean twilight zone (also known as mid-water) off the coast of Cape Cod. "We're leveraging the skills of the tuna and the swordfish as information collectors, as ocean samplers, and oceanographers, because they have the ability to collect information that we don't," she said.

Willis' advisor, Simon Thorrold, a senior scientist at WHOI, was first drawn to twilight zone research after tagging studies turned up surprising results: These large open ocean animals were spending much more time in deep water than previously thought. The information Willis asked tunas and swordfish to gather (which, it should be noted, they were doing anyway) revolves around their diet and what it might reveal about the twilight zone, a critically

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important part of the ocean. It spans from about 200 to 1000 meters below the ocean's surface, is a primary source of food for many large open ocean animals, and plays a key role in carbon sequestration processes.

WHOI scientists release a newly tagged yellowfin tuna. (Photos courtesy of Camrin Braun © Woods Hole Oceanographic Institution)

Around the world, due to the growth in both aquaculture and nutraceutical industries (both of which depend on fish meal and fish oil), interest has been growing within the commercial fishing sector to begin harvesting fish from this part of the ocean. "There is a truly immense amount of fish in the mid-water," Willis said, "estimated at about 10 billion tons, and that's just fish, never mind all the squid, shrimp and other invertebrates." And yet, there is little available data on how commercial fishing of the ocean's mid-water might impact economically important surface fisheries like those for tuna and swordfish.

Scientists have long known that both tuna and swordfish depend on the mesopelagic zone to some extent, they both dive down deep with some regularity, but exactly how much they need it and what exactly they need it for, has largely remained unknown. Without establishing a baseline of information, it will be difficult to know if this part of the ocean can be fished responsibly, especially since much of the fishing would take place in international waters, where transparency and accountability are harder to establish.

Enter Willis, who sees her work as helping to enable a precautionary approach, the idea that actions with unknown consequences should be avoided and decisions with potentially disastrous effects should not be rushed. "There are dark holes in our understanding of the mesopelagic, including the connections between this zone and highly migratory ocean predators," Willis said. She believes considering food webs and predator–prey interactions is a key part of sustainable fisheries management.

Camrin Braun, a marine ecologist at WHOI who works closely with Willis and Thorrold, said, "If we start extracting the biomass at some meaningful scale, not only are we impacting a resource that we don't fully understand," meaning the life in the mid-water, "but it will almost certainly impact a resource that we have been using for centuries," referring to high-value fisheries like tuna and swordfish. Stomach contents, however, have their shortcomings: "They only provide one snapshot in time," Willis said, "so they're not necessarily reflective of the whole diet."

The researchers also looked at liver tissue, which provides a broader picture of where a predator's energy comes from. Body tissues contain essential amino acids that are built from carbon atoms. In the ocean, essential amino acids are only formed at the base of the food web by primary producers like phytoplankton or microbes, so the isotopic ratios of their carbon atoms are fixed from the beginning and stay intact all the way from the bottom of the food web to the top. Different ecosystems' food webs are fuelled by different primary producers, potentially resulting in unique isotopic "fingerprints" among the food webs.

Willis and other researchers have determined unique isotopic signatures of food webs from surface waters and the mid-water and they can compare these signatures in tissues of the predators. The composition of their tissue, which is formed by metabolizing the food they eat, shows where they have been eating and, in this case, whether prey species were residing primarily in surface waters or the twilight zone. It

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turns out that swordfish get just over a third of their carbon from the mesopelagic zone, despite spending half of their lives there. But bigeye tuna, who spend only 16% of their time down below, get 67% of their carbon from mesopelagic species. For yellowfin tuna, it's even more dramatic: they spend 3% of their daily time in the ocean twilight zone, but half their carbon comes from there. Given this discrepancy, it appears likely that yellowfin tuna are foraging at night on mesopelagic fish and invertebrates that are migrating into surface waters to feed.

Ciara Willis inspects specimens in the WHOI necrospy suite. (Photo by Daniel Hentz, © Woods Hole Oceanographic Institution)

Determining these baselines will prove valuable to the fishing industry and regulatory agencies as commercial interest increases. It's also crucially important to understand these dynamics and the various forces at play as the ocean continues to undergo massive and rapid changes resulting from climate change, ocean acidification, and other pressures on global fishing stocks. "I've established the isotopic baselines for these deep versus shallow food web communities," Willis said. "With climate change or heavy fishing pressures, we can now check in with those communities and see how they are shifting or find out how maybe the key players of the food web are changing."

The unknowns in this area and the rapidly shifting nature of the ocean have made this a particularly exciting area of research for Willis, who is also passionate about collaboration between scientists and policy experts. Di Jin, a senior scientist at the Marine Policy Center at WHOI, has been a lead scientist in WHOI's Ocean Twilight Zone Project with Thorrold and others since the project started in 2018 with funding from the Audacious Project housed at TED (Technology, Education, Design). The project has two goals: first to better quantify how carbon moves through the twilight zone and second, to understand the implications of large-scale fishing in this part of the ocean as a dimension of food security in the coming decades.

As a bioeconomist, Jin has studied the economic implications and feasibility of allowing industrial fishing in the ocean's mid-water. Willis' work is beginning to inform that research by providing data that helps evaluate the potential impact on other fisheries. "The impact on valuable surface fisheries has been recognized," said Jin, "but it's never the focus of this concern," although now, he said, "this issue has become, through her work, an important one to be examined." Willis said one of the most exciting parts of the project was that their findings would be accessible and perhaps useful to the fishing community, and Jin's expertise and connections are making this possible. Braun, too, finds this an especially motivating and important aspect of their work: "I'm very excited about trying to enable fishers and fisheries to be proactive in the climate space, to the extent that we can leverage whatever science that we're doing to develop climate-resilient fishing strategies," he said. "It's a win–win for everyone."

Read the original article *here*. The research was funded by the Ocean Twilight Zone project (funded as part of the Audacious Project housed at TED), the WHOI Ocean Venture Fund, a Natural Sciences and Engineering Research Council of Canada (NSERC) Postgraduate Doctoral Scholarship, and an MIT Martin Family Society of Fellows for Sustainability Fellowship. ***:- by Tatiana Schlossberg, Woods Hole Oceanographic Institution***

CALENDAR

2nd-6th September 2024: Challenger Society for Marine Science conference 2004

Oban, Scotland

Details of the conference are on the Challenger 2024 website: https://challenger2024.co.uk. Oban is a beautiful coastal location, but as a tourist destination accommodation gets booked

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up very quickly. If you are interested in attending, it is advised that you book accommodation as soon as you can. Accommodation options can be found on the conference website and there may also be an option for free camping at SAMS for those who would like to reduce costs.

10th-12th September 2024: ICOS Science Conference 2024, from GHG observations through science to services.
Versailles, France
ICOS (Integrated Carbon Observation System) is pleased to open the Call for Abstracts with the overarching theme "From GHG observations through science to services", the sessions cover ICOS's three domains, Atmosphere, Ecosystem and Ocean.

More information can be found here:https://www.icos-cp.eu/news-and-events/science-conference/icos2024sc/call-for-abstracts.
The ICOS Science Conference logo can be downloaded for this purpose here. Keep up-to-date with the latest ICOS Science Conference news on our channels:

- ICOS Science Conference website: https://www.icos-cp.eu/news-and-events/science-conference/icos2024sc
- ICOS Science Conference newsletter: https://www.icos-cp.eu/news-and-events/newsletters
- X (formerly Twitter): https://twitter.com/ICOS_RI
- LinkedIn: https://linkedin.com/company/integrated-carbon-observation-system
- Instagram: https://www.instagram.com/icosri/

23rd-24th September 2024: Challenger Society Sea Ice Special Interest Group workshop
Southampton, UK
This will take place as an in-person event at The National Oceanography Centre (NOC), Southampton. The workshop is open to all, particularly early career scientists, with an informal atmosphere for talks or posters. Topics covered include polar atmosphere, ocean and cryosphere with an emphasis on sea ice modelling, processes and observations.

Presentations will be streamed online for those unable to participate in person. There is no registration fee for the meeting but, if you intend to participate, please fill in and submit the online registration form (UK Sea Ice Group Meeting 2024 | NOC Events (noc-events.co.uk) by 1st September at the latest. Further details of the agenda and timings will follow shortly.

Please feel free to forward this announcement to colleagues or to relevant mailing lists. We look forward to seeing you at UK Sea Ice 2024. If you are looking to stay in hotels in Southampton please click here for further information; local organiser - ***Dr Yevgeny Aksenov, Marine Systems Modelling, National Oceanography Centre Southampton***

23th-26th September 2024: IMBIZO7, Transitioning towards Sustainable Ocean Governance by 2030, Commitments and Challenges
Rabat, Morocco
IMBeR will hold its seventh IMBIZO (the Zulu word for 'a gathering') at the Institut Agronomique et Vétérinaire Hassan II (IAV) in Rabat, Morocco. IMBeR aims to promote and enable transdisciplinary marine research towards ocean sustainability and its governance. Topics addressed during IMBIZO7 will showcase current and emerging research, and explore potential solutions towards sustainable ocean governance by 2030, the target of multiple global sustainability initiatives.

We will follow the usual IMBIZO format of three distinct but interacting workshops. To optimise discussions, the number of IMBIZO7 participants will be limited to about 120 people (around 40 per workshop). The workshop topics are:

1. Science based adaptive management and policy responses to the causes and consequences of eutrophication.
2. A framework for development of social-ecological models of transformative change for sustainable ocean management.

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3. Governance transformations for resilient fisheries and aquaculture: Progressions, challenges and opportunities, imber.info/imbizo7-workshop-3/.

Plenary keynote presentations and poster sessions will enable you to learn about the work of participants in other two workshops.

14th-18th October 2024: 43rd CIESM Congress: Marine and Cultural Heritage in the Heart of the Mediterranean
Palermo, Italy
Join us after a 2-year hiatus imposed by the global pandemic and subsequent issues, we are excited to resume our traditional marine research showcase. This event will foster scientific excellence and promotes peaceful dialogue across the Mediterranean and Black Sea basins. Sicily, the chosen location for our next congress, offers a stunning backdrop, combining marine science with rich coastal heritage in a region steeped in cultural and historical significance.

Dive deep into the realm of open science with our first morning plenary panel. This strategic discussion will explore the benefits and challenges of open science practices, towards more sustainable and reliable scientific publication policies. Join leading experts debating on popular science, unbalancing and distorting science, incentives versus regulations, science marketing and non commercial licences, and ethical use of AI.

You can now register online. Please, do not hesitate to contact us if you need any additional information, but be sure to check first our Congress webpages.

Our 2024 CIESM (The Mediterranean Science Commission, headquartered in Monaco) Congress will explore a wide range of marine disciplines, featuring multidisciplinary scientific sessions and contextual side events that will immerse you in the unique Sicilian atmosphere. Save the date and stay tuned for regular updates on the rich scientific and cultural programme throughout 2024.

17th-19th October 2024: Arctic Circle 2024 Assembly
Reykjavik, Iceland
For more information, http://www.articcircle.org.

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OCTOBER 17-19

A new initiative, the Business Forum will be announced at this assembly. Participants will benefit from a wide range of connections, opportunities and networking events, along with discussions on future trends, entrepreneurship and finance.

18th-20th October 2024: 'Archwiliwch ein planed - Explore our planet' public event
Cardiff, UK

In partnership with the Natural Environment Research Council (NERC) and Techniquest,

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Cardiff, we are excited to announce a free public event 'Archwiliwch ein planed - Explore our planet'. The event will offer a blend of hands-on attractions and in-person talks led by the UK's leading environmental scientists, and we're even bringing one of our world-leading research vessels RRS J*ames Cook.*

'Archwiliwch ein planed - Explore our planet' will include free, ticketed access to Techniquest, the Cardiff based science discovery centre: focused on exploring the world of science, technology, engineering and mathematics for schools, families and adult visitors. Dr John Siddorn, NOC CEO, said: "This is a unique opportunity for the public to visit a working research ship and understand what life on the ocean is like for our researchers and crew. Our scientists and technologists can be at sea for weeks at a time, carrying out critical research under difficult conditions. It takes great skill across a range of disciplines to understand the ocean. Adults and children can see first-hand what it's like on the ship, and we may even inspire some to become the oceanographers of the future".

5th-7th November 2024: Marine Alliance for Science and Technology, Scotland (MASTS), annual science meeting
Glasgow, Scotland
The MASTS ASM will take place at the Technology & Innovation Centre, and we have officially opened the call for special session and workshop ideas. Stay up to date with all the latest news on our ASM webpage.

Abstracts for talks and posters are now invited for our general science sessions or one of our five special sessions. Abstract submission deadline is 22nd August.

Abstracts are invited for sessions on:

- General Science Sessions (any field of study related to marine science)
- Multiple Stressors
- Sea Lice Surveillance and Monitoring
- Deep Sea
- Marine Biogeochemistry
- Marine Mammals in an Ocean of Change

Special sessions (focussing on a specific topic or area of science) can take place on either Tue 5th or Wed 6th November. They would be in plenary in one of the large lecture theatres, may have the option of remote viewing and are generally 2 hours long. Special session organisers can have a call for abstracts or devise a programme of invited talks.

We are pleased to confirm our first special session for the 2024 MASTS ASM. Pitcairn's MPA (Marine Protected Area) is the 3rd largest in the world, is a platinum level Blue Park Award winner, and its purity as a fully intact marine ecosystem provides an important scientific reference point in measuring the impact of climate change. The session will cover the ambition of the new Marine Science Base on Pitcairn, scientific evidence on the health of marine biodiversity through recent science expeditions and the efforts of the Pitcairn Islands Government in protecting such a large MPA, with the support of the Blue Belt Programme.

Workshops are to be held on Thurs 7th November, and can be anything from a half to a full day. These allow an opportunity for breakout sessions/small group working/discussion etc. We have access to 8 conference rooms and an Executive Suite for workshops. The rooms are of different sizes and can accommodate a variety of delegate numbers depending on the format of the room and the type of workshop you may wish to run. MASTS provide the room, catering, registration etc, but the actual programme and running of the workshop would be down to the workshop organiser. If you would be interested in hosting a special session or running a workshop as part of the event, please contact Emma Defew via email.

As part of the MASTS Annual Science Meeting, Prof William Austin (University of St Andrews) and Prof Hilary Kennedy (Bangor University, Emeritus) are hosting a workshop on "Filling knowledge gaps and identifying priorities for Blue Carbon". This workshop will take place in-person in Glasgow on Thursday 7th November (1030-1600). Part of the workshop will be dedicated to talks on blue carbon, and abstracts are now invited for short talks (10-15mins) that illustrate the growing power or constraints of current data sets, modelling or mapping that can advance or limit the evidence base, conceal or reveal the priorities needed to support Blue Carbon (BC) Ecosystems inclusion in national and international policy as well as carbon accounting.

A current grouping of BC ecosystems (BCE), based on the evidence available to support

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climate mitigation, are termed “actionable” and include seagrass, tidal marsh, and mangrove. Another group of BCEs, termed “emerging” include macroalgae, tidal flats and subsurface sediments, while a third grouping are termed “non-actionable” (sometimes also referred to as “supporting” BCEs) and include corals, shellfish and maerl. If you would like to submit an abstract for this workshop, please submit your abstract using this form before close on Tuesday 1st October.

We are pleased to announce that MEDIN Marine Data will be running a workshop at this year’s Annual Science Meeting on "Marine Data Management, Governance, and the MEDIN Toolset". With data management being such a critical skill, underpinning the integrity, efficiency, and impact of research, this workshop will enhance attendees’ knowledge and skills in marine data management as well as introducing MEDIN's catalogue of useful resources. This is an open workshop, but particularly aimed at PGRs. Find out more below and check MEDIN's website for more workshops; find out more here.

“Linking conservation/restoration projects with community empowerment”. The purpose of this workshop is to start a discussion regarding how to transition existing marine conservation/restoration research projects into ongoing community-led environmental projects through community empowerment. It will include short presentations by those working with communities on conservation/restoration projects, detailing lessons learned and best practice. This will be followed by a facilitated session to identify a generic theory of change.

“Tracking top predators in marine renewable energy development areas”. An opportunity for the marine wildlife tracking community (i.e., academia and industry) to come together to identify key knowledge gaps and provide “best practice” guidance on the advantages and limitations of tracking data in the context of assessing effects of marine renewables on wildlife.

“Innovations in sea lice monitoring”. Scotland is undergoing a new approach to sea lice management through the new sea lice risk assessment framework. The framework calls for improved sea lice monitoring methods, both targeting the in-water larval stages as well as automation of sea lice counting on farms. This workshop will look at innovations in methods for monitoring sea lice.

Abstracts are invited for 12-minute presentations or 5-minute speed talks, for a special session that will explore the theme: ‘Marine mammals in an Ocean of Change’. Contributions are welcomed from all career stages, from anyone working on this topic that would like to present (e.g. academia, consultancy, industry). We would encourage talks on topics related to marine mammals and changing oceans (for example, related to climate change, anthropogenic impacts (e.g. fishing activity, vessels, renewable developments)). Projects do not need to be complete or have results to be considered for inclusion, we would welcome early-stage PhD students or similar to consider submitting abstracts.

“Designing multiple driver experiments”. This workshop is aimed at students and ECRs new to multiple driver experiments. It is focused on the design of manipulation (laboratory or field) experiments, though many of the concepts are applicable to observational data.

5th-7th November 2024: Marine Autonomy and Technology Showcase
Southampton, UK
MATS registration is now open. MATS has proudly grown over the last decade to become one of the foremost events in the marine technology calendar, attracting presenters and delegates from around the world. Huw Gullick, Managing Director of NOC Innovations, said: "This will be our 10th MATS and whether you are joining us for the first time or are an event regular, we are looking forward to celebrating the occasion with you."

25th-28th November 2024: The 4th Mediterranean Geosciences Union Annual Meeting.
Barcelona, Spain
The 4th MedGU Annual Meeting will be held this year in-person and online. Visit our website (www.medgu.org) to learn more about the event. On this occasion, we are pleased to invite you to attend the conference and share/discuss your latest research findings. Your participation in-person or virtually will support MedGU’s mission

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of ensuring a sustainable future for humanity in the region and for the planet.

11th-13th March 2025: The 4th Ocean Visions Biennial Summit.
Vancouver, Canada
We're thrilled to announce that the 4th Ocean Visions Biennial Summit 2025 will be held in March in Vancouver, Canada. This action-oriented event will bring together scientists, policymakers, innovators, funders, students, and others to explore solutions and strengthen partnerships to help restore our ocean and stabilize the climate. We invite you to be part of the movement. Join a multidisciplinary community focused on advancing solutions to the ocean's most pressing challenge, climate disruption.

Programming will be highly interactive and include ample opportunities for collaboration. Participants can look forward to:

- ***Sharing & Learning****:* Gain insights from inspiring keynote speakers and panel discussions on the forefront of ocean-climate research and innovation.
- ***Workshops****:* Dive deeper with fellow attendees on challenges and issues of mutual concern.
- ***Networking****:* Connect with leading experts, industry pioneers, and decision-makers shaping the future of ocean-climate health through time devoted to building and strengthening relationships.
- ***Collaborating****:* Forge partnerships and collaborations to accelerate the impact of your work in ocean-based climate solutions through interactive, action-oriented sessions and activities.

Registration information coming soon; we look forward to hosting this special convening of the ocean-climate community, our fourth biennial summit, and hope to see both new and familiar faces.

The CSMS email address is challenger.society@gmail.com. Contributions for next month's edition of Challenger Wave should be sent to: john@myocean.co.uk by the 30th August.

JOBS and OPPORTUNITIES

Research Faculty Position - Oceanography

Open at the Cape Eleuthera Institute in The Bahamas. This is a great opportunity for an ECR (PhD preferred) to start an independent research program whilst joining an existing collaboration working with sea gliders in the western Atlantic. This is a teaching and research role with a teaching component 2-day per week commitment during spring and autumn semesters.

Apply here: **Research Faculty (Physical Oceanography)**

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There are jobs in the IMBeR newsletter

- Assistant Scientist, United States of America, Florida, USA. Open until filled.
- Marie Skłodowska-Curie Actions Postdoctoral Fellowships (MSCA-PF), University of Aveiro, Portugal. Apply by **11 September**.
- Full Scholarship for Master's in Marine & Lacustrine Science. Cook Islands Investment Corporation, Avarua, Cook Islands. Apply by **19 November**.
- Humboldt Research Fellowship for postdoctoral researchers and experienced researchers. 6-24-month research stay in Germany. Applications open.
- 2024 Antarctic-related Fellowships for early-career researchers. Apply by **9 September**.
- 2024 NF-POGO Open Call for Shipboard Training Fellowships is now open.
- Call for Applications: Atlantic Project Awards 2024. Apply by **20 September**.

There are jobs in the MASTS newsletter

New vacancies:

- Marine Ornithology Adviser (5 Positions) – NatureScot – 21/08/24
- Natural Environment Research Council – Future Leaders Council Members – 17/09/24
- Professional Secretary – HELCOM Secretariat – 03/09/24
- Research Assistant Fish Epigenetics – Swansea University – 02/09/24
- Research Officer (Post Doctoral) Fish Epigenetics – Swansea University – 22/08/24
- Estuaries And Coasts Advisor – Environment Agency – 27/08/24

Still open vacancies:

- Join the UK Women in Fisheries Team (2 roles) – Network Coordinator and Comms Officer – 20/08/24
- Future Marine Research Infrastructure (FMRI) Science Advisory Group Recruitment – UKRI – 20/08/24

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