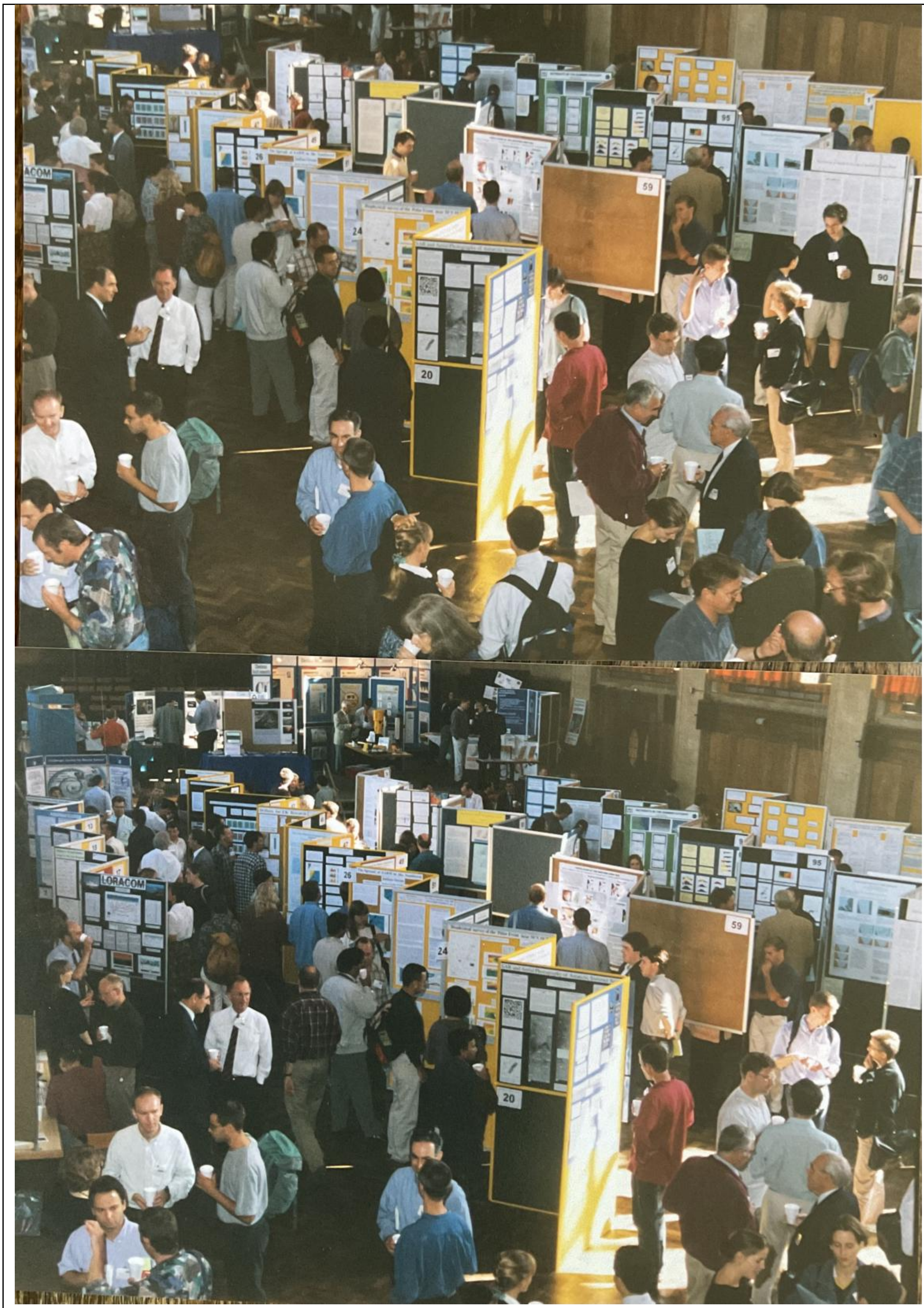

The poster session at the 1996 Challenger Conference here in Bangor. Is there any one you recognise? (Photo: Ed Hill)

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Disentangling the complex biogeochemical cycles that influence DIC export from the Norwegian Trench into the Atlantic Ocean

The North Sea is a productive shelf sea and a net sink of atmospheric carbon dioxide (CO_2). The continental shelf pump has been well established in this region for over two decades, exporting carbon to the North Atlantic via the Norwegian Trench, yet the fate of the absorbed carbon remains uncertain. The mixing of waters from different origins (Atlantic, Baltic and land runoff) and strong seasonal stratification make the trench a site of complex biogeochemical cycling that is difficult to constrain without high-resolution observations.

Within the NoSE (North Sea-Atlantic Exchange) project, we sampled the entire water column for dissolved inorganic carbon (DIC), total alkalinity, pH, macronutrients and hydrography along repeated transects in the Norwegian Trench during three consecutive late spring–summer cruises (2023–2025). The trench exhibits a two-layer stratified structure: a low-salinity, low-DIC, low-nutrient surface plume overlying DIC-enriched subsurface waters, the vertical signature of the shelf pump's surface CO_2 uptake and subsurface accumulation of remineralised DIC.

Here we characterise the vertical and horizontal distributions of these parameters, distinguishing the biogeochemically modified surface plume from the DIC-enriched subsurface layer that drives shelf carbon export. We examine the contributions of the multiple source waters that mix within the trench to the DIC inventory, and assess the interannual variability of these signatures. Together, these observations characterise the biogeochemical cycling between the North Sea and the North Atlantic, and provide first insights into the fate of the carbon absorbed by the North Sea.

Amir, Hana

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From colonies to reefs: multi-scale variation in coral trophic strategy

Heterotrophy plays a critical role in coral resilience and recovery following thermal stress. Although coral trophic strategies vary by species, location, and season, we lack a comprehensive understanding of how these strategies differ across spatial scales. Hence, we do not fully understand the extent to which scale-dependent feeding strategies contribute to the patchiness of coral survival observed across reefs. We investigated the trophic strategy and physiology of reef-buildings corals across multiple spatial scales comparing across (>50 km) and between reefs (patch vs outer rim reefs, >20 km), within reefs (<1.5 km) and among colonies (<3 m).. Coral nutritional modes were quantified using stable isotope analyses and paired with tissue biomass measurements to assess how trophic differences affect coral fitness across scales. Finally, we paired our biological data with satellite derived and in-situ environmental data to access how environmental regimes affect biological responses. Isotope and physiological analyses show significant differences in the mean across all spatial scales with the greatest variation observed at the smallest spatial scale. Environmental regimes like turbidity and upwelling modified responses within the same spatial scales over time. By elucidating the patterns and magnitude of variability in coral trophic strategies, this study contributes to a deeper understanding of coral resilience under escalating climate pressures and anthropogenic modification of the marine environment.

Ayres, Holly

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Freshwater-driven subpolar gyre cooling and atmospheric regime relationships using a large ensemble climate model.

The North Atlantic subpolar gyre is a key region of coupled ocean–atmosphere variability, where changes in freshwater content, upper-ocean stratification, and deep convection strongly influence regional and large-scale climate. Previous analysis using the CANARI Large Ensemble (HadGEM3-GC3.1) showed that winters with anomalously fresh surface conditions are associated with cooler sea surface temperatures and shallower mixed layers despite enhanced surface heat loss. This behaviour reflects strengthened upper-ocean stratification and reduced convective overturning, favouring subsurface heat retention and conditions consistent with the North Atlantic Warming Hole (NAWH).

Here, we investigate how this wintertime subpolar cooling relates to the overlying atmospheric circulation under different ocean cooling and atmospheric background states. We focus on extreme winter cooling events in the subpolar North Atlantic and assess their associated pressure responses in late winter. SST anomalies are analysed by removing the basin-scale mean, retaining regional variability and trends. Patterns are characterised using PCA and latitudinal structure metrics and grouped via Z-score standardised K-means clustering. We show that the atmospheric relationships with comparable SST cooling anomalies is strongly state dependent, depending on the prevailing circulation regime.

These results suggest that freshwater-driven ocean stratification changes may modulate atmospheric circulation through multiple dynamically consistent pathways, rather than through a single deterministic response. The findings highlight the importance of background circulation state in shaping coupled North Atlantic variability and provide new insight into the range of atmosphere–ocean feedbacks that may accompany continued subpolar freshening under climate change.

Baker, Chelsey

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Climate-driven shifts in Southern Ocean transport control nutrient trapping by 2300

The effects of climate change-driven impacts on ocean biogeochemistry have been widely explored out to 2100. However, due to the slow nature of ocean circulation, some consequences do not emerge until after 2100 but may already be in motion. One reported example is a reduction in nutrient export from the polar regions which have been reported to lead to widespread decreases in low latitude net primary production (NPP). Here, we explore the changes in NPP and Southern Ocean nitrate transport using Coupled Model Intercomparison Project (CMIP) 6 projections under an end-member shared socio-economic pathway (SSP5-8.5) that was extended to 2300 for 4 models. We focus on the role of Southern Ocean nutrient trapping to assess how different climate-driven responses in ocean circulation and biogeochemical processes may change by 2300. By 2300, we find consensus that nutrient trapping in the Southern Ocean occurs (+1-8% of nitrate inventory). In 3 out of 4 models, this is predominantly due to large-scale circulation changes, although biogeochemical recycling does drive shifts towards greater regenerated nitrate concentrations. There is strong inter-model variability in terms of the magnitude, distributions and partitioning of nitrate meaning that the connection between reduced nutrient export out of the Southern Ocean and divergent NPP responses outside the Southern Ocean remains complex. Future changes in NPP could have critical implications for fish biomass beyond the polar regions and this study highlights the importance of understanding the long-term impact of climate-driven changes on ocean circulation, biogeochemistry and biology and identifying the dominant driver(s).

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Climatic and Oceanographic Drivers of Calving at Totten Ice Shelf, East Antarctica (2015-2024)

Ice shelf calving is a primary mechanism of Antarctic mass loss, yet whether atmospheric, oceanographic, and sea ice conditions are anomalous relative to background variability at the time of calving remains unexamined for East Antarctic ice shelves. Here, this is addressed for Totten Ice Shelf, East Antarctica's largest and most dynamic ice shelf, between 2015-2024.

Fifteen calving events exceeding 10 km^2 were identified using the IceLines dataset (Baumhoer et al., 2023) and manual Sentinel-1 SAR delineation, quantified via the rectilinear box method (Loebel et al., 2024), totalling ~209 Gt. Atmospheric conditions, ocean swell, tidal forcing, and sea ice concentration were assessed using ERA5 reanalysis, WAVERYS, CATS2008_v2023 (IBE corrected), and the NSIDC Sea Ice Index v4 respectively. All variables were evaluated against a 2015-2024 monthly climatological baseline and tested for statistical significance against 30 randomly sampled bootstrap resampling windows.

Of eleven variables tested, only eastward wind direction ($p=0.018$) and eastward swell propagation direction ($p=0.0009$) were anomalous relative to background variability. Both reflect SAM driven strengthening of Southern Hemisphere westerly winds, which simultaneously displaces sea ice from the ice front, increases swell energy, and enhances CDW intrusion beneath the shelf. However, no single forcing regime was consistently associated with all events, indicating that calving is governed by internal stress thresholds, with external forcing acting as a timing modulator rather than the direct driver of calving. This supports a multi driver framework in which environmental forcing is assessed relative to background variability, rather than attributing calving to isolated drivers.

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Getting Started with Argo: Practical Guidance for New Users"

The Argo array is a collaboration of contributions from over 30 different countries. Funding mechanisms differ widely between countries and involve over 50 research and operational agencies. Each national program has its own priorities, but all nations subscribe to the goal of building the global array and to Argo's open data policy. Broader participation in the Argo project by many nations and research groups is encouraged either through float procurement, logistical support for float deployment, or through analysis and assimilation of Argo data.

The UK Argo programme is undertaken by a partnership between the Met Office and the National Oceanography Centre (NOC) which includes the British Oceanographic Data Centre (BODC), British Antarctic Survey (BAS) and University of Southampton (UoS) and is a strong contributor in helping to improve and understand our knowledge of many science areas. BODC acts as the UK Argo Data Assembly Centre (DAC), one of 10 Argo DACs globally, and is a crucial UK partner for operational purposes, research and development applications and creating Argo-based products.

This presentation will provide an overview of the Argo programme guidelines aimed at supporting new user adoption from an operational standpoint. It will cover key aspects such as mission planning procedures, data management requirements, an outline of BODC DAC's current capabilities, and the various stages of data processing. Our presentation will raise awareness among scientists of the value that can be added to their float data by joining the UK Argo program, and many benefits that come with that.

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We're krilling it: Climate driven changes in Antarctic krill distribution and carbon export

Antarctic krill are a keystone species in the Southern Ocean ecosystem and play an important role in regional carbon cycling. Rapid environmental change, including regional warming, declining sea ice extent and increasing fishing pressure is likely to alter krill distribution and abundance, with implications for ecosystem functioning and biogeochemical processes. However, existing growth and habitat models used to project future krill distribution do not represent the physical oceanographic processes and trophic interactions that drive krill dynamics.

For the first time, a global ocean biogeochemical model incorporating plankton functional groups and ecosystem interactions, PlankTOM, has been used to investigate Antarctic krill distribution and carbon export under future climate change. We modified model parameterisation to better capture Southern Ocean krill dynamics, including trophic interactions, grazing behaviour and environmental responses, before simulating future changes under different climate scenarios. Our model simulations reproduce broad spatial patterns consistent with observational data, including elevated krill abundance around coastal and shelf regions and within the Scotia Sea. Projected krill abundance is subsequently used to calculate regional carbon export, enabling assessment of how climate change may alter the biogeochemical role of Antarctic krill in the Southern Ocean.

By projecting future krill distribution and carbon export, this work will improve understanding of climate change impacts on Antarctic krill and their influence on Southern Ocean ecosystems and carbon cycling. Identifying regions vulnerable to changes in krill distribution, abundance and associated carbon export will support future conservation and management efforts, including sustainable fisheries management and marine protected area planning.

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Isolating Biogeochemical and Circulation Controls on Ocean Carbon Storage by the Biological Carbon Pump

Earth System Models participating in intercomparison projects such as CMIP6 differ in their underlying assumptions and prognostic biogeochemical relationships. These differences arise not only from the ocean biogeochemistry model itself, but also from the development of its coupled components, including ocean circulation, atmosphere and ecosystem parameterisations. In models that represent the Biological Carbon Pump (BCP) through NPZD-type ecosystems, differences in production, particle export, and tracer-controlled remineralisation pathways can lead to differences in transfer efficiency of particulate organic carbon from the surface to the deep ocean, and consequently substantial variability in biologically driven global ocean carbon storage. To investigate these uncertainties, we resolve the variety of particulate models in the CMIP6 ensemble within a 1-D framework in a Python package. Each particulate model is forced with prognostic biogeochemical tracers from different models in a “round-robin” approach to quantify the uncertainty associated with biogeochemistry. We combine this approach with first passage times predicted from CMIP6 transport matrices to further isolate the uncertainty associated with ocean circulation. By fixing the biogeochemical formulation and adopting circulation-sensitive tracer fields, this framework provides a basis for interpreting inter-model spread and identifying model-intrinsic biases that affect biologically-mediated global ocean carbon storage under projected climate change.

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Heat Transport Mechanisms Sustaining Ocean Circulation Beneath the Ice Shell of an Icy Moon

Many icy moons host deep subsurface oceans beneath thick ice shells. Heat generated through tidal interactions with their host planets is thought to provide sufficient energy to sustain liquid water beneath the ice. Understanding how this heat is transported throughout the ocean is therefore essential for explaining the dynamics, circulation, and the resulting meridional variations in ice-shell thickness, one of the most observationally constrained properties of these extraterrestrial oceans. In this study, we investigate the mechanisms responsible for ocean mixing and transporting tidally generated heat in deep oceans (order of 50 km depth), from the ocean floor to the ice shell above. We examine the role of processes across multiple scales, including small-scale convection, intermediate-scale baroclinic eddies, and large-scale Taylor-column-like structures. Using high-resolution numerical simulations, we explore how the interaction between these dynamical processes drives meridional heat transport and contributes to spatial variations in ice-shell thickness. Our results aim to improve the understanding of ocean circulation and heat redistribution in icy moons, with implications for their long-term thermal evolution and potential habitability.

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Interannual Variability of the Anthropogenic Carbon Budget of the North Atlantic

The North Atlantic (NA) plays a major role in mitigating the increase of atmospheric CO_2 with its high uptake and storage of anthropogenic carbon (C_{anth}). This is thought to be driven by the Atlantic Meridional Overturning Circulation (AMOC): in its northward flowing upper limb, strong surface heat loss enhances the CO_2 solubility pump and nutrient supply fuels high biological productivity. These carbon rich surface waters are then transported to depth and into the AMOC's southward flowing lower limb, enabling long term sequestration. Given a potentially weakening AMOC, a key question is whether the NA can maintain its effectiveness as a CO_2 sink under future climate change.

Surface CO_2 flux products have greatly improved our understanding of air-sea CO_2 exchange and its drivers, but they cannot separate natural and anthropogenic components. Here we address this gap using a NA box-model framework that, for the first time, separates natural and anthropogenic fluxes on an annual timescale. By combining high-resolution C_{anth} transport estimates into and out of the region from the subtropical RAPID and subpolar OSNAP mooring arrays with new estimates of C_{anth} storage, we infer the C_{anth} air-sea fluxes using a budget approach. We describe how the anthropogenic and natural components of the air-sea fluxes vary in magnitude, how their contributions to net regional CO_2 uptake evolve with time, and how this variability relates to AMOC strength across multiple timescales.

Together, these results provide the first observation-based view of how overturning-driven variability shapes the NA's evolving role in the global anthropogenic carbon sink.

Bricheno, Lucy

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Climate change impact on seabed stress and mobility.

Sea level rise and climate change will impact currents, waves, and their interactions, especially in nearshore regions where the relative importance of water depth becomes large. Coastal and shelf seas host sensitive ecosystems and are becoming increasingly important to human activities, particularly with the rapid development of offshore renewable energy infrastructure. It is therefore essential to understand the implications of climate change in these environments. Here we use numerical modelling simulations from the NEMO ocean model and WaveWatch III spectral wave model to project future changes in waves and ocean currents, with particular focus on seabed stresses around the Northwestern European Shelf. We run two-month simulations in summer and winter for present-day, mid-century, and end-century periods, estimating the combined contribution to seabed stress from ocean currents and orbital wave energy. We show that, on average, increasing water levels are expected to reduce stress acting on the seafloor by decoupling surface wave signals from the bed. Conversely, transient storm events, expected to become more frequent and intense in the future, lead to a strong increase in seabed stress. Individual storm events generate stresses up to an order of magnitude higher than regular currents in calm conditions. This process can alter sediment mobility at the bed and consequently affect local benthic habitats. For the first time, we present maps of seabed mobility by estimating the coarsest grain size that can be mobilised by the seabed stress projected in future scenarios.

Brown, Pete

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Variability in biogeochemical Arctic outflow through Davis Strait

Polar ocean ecosystems are a key source of nitrogen (N) and phosphorus (P) to global oceans. Climate change is already affecting elemental cycling at the poles, but interruption of polar nutrient exports could suppress global primary productivity and fisheries by around a quarter over multi-century timescales. It is thus essential to constrain both the mechanisms and variability of these fluxes, and their global implications.

The Arctic specifically exports an excess of P relative to N (P*), equivalent to ~90% of the net phosphate flux to the Atlantic at 47°N, supporting a significant fraction of North Atlantic N-fixation. Of the Arctic gateways, Davis Strait has the strongest net southwards transport. A mooring array has been tracking volume and freshwater transports there since 2004, yet biogeochemical transports remain poorly quantified. To address this gap, two autonomous water samplers were deployed at the western boundary of Davis Strait in 2022 targeting the P*-rich core of the Baffin Bay outflow (~100db), with ~2-week sampling over two years tracking both nutrient exports and the variability in their N:P relationship.

Initial results show strong seasonal cycles, potential interannual variability, and enhanced southward exports in late summer/fall. While volume transport variations dominate the overall signal, chemical concentration variability substantially impacts shorter timescales. The high-resolution sample analysis reveals clear seasonal pacing alongside distinct spatial differences between the two mooring sites. Early indications also suggest longer-term changes in outflow N:P ratios. Ongoing work will further refine transport estimates and assess implications for Arctic–Atlantic nutrient connectivity.

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OBPS as a Cross-IOC Initiative for Community-Driven Ocean Best Practices and AI-Assisted SOP Development

The Ocean Best Practices System (OBPS) has reached a major milestone. At the 33rd Session of the Intergovernmental Oceanographic Commission (IOC) General Assembly in June 2025, Decision IOC-3.4.4 formally transitioned OBPS from a GOOS–IODE project into an IOC-wide system. This shift reflects the growing importance of best practices as a cross-cutting need across ocean observing, data management, capacity development, and science-policy integration.

As an IOC system, OBPS now provides a collaborative framework for programmes and regional subcommissions to develop, review, share, and sustain best practices. This strengthens coordination across the ocean observing value chain and enhances alignment with global initiatives such as the UN Decade of Ocean Science. A central goal is enabling transparent, community-driven processes for creating and maintaining interoperable practices.

This poster presents a pilot initiative to develop an AI-assisted Standard Operating Procedure (SOP) for nutrient sampling in coastal environments. The project explores how generative AI workflows can support scalable, reusable best practices aligned with OBPS policy. Using guidance documents, workshops, expert input, and community review, tools such as NotebookLM, Claude, and Gemini are applied to synthesize structured SOPs. The workflow incorporates iterative cycles of AI generation, expert review, revision, validation, and compliance assessment.

The pilot demonstrates how AI can accelerate best practice development while preserving rigor and traceability. Emphasis is placed on source attribution, reproducibility, metadata standards, and validation approaches inspired by AMLAS. Beyond producing a nutrient sampling SOP, the project establishes a reusable methodology for AI-assisted best practice generation across ocean science.

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and Sam Harthan-Evans, Sam

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Hidden Waves Beneath Polar Ice; Why internal waves matter for polar regions

Internal solitary waves (ISWs) are large-amplitude subsurface waves that propagate along density interfaces in stratified fluids and are increasingly observed in polar environments. Despite their importance for ocean mixing and energy transport, their interaction with sea ice and floating ice remains poorly understood. This study investigates how ISWs behave beneath ice and the implications for ice–ocean dynamics using controlled laboratory experiments.

Experiments are conducted in a stratified wave flume, where mode 1 ISWs of depression are generated using a lock-exchange mechanism. Both real ice and synthetic floating elements are employed to represent a range of ice conditions. High-resolution flow visualisation, including particle image velocimetry, is used to quantify wave structure, velocity fields, and energy dissipation. This framework enables systematic investigation of ISW–ice interactions that are difficult to capture in the field.

Results show that the presence of ice significantly alters ISW dynamics. Waves can steepen, distort, or break near ice edges, depending on the relative ice draft and stratification. ISWs also induce motion in floating ice, with floe dynamics strongly dependent on floe length relative to wavelength: smaller floes behave like passive tracers, while larger floes exhibit delayed but sustained motion. A simple model, assuming ice moves with the depth-averaged underlying flow, accurately predicts this behaviour. Additionally, wave-induced boundary layer separation at floe edges generates vortical structures beneath ice, although only a small fraction of wave energy is dissipated.

These findings demonstrate that sea ice acts as an active dynamical boundary, influencing both wave evolution and mixing processes. The results have important implications for understanding heat and momentum transfer beneath ice, improving parameterisations in climate and ocean models, and interpreting processes such as glacier calving-induced internal waves. Overall, this work provides new insight into ISW–ice interactions and their role in polar ocean dynamics.

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Ecosystem Response to Variable Source Water Inputs in the Canary Upwelling System: Insights from In Situ Incubation Experiments

Eastern Boundary Upwelling Systems (EBUS) are among the most productive marine environments, sustaining high biological production and globally significant fisheries. However, their response to climate-driven changes in upwelling dynamics remains poorly constrained, particularly how shifts in source water depth affect nutrient supply and ecosystem functioning. Nutrient availability and plankton community composition are key drivers of ecosystem response, yet their high spatial and seasonal variability makes predictions challenging. This study investigates how variations in source water depth and composition influence phytoplankton community structure, nutrient utilization, and carbon cycling in the Canary Upwelling System (CUS). During cruise DY204, a series of in situ incubation experiments were conducted offshore of Western Sahara and the southern Canary Islands along 26.5°N. Controlled mixtures of nutrient-rich waters from below the mixed layer and surface waters simulated contrasting upwelling scenarios, including varying contributions of North and South Atlantic Central Waters. Incubations were maintained under near-natural conditions for 48 hours, with sampling at initial and final time points. A suite of biogeochemical and biological variables was measured, including inorganic nutrients, dissolved inorganic and organic carbon, particulate organic carbon, chlorophyll-a, dissolved organic phosphate, and plankton community structure assessed via flow cytometry and imaging. This approach quantifies nutrient drawdown, shifts in stoichiometry, and changes in community structure under different mixing regimes. Linking experimental and satellite-derived productivity provides insight into the sensitivity of upwelling ecosystems under future climate scenarios.

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Simulated current velocities in the equatorial Pacific Ocean show opposite changes to those observed

Sea-surface temperature (SST) variability in the tropical Pacific plays a key role in regulating global climate through ocean-atmosphere coupled processes, giving rise to phenomena such as the El Niño–Southern Oscillation (ENSO). Observed SST trends in this region are often opposite in sign to those simulated by climate models. These models continue to struggle to accurately represent the subsurface processes that contribute to this mismatch, particularly those controlling heat uptake and surface temperature variability in the Pacific cold tongue region.

We investigate the representation of subsurface temperature and Equatorial Undercurrent (EUC) structure and change in climate models, and the impact these have on tropical Pacific SST. Using ocean-only model output from the Ocean Model Intercomparison Project Phase 2 (OMIP2) and observational data from the Tropical Atmosphere Ocean (TAO) array, we investigate model-observation mismatches in thermocline and EUC structure and trends between 1993 and 2018.

We find that ocean-only models fail to capture the long-term trends in Equatorial Undercurrent velocity, while they are relatively successful in representing observed subsurface temperature changes. We assess how mean-state biases, model resolution, and the process representation of vertical mixing contribute to these discrepancies in long-term trends. This work aims to contribute to climate model development and improve the accuracy of future simulations of tropical Pacific variability and its influence on the wider climate system.

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Observations of reduced stratification in the in the tidal wakes at a floating wind farm

With increasing pressure to meet Net Zero targets, offshore floating wind farms are being deployed in deeper, seasonally stratified shelf seas where their hydrodynamic impacts remain poorly understood. While previous studies have examined turbulence and mixing associated with fixed monopile foundations, the effects of floating wind structures in stratified environments have not yet been directly quantified.

This study investigates the development of a turbulent wake generated by tidal flow past a floating wind turbine and its impact on local water column structure. Observational data collected in August 2025 near the Kincardine and Hywind offshore wind farms were analysed, including towed temperature and dissolved oxygen profiles alongside coincident acoustic Doppler current profiler (ADCP) measurements. Stratification was quantified using potential energy anomaly (PEA), calculated from density inferred from temperature, and examined in relation to tidal phase and distance from the turbine structure.

Preliminary results indicate enhanced mixing within the turbine wake, characterised by reduced stratification and increased vertical exchange relative to background conditions. These changes are spatially confined but vary with tidal forcing, suggesting a strong dependence on flow conditions. Although localised, such perturbations may have implications for nutrient fluxes, oxygen distribution, and primary productivity in stratified shelf seas.

These findings highlight the potential for floating wind infrastructure to modify small-scale hydrodynamics in ways that are not captured by existing large-scale assessments. As offshore wind development expands, understanding these interactions will be critical for predicting ecosystem responses and informing sustainable marine management.

Crowley, Danielle

Collins, Claire; Barker, Joanna; Haque, Alifa Bintha; Godage, Lasuni Gule; Massey, Yoluène; Mourier, Johann; Ward, Sophie L; Wray, Ben; Robins, Peter; Curnick, David J

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Socio-cultural and relational values of elasmobranchs (sharks, skates and rays): current research and knowledge gaps

The socio-cultural and relational values of elasmobranchs (sharks, skates and rays) are poorly understood, despite their importance in tailoring context-appropriate conservation solutions. We conducted a systematic literature review using Boolean logic and a backwards citation search to assess their value through research, the techniques used, and whether spatial and species bias existed. Thematic coding analysis of 150 peer-reviewed articles suggests that elasmobranchs are valued for their contributions to livelihoods, storytelling and communities. Relational values relating to interactions, education, and personal identity were the most frequently identified. We also identified clear trends and biases in research. Research focused on large charismatic species. Most research was conducted by authors based in the Western hemisphere, generating a spatial bias in our understanding. Research tended to use surveys or interviews, with primarily male participants, instead of methods better suited to understanding complex values. We highlight priority gaps in values-based elasmobranch research and consider ways conservation policy could incorporate the values identified into practice.

Daly, Eoghan

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Surface Marine Heatwaves in Irish Waters

Marine heatwaves (MHWs) are increasing in frequency and intensity due to anthropogenic climate change, with growing evidence of their occurrence in the Northeast Atlantic. These events arise from interacting atmospheric and oceanic processes, including local heat fluxes, circulation patterns, and large-scale climate modes. MHWs can occur year-round, driving a wide range of ecological impacts, from shifts in species distributions to mass mortality events and habitat degradation, with consequences varying by season and ecosystem sensitivity. Despite recent extreme events, understanding of their impacts in Irish waters remains limited. This study addresses that gap by analysing trends in the occurrence and intensity of regional surface MHWs.

Here, a long-term (1982-2025) analysis of marine heatwave number, duration and intensity for the Irish region is presented, based on the Operational Sea Surface Temperature and Ice Analysis (OSTIA) system run by the UK's Met Office. Yearly duration and cumulative intensity (ºC day) linear trend analysis are shown for the whole Irish EEZ and, in more detail, at the locations of the M2-M6 met-buoys from the Irish Marine Data Buoy Observing Network. Analysis shows an increasing trend in the duration and intensity of surface MHWs throughout the region, especially in the Irish Sea, where MHWs have become increasingly persistent, at a rate of 24 days per decade. In addition, CTD observations are presented to characterise the vertical structure of the 2025 surface MHW in Irish Shelf seas, showing highly stratified water and a MHW thermocline at <16m depth. Finally, impacts on fisheries and ecosystems are discussed.

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The Scientific Value of Marine Sediment Archives for Future Discovery and Early Career Research

The British Ocean Sediment Core Research Facility (BOSCORF) sediment core archive at the National Oceanography Centre represents a globally significant scientific resource, preserving irreplaceable records of Earth's environmental history. Using non-destructive analytical tools such as X-radiography and X-ray fluorescence core scanning, BOSCORF enables detailed characterisation of sediment composition, structure and stratigraphy while maintaining archive integrity. These analyses support research into palaeoclimate, palaeoceanography, sedimentology, geohazards and environmental change.

The scientific value of these samples increases over time as new analytical techniques emerge, allowing archived material to be revisited at increasingly fine-scale spatial and geochemical resolution. Advances in imaging, geochemistry and environmental proxies continue to unlock new information from sediment cores collected decades ago, extending the scientific legacy of historic expeditions beyond their original objectives. Many BOSCORF cores originate from environments that are now difficult, hazardous or impossible to re-sample under equivalent conditions, including polar glacial systems, hydrothermal fields and geopolitically restricted regions, making them unique and non-repeatable scientific records.

Unlike digital data repositories, BOSCORF's core archive preserves lasting physical samples that are not constrained by outdated calibration methods or processing assumptions, permitting reanalysis and reinterpretation as scientific understanding evolves. Furthermore, the archive maximises the long-term scientific return of costly research expeditions, providing students and early career researchers open access to globally significant material (valued at ~£68.3 million) without the prohibitive costs of ship time and offshore sampling. BOSCORF's repository therefore serves as an onboarding platform for the next generation of scientists, providing unique opportunities and facilitating new discoveries.

Droste, Elise

Lénaïg Brun; Faron Quinn; Filipa Carvalho; Alex Brearley; Kate Hendry; Hugh Venables; Amber Annett; Siobhan Foden; Michael Meredith; Povl Abrahamsen; Andreas Cziferszky; Nathan Fenney; Andrew Fleming; Mark Inall; Katy Sheen; Benjamin Wallis; Ciara McDonal

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Waves of change in marine biogeochemical cycling due to glacial calving

Glacier ice calving generates underwater waves that cause ocean mixing on par with, or stronger than, mixing caused by tides and wind. In highly stratified coastal waters of Antarctica, mixing can significantly alter the water column's physical structure and surface biogeochemical (BGC) properties underpinning marine ecosystems and sea-air interactions. The NERC-funded POLOMINTS project (POLar Ocean Mixing by INternal Tsunamis) investigates these processes using multi-disciplinary observational methods.

We present observations from Ryder Bay, West Antarctic Peninsula, between January and April 2026, focusing on Sheldon Glacier calving events. Two BGC Slocum gliders surveyed the bay, collecting high resolution data. Twice-weekly, we deployed a CTD and micro-structure sensor from small boats and collected seawater for BGC analyses. We use these data to understand baseline conditions and changes due to calving events in nutrient fluxes, phytoplankton community composition, ocean productivity, and carbon export. Calving events were monitored throughout the season by standalone cameras.

One calving event occurred during sampling near the glacier front. The resulting internal wave was captured in shear and dissipation rate of turbulent kinetic energy data between 45-106 m with an estimated propagation of 0.45 m/s. We observed a shoaling of strong salinity and temperature gradients coinciding with enhanced turbulence, shoaling of the deep turbidity peak associated with a glacial meltwater plume, and a striking reduction in chlorophyll at 60 m (~-50%). These observations provide first insights and evidence that calving-driven internal waves may exert immediate and seasonal controls on Antarctic coastal biogeochemistry, with potentially increasing importance under future climate change.

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Impacts of eddy damping on the ocean stratification and general circulation

Eddies play an active role in setting the stratification of the ocean by transporting fluid laterally away from a lens, preventing further deepening. Current-wind feedback, or relative wind stress is a method of calculating wind stress which includes the effect of the ocean surface current. Including this surface current better reproduces the full effects of air-sea interactions. Relative wind stress is known to reduce wind power input by up to 35%, surface eddy kinetic energy by up to 50% and total eddy kinetic energy by up to 30%.

The effects of relative wind stress on ocean stratification are not well understood. MITgcm is used to investigate the impact of relative wind stress on the stratification, heat transport and overturning circulation for an idealised double gyre model.

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Resolving Daily Heat, Salt, and Biogeochemical Transports in the Florida Current

Understanding heat, salt, and biogeochemical transport through the Florida Straits is fundamental to quantifying the role of the Atlantic western boundary current in the meridional overturning circulation. As part of the C-Streams programme, three moorings were deployed across the Florida Straits at 26.5°N during two annual deployments from August 2023 to July 2025. Mooring A was located on the western slope at 79.72°W (557 m depth), while Moorings B and C were situated on the eastern side at 79.60°W and 79.58°W (743 m depth). Given their proximity, B and C are treated as a single site (Mooring BC). Each mooring was equipped with SBE37 MicroCAT instruments at three to five depths measuring temperature, salinity, pressure, and dissolved oxygen, alongside SUNA sensors at 2–3 depths recording nitrate at 4-hour intervals. Cross-sectional velocity fields were obtained from co-located acoustic Doppler current profiler (ADCP) measurements.

To enable property flux calculations, daily vertical profiles were reconstructed using the gradient-integration method of Johns et al. (2005). Monthly climatological profiles from the Western Boundary Time Series dataset provided background vertical gradients, while MicroCAT observations constrained variability at instrument depths. This approach ensured reconstructed variability was observation-driven. Daily profiles of temperature, salinity, dissolved oxygen, and nitrate were generated on a 10 dbar grid from 0 to 800 dbar and interpolated horizontally between moorings to produce a two-dimensional section with bathymetric masking. Combined with ADCP-derived velocities, these fields allow computation of daily heat, salt, dissolved oxygen, and nitrate transports across the Florida Straits over the two-year deployment.

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Quantifying short-term and multigenerational warming impacts on zooplankton rate processes and growth efficiency

Mechanistically understanding how temperature affects zooplankton physiology is essential to confidently predict climate-driven changes in ocean biogeochemistry. We established cultures of the calanoid copepod Acartia tonsa at different temperatures and conducted a series of experiments to disentangle the effects of short-term warming and multigenerational thermal acclimation on carbon-specific respiration, ingestion, and growth rates. We will present how varied thermal sensitivities of respiration and ingestion rates may result in negative warming-driven impacts on zooplankton growth efficiency, and how these impacts can be moderated by multigenerational acclimation.

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The Scotland–Canada overturning array (SCOTIA): twenty years of meridional overturning in the subpolar North Atlantic

The Atlantic meridional overturning circulation (AMOC) is expected to decline dramatically over the 21st century, with severe impacts for Northern Hemisphere climate. After 20 years of sustained monitoring in the subtropics, a detectable AMOC weakening trend is now beginning to emerge. However, continuous observations at subpolar latitudes are currently too short-lived to determine any weakening signal above the large-amplitude interannual variability. Here, we introduce a new subpolar observing configuration, SCOTIA (Scotland–Canada overturning array), combining parts of the existing OSNAP mooring array with scattered CTD and Argo data, to extend the record of subpolar AMOC backward in time to cover the subtropical monitoring period, 2004–2024. SCOTIA facilitates a rigorous comparison of the decadal-scale variability in transports and overturning at subpolar and subtropical latitudes. Our results show subpolar AMOC varies on pentadal to decadal timescales with an amplitude comparable to that observed in the subtropics. Anomalously high overturning during 2016–2020 was driven by increased southward transports in the density classes associated with Labrador Sea Water. We find no statistically significant trend in subpolar AMOC during the period 2004–2024.

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From Sensor to Scientist: Developing End-to-End Data Management Systems for Emerging Marine Sensor Technologies

Future Marine Research Infrastructure (FMRI) is a NERC-led programme focused on securing a sustainable marine research infrastructure whilst supporting high-impact research to inform policy and benefit society.

FMRI has funded 'The Accelerated Adoption of marine Sensor Innovation' (AASI) programme to integrate and deploy novel marine biogeochemical sensors and validate these using autonomous underwater platforms from the National Marine Equipment Pool.

AASI supports three projects (SixSense, MASCOT and ASIMOV) which have developed new sensors for Total Alkalinity and Dissolved Inorganic Carbon, a new multiparameter sensor measuring dissolved oxygen, REDOX, pH alongside temperature, conductivity and pressure and new Lab-on-chip nitrate & phosphate sensors with improved limit of detection and resolution.

The British Oceanographic Data Centre (BODC), part of the Digital Science Division at the UK's National Oceanography Centre (NOC), provides data management services for autonomous platforms by supporting deployments in near-real time, recovery (i.e. full resolution), and delayed mode.

BODC is supporting the integration of these novel sensors by expanding its own digital architecture, creating new controlled vocabularies and developing or enhancing metadata and data processing tools.

BODC is also collaborating with the Marine Autonomous Robotics Systems group (MARS) in NOC to develop a scientist application. This will be a 'one stop shop' for research scientists to track active deployments, access data, and make operational decisions during missions.

This presentation will focus on the new workflows and tools BODC has developed under this project, demonstrating how we are integrating novel sensors working towards automated end-to-end systems.

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Objective Machine Learning-based Water Mass Classification in the Arctic from 40 Years of Observations

The recently changing climate is affecting the Arctic Ocean. Quantifying this transformation in water masses proves to be a challenge due to the subjective nature of current oceanographic water mass classification methods. The requirement of end member definition in these methods creates a systematic bias, especially when analysing temporal changes. We propose a new unsupervised clustering method, namely an ensemble of Gaussian Mixture Models, to classify water masses in the Arctic based on 43 years of observations. This method classifies based on conservative temperature and absolute salinity measurements, and on calculated potential vorticity from observations. For robustness, both geographical and temporal bias mitigation was necessary by Polar Stereographic projection binning and under-sampling bins above a capacity threshold. A comparison of the results and an oceanographic method of water mass classification (OMP analysis) was carried out using the same dataset. Identification of each cluster is proposed. Larger water masses such as Atlantic Water were identified comparatively to OMP analysis results.

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Were there tides on ancient Mars?

It is widely believed that there was an ocean on the surface of Mars approximately 4 to 3 billion years ago. The Curiosity, Zhurong, and Perseverance Rovers were sent to Mars to explore the surface and search for evidence of the past presence of water. In their exploration, the first two rovers have taken pictures of sedimentary rocks that show features typically associated to tidal deposits found on Earth (Schieber et al., 2022; Liu et al., 2025; Xiao et al., 2023), including herringbone cross-stratification and pseudo-cyclic cross-stratified bundles with mudstone drapes. To determine if tides on Mars had the capacity to move sediment and form these structures, Martian tides have been simulated using the Oregon State Tidal Inversion Software (OTIS) with topographic data of the Martian surface. A total of 33 simulations were carried out at a range of ocean depths, and their tidal current speeds were analysed using a Shields curve modified to consider the effects of lower gravity on Mars (Fig. 1). The results dispute the interpretation that the rocks seen by the Zhurong rover and in Gale crater are tidal in origin. The maximum current speed at a realistic sea level at this location is less than 1 cm/s, below the calculated threshold for the movement of silt. There are other areas of the planet where tides may have the energy necessary to redistribute sediment. However, we show that tides should not be considered as a major driver for sedimentation in the areas that have been explored by the rovers on Mars. The observed sedimentary structures can be explained by non-tidal processes, such as trough cross-stratification appearing bidirectional in 2D outcrops (mimicking herringbones) or bedform superimposition producing bundles. These findings underscore the value of simulations for constraining tidal regimes on other planets and highlight the need for caution when interpreting tidal processes from sedimentary structures.

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Mixing traps heat on Antarctic shelves but removes it at ice-shelf fronts

Ocean heat drives basal melting of Antarctic ice shelves, yet the mixing that redistributes this heat remains poorly constrained. Here we combine an Antarctic-wide compilation of ocean microstructure observations with a variance-budget framework to quantify the distinct roles of vertical and horizontal mixing. Horizontal heat fluxes exceed vertical fluxes by 10--1000 times, demonstrating the leading role of horizontal stirring in redistributing heat around Antarctica.

However, the direction of this redistribution depends on location. Across shelf seas, mixing-driven fluxes are downward and onshore, concentrating heat toward the ice. Whereas within tens of kilometres of ice-shelf fronts, this pattern reverses and heat is redirected away from the ice, with efficiency set by meltwater. Where meltwater is present, strong upward and away-from-ice fluxes act together to offset up to half of the incoming heat, whereas in its absence fluxes are weaker, vertical transport remains downward, and horizontal fluxes act in isolation. These results reveal a mixing-driven secondary circulation that redistributes heat both toward and away from ice shelves, helping regulate Antarctic basal melt, highlighting a key process currently absent from projections of future sea-level rise.

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Regional and seasonal differences in subsurface marine heatwave characteristics on the Northwest European Shelf

Marine heatwaves (MHWs) have increased in frequency and intensity in recent years, with well documented adverse impacts on marine ecosystems. Effective ecosystem based management depends on our ability to understand and predict such environmental stressors, yet our knowledge of MHWs remains limited primarily to their surface signatures, leaving subsurface processes and impacts underexplored. We investigate the vertical structure of MHWs on the Northwest European Shelf (NWES) and quantify subsurface residence times following downward propagation within different oceanographic regimes, defined by stratification, mixing, and circulation.

We present a regime partitioned analysis of historical MHWs (1993–2025) using observationally constrained ocean reanalysis data. For identified MHW events, we examine the temporal evolution of subsurface temperature anomalies and assess how vertical structure depends on season, location (e.g. Celtic Sea, southern North Sea), and dynamical regime. Results show that oceanographic regimes modulate the frequency and vertical evolution of MHWs, with contrasting behaviour between summer and winter conditions. Analysis of long term changes in MHW occurrence across the NWES, using both fixed and shifting climatological baselines, also highlights how baseline choice influences interpretation depending on the research question.

Improved dynamical understanding of the subsurface structure and evolution of MHWs provides critical context for interpreting observed impacts, by linking observed biological impacts to physically distinct MHW behaviours, and enables more robust assessment of future MHW risks on the NWES.

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A reaction-diffusion model for calcification in foraminifera

Foraminifera are single-celled protists that form calcite shells. They contribute to the inorganic carbon pump, and the composition of foraminiferal calcite is used for reconstructing paleo-environments. A mechanistic understanding of the biomineralization process in foraminifera is required to determine how foraminiferal calcification may be affected by environmental change. Experimental studies have revealed that foraminifera precipitate calcite from a 'calcifying fluid' with a biologically controlled composition, that is only partially separated from the environment. Here, we develop a reaction-diffusion model for a foraminifer and its microenvironment and fit it to experimental data to show how and to what extent different foraminifera species control the composition of the calcifying fluid. We investigate whether the active removal of protons from the calcifying fluid, combined with passive transport of DIC to the site of calcification, can explain empirically established calcification rates. We also quantify the rate at which protons are removed from the calcifying fluid for both high- and low Mg species. We try to constrain the extent to which foraminifera control the composition of the calcifying fluid, which controls their response to environmental changes. This may have consequences for the ocean carbon cycle and the interpretation of proxy data for paleo-reconstructions.

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Biogeochemical impacts of meltwater in the Bellingshausen Sea: Insight from glider bio-optical studies

Despite being located between the relatively well-observed Western Antarctic Peninsula and the Amundsen Sea, the Bellingshausen Sea remains a poorly-understood sector of the Southern Ocean. Recent studies have highlighted the important role the Bellingshausen Sea plays in regional ocean circulation, with high rates of ice shelf mass loss, leading to increasing rates of meltwater entering the region from the Peninsula before flowing southwestwards into the Amundsen and Ross Seas. This flux of meltwater has important implications for the transport of heat and salt, the formation of the Antarctic Slope Front/Current, as well as important biogeochemical processes. In austral summer 2024/25, two autonomous gliders and two NKE floats were deployed to complement shipboard sampling and evaluate the physical and biogeochemical oceanographic characteristics in the region of the Ronne Entrance, the southern terminus of George VI ice shelf. Findings show overall high biomass throughout the region, with highest values in coastal areas experiencing enhanced ice melt (chlorophyll a and particulate organic carbon concentrations >4 and 400 μg L-1, respectively). Rates of net primary production were modelled using bio-optical water properties measured via the gliders and range from <1 to >7 g C m-2 d-1 in the region. A strong southwestward flowing coastal current circulation through the region suggests that these regions of patchy, but high, productivity and biomass may be subject to substantial lateral advection, leading to a spatial decoupling from rates of localized carbon export. Understanding these dynamics is critical to understand the region's role in the Southern Ocean carbon cycle under changing climatic conditions. This study represents one of the first campaigns to characterize the biogeochemical characteristics of the Bellingshausen Sea during austral summer in nearly thirty years and highlights the critical role autonomous instruments have in changing the way we study the ocean, particularly where access is logistically challenging.

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Biogeochemical Impacts of Sea Ice Thickening in the Arctic

The Arctic is home to a variety of endemic species, however, changes in the system affect not only local biodiversity but global climate. Temperatures have been warming at rates up to 4 times the global average, with sea ice loss over the last 40-50 years the most visual indicator. There has been a significant shift from multi-year to seasonal sea ice, bringing changes to the dominant physical, chemical and biological properties and processes. Albedo and average sea ice thickness have decreased as thinner first year ice has become more prevalent, with larger melt ponds during the melt season, while increased light levels are boosting phytoplankton growth. Methods have been proposed in the literature to try and mitigate the impacts of these changes through various techniques. This project focuses on attempts to thicken sea ice by pumping sea water from under the ice onto its surface where it freezes or forms snow ice. The project's aim is to assess the potential impacts of this proposed technique on the biogeochemistry, through computer models and laboratory experiments. Small scale 1D models using Icepack will investigate nutrient cycling and chemical processes within the ice, while pan-Arctic impacts will be assessed through a coupled NEMO-MEDUSA GCM. Laboratory experiments will consist of small mini-cores with lab grown snow and potentially larger scale natural-like sea ice growth in a tank. Results from this project will contribute towards the Eco-ICE project at BAS and aim to improve understanding of sea ice internal dynamics in models.

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Furthest-first inversion for internal consistency adjustments in the biogeochemical data product GLODAPv3

The ocean absorbs a significant portion of anthropogenic CO2 emissions. Tracking the absorbed CO2 and its impacts requires an internally consistent global observational dataset spanning decades. In the Global Ocean Data Analysis Project (GLODAP), measurements from disparate cruises are compared, adjusted for consistency where necessary and compiled into a data product. Differences between cruises are quantified with a crossover analysis, comparing measurements at depth from nearby stations, and an inversion algorithm calculates a set of adjustments to minimise these differences globally. The adjustments are reviewed by an expert committee and a subset applied to the final data product. Previous GLODAP versions used a weighted least squares (WLSQ) inversion approach. However, several issues became apparent when applied to the GLODAPv3 dataset, primarily significant regional biases in calculated adjustments. To address these issues, a new inversion algorithm called furthest-first (FF) has been developed for GLODAPv3, which has been implemented in a freely available, open-source Python package (xover). Here, we describe the FF approach and test it on simulated datasets and by comparing it to WLSQ, finding that it produces accurate adjustments. The FF approach can also be adapted to avoid the regional biases that appear in WLSQ, to approximately preserve selected trends in the cruise-by-cruise differences, and to find an optimal set of adjustments accounting for the fact that some cruises will ultimately not be adjusted. While FF represents a marked improvement on WLSQ for the GLODAPv3 application, no algorithm can completely replace the role of expert judgement in the inversion process.

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Lagrangian changes in nitrate in the Gulf Stream and implications to subpolar carbon uptake

Southern Ocean sourced waters are transported northward as intermediate waters underlying the oligotrophic subtropical gyres. On density surfaces of σ_0 >27 kg m-3, these waters are characterised by elevated nutrient concentrations. The Gulf Stream serves as an efficient conduit, carrying these waters high in nutrients into the North Atlantic Subpolar Gyre, driving high levels of primary production. As part of the C-Streams project, we have deployed two biogeochemical Argo floats in the Florida Straits to investigate the northward transport of nitrate, and to identify ventilation pathways. We augment our measurements with the wider float network to produce a highly spatially resolved transect of nitrate in the Gulf Stream between 24-45°N. Relatively unmodified Antarctic Intermediate Waters have high nitrate (~28 μM) in the Florida Straits at 24°N which remains near stable (>26 μM) until 40°N. Here, nitrate decreases by 44°N as these waters are increasingly ventilated. The physical processes driving ventilation, nitrate drawdown and elevated primary production are identified and discussed in the context of a fast changing climate.

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Wintertime silicon and iron fluxes from glaciers and sediments at the West Antarctic Peninsula

Silicon (Si) and iron (Fe) are essential (micro)nutrients for the growth of marine primary producers. The supply and cycling of Si and Fe to the ocean are therefore key drivers of marine productivity and ocean carbon storage. Antarctic glaciers deliver significant fluxes of sediment to the marine environment, rich in highly reactive and potentially bioavailable Si, Fe, and other bioactive elements.

We present the first wintertime sediment pore water profiles and diffusive fluxes of Si and Fe, collected from the West Antarctic Peninsula. Shallow sediment cores were collected from six sites both proximal and distal from glaciers across Ryder Bay, to determine the influence of glacial material upon Si and Fe cycling. Additional quantification of reactive Si and Fe solid-sediment pools will provide evidence of the drivers of Si and Fe concentrations in pore waters. In summertime, pore waters are highly enriched in both Si (up to 800 µM) and Fe, and we will compare winter results with existing data to determine the importance of seasonal cycling of Si and Fe in Antarctic shelf sediments.

We highlight active Si sorption to prevalent Fe (oxhydr)oxides, and rapid redissolution of reactive Si, are competing in the flux of Si (and Fe) to the dissolved phase at the sediment-water interface. These results will elucidate the influence of glaciomarine sediments upon wintertime fluxes of nutrients Si and Fe to the highly productive Antarctic Peninsula shelf.

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Downscaling Climate Projections of Shelf – Open Ocean Exchange in the Atlantic Ocean: An Example in the Canary Current Upwelling System

To overcome the limitations of global climate models and better project the impacts of climate change in the Atlantic Ocean, particularly at regional scales, we use a NEMO-ERSEM coupled hydrodynamic-ecosystem ocean model to downscale globally a 4-member ensemble of future climate projections (2 emission scenarios and 2 global climate models). In our global ocean downscaling, atmospheric conditions are forced by selected global climate models selected for their realism and uncertainty span. The model resolution (1/4 of a degree) is higher than the ocean component of many of the global climate models, and the river runoffs are represented more realistically. The main aim of the downscaling is to better resolve the shelf break and the water exchange between the shelf and the open ocean, as well as the influence of this exchange on both basin and regional scales. Using these downscaled projections, we investigate the cross shelf-open ocean volume, heat, salt and nutrients transports along the Atlantic Ocean margins and how they may change in the future. The Canary Upwelling System is used as an example to illustrate the role of climate-induced changes in large-scale circulation versus changes in regional water content/properties (e.g., heat, salt and nutrients) in driving changes in the shelf-open ocean exchange, with emphasis on how shifts in the intensity and position of boundary currents affect this exchange.

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Lessons learned from integrating blue carbon into national greenhouse gas inventories: A cross-country comparative analysis.

The submission of national GHG inventories serves as a key instrument for tracking progress towards limiting global warming to well below 2 °C above pre-industrial levels. Countries, including UK, report anthropogenic emissions from multiple sectors, including the Land-Use, Land-use Change, and Forestry sector that includes coastal wetlands. A defining characteristic of this sector is that it encompasses not only emissions, but also removals of GHGs through the management of natural carbon sinks, such as in the coastal wetlands of mangroves, seagrass and tidal marsh. Despite international policy to account for human management activities that result in emissions or removals of GHG having been published more than a decade ago, only a limited number of countries have included coastal wetlands in their national GHG inventories.

Our aim is to provide evidence from early-adopting countries that have already incorporated coastal wetlands into their GHG inventories, with the objective of understanding the different approaches adopted and sharing lessons learned. The analysis assesses how countries have applied and interpreted the Wetlands Supplement, how data requirements have been addressed, and which institutional conditions have enabled the inclusion of BCEs in national GHG inventories. Whereas previous studies have examined inventory reporting practices in individual countries (e.g. Crooks et al., 2018), there remains a research gap in comparative, cross-country analyses, which this study addresses by synthesizing evidence across early-adopting countries

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Impact of Ice-Calving Events on Ocean Stratification in Ryder Bay, Western Antarctic Peninsula

Buoyancy forcing, winds and tides are known processes locally driving a vertical homogenization of salinity or temperature in Polar Regions, the latter having a direct impact on marine-terminating glacier dynamics. Recent observations in Borgen Bay, Western Antarctic Peninsula, demonstrated a non-negligible role of internal tsunamis induced by ice-calving events on vertical mixing. The global rise in atmosphere and ocean temperature will strengthen the retreat of glaciers leading to the generation of stronger and more frequent calving events.

Analysis of the Rothera Oceanographic and Biological Time Series (RaTS), west of Ryder Bay, Western Antarctic Peninsula, was carried out from 2018 to 2024 to investigate the impact of ice-calving-induced processes on vertical mixing. Collapse events of the Sheldon marine-terminating glacier, northwest of the Bay, were identified on the same time period using Sentinel-1 SAR satellite data. Variations in the water column of meteorological origin were considered using ERA 5 data implemented in a 1D mixing PWP model.

The observations showed significant variations in the water column properties during periods of calving. Seven cases of characteristic vertical profiles of temperature, salinity, density and Brunt-Vaisala frequency have been identified. Calving events occurring at the beginning of summer induce a strong increase in temperature and decrease in density above 20 m. Events observed in the middle of summer showed significant variations depending on the calving type. Conversely, events occurring in winter are associated with a decrease in surface temperature. These observations suggest a seasonal variability of the water column response to ice-calving events.

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SCOR ATOMIX: Analysing ocean turbulence measurements to quantify mixing.

The SCOR ATOMIX working group has been developing best practise for the estimation of turbulent kinetic energy, epsilon, for three different instrument platforms including: shear probes, acoustic Doppler current meters (ADCP) and velocity point measurements (ADV). The working group is accordingly divided into three subgroups addressing best practice for each of these instrument platforms. To fulfil our terms of reference, we aimed to define, and explain to new users via an easy-to-follow wiki, the algorithms required to achieve robust estimates of epsilon from the raw data, as well as providing benchmark datasets at several processing levels for scientists to test their code. Each subgroup would also publicise the benchmark data via a peer-review publication. In this poster, we report on the progress of the working group and provide links to the resources currently available.

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Experimental constraints on organic carbon reactivity in disturbed shelf sediments

Continental shelf sediments have recently been recognised as Blue Carbon environments due to their ability to store organic carbon (OC) on climate relevant timescales. If managed correctly, these sediments could help mitigate the effects of anthropogenic CO2 emissions. A potential threat to OC stored in shelf sediments is the widespread practise of bottom trawling for demersal fish and crustaceans where 22 Gt of sediment is thought to be resuspended globally per year. Recent studies have estimated that trawling is responsible for the remineralisation of 0.16-0.40 Pg C yr^{-1} and the release of 0.6-1.5 Pg CO2 yr^{-1}. However, these models rely on theoretical OC reactivity rates, and little is known about the vulnerability of the OC in these sediments. This research will use sediment incubation experiments to explore the effect of disturbance and priming on the reactivity of organic carbon over time.

Sediment microcosm incubation experiments have been established at the University of Leeds and will continue for 18 months. Seabed sediment was collected from the western Irish Sea during February-March 2026, aboard the RRS Discovery as a part of the SeaSTORE project. Treatments will include undisturbed sediment, and sediment that is regularly disturbed (eight times per year) to recreate the effect of trawling. Isotopically (13C) labelled algae will be added to additional microcosms to investigate the effect of priming during summer. To quantify OC compositional change over time and degradation rates a suite of sediment characteristics will be monitored including SCOC, thermogravimetric analysis (TGA), chlorophyll, amino acids, iron-associated carbon (FeOC).

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Bottom dynamics and temperature across the Porcupine Seabight margin from an array of landers.

High temporal resolution near seabed (~0.5 m above bed) currents and temperatures have been measured over a 1 to 2 year period in depths between 200-750m at the continental margin adjacent to Porcupine Bank, NE Atlantic. Measurements were made on simple seabed lander platforms utilising the LanderPick system – a remotely operated towed platform (negating the need for a release system).

Currents are topographically steered along-slope as might be expected from observations close to the seabed and predominantly poleward directed, with an exception of that measured on the western Porcupine Seabight slope. Whilst immediately adjacent topography will locally steer currents with some variable direction, a downslope component to residual current flow can be recognised, consistent with an Ekman layer. Seasonality is apparent in the deeper saddle between the inner Irish shelf and Porcupine Bank with seemingly warmer temperatures in autumn/winter months related to enhanced wintertime poleward slope current flow. Temperatures measured over two consecutive years indicate a significant difference in summer temperature perhaps highlighting a change in heat advection in the boundary flow.

West of Porcupine Bank residual poleward flow is more persistent. At a deeper location (712m depth), large cross slope currents are observed with large asymmetric temperature variability indicating significant internal wave activity. The high temporal resolution (5 secs) of temperature allowed an estimate of energy dissipation. Periodic increases in dissipation is associated with the sharp reduction in temperature and could be suggestive of active wave breaking and bore like characteristics.

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Exploring future changes in Arctic Water Mass Transformation

Water masses within the Arctic Ocean are transformed by surface buoyancy fluxes and mixing, setting the properties of waters exported to the North Atlantic. These exported waters play a key role in large-scale ocean circulation and climate through the transport of heat, freshwater, and carbon. However, it is unclear how projected surface ocean warming and freshening will alter Arctic water mass transformation (WMT), and what the broader implications will be for the global climate system.

To address this, we analyse Arctic WMT over the 21st Century using output from the UK CMIP6 coupled-climate model, HadGEM3-GC3.1 MM, for a future high-emissions scenario (SSP5-8.5). By analysing WMT in both density-space and temperature-salinity space, we quantify the relative contributions of surface heat fluxes, freshwater fluxes, and interior mixing processes to the total transformation rate. We assess how these contributions vary over monthly to multi-decadal timescales, providing insight into the mechanisms driving future changes in Arctic WMT.

Meng Yao

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COSSMoSS Project: Using Seismic Oceanography to Quantify Interior Mixing and Validate Ocean Models

Ocean mixing plays a central role in redistributing heat, carbon, oxygen and nutrients, linking small-scale turbulence to large-scale overturning circulation and marine ecosystem productivity. However, interior submesoscale currents remain poorly observed. These features occur on scales of O(100) m to O(10) km and evolve over hours to weeks, potentially bridging energetic mesoscale flows, internal waves and centimetre-scale turbulent dissipation. Their intermittent and three-dimensional nature makes them difficult to capture with conventional ship-based or autonomous measurements.

The COSSMoSS project addresses this gap by combining seismic oceanography, hydrographic observations, autonomous measurements, moorings and high-resolution numerical simulations. Seismic oceanography uses active acoustic reflections from temperature and salinity gradients to image fine-scale thermohaline structure through the water column with O(10) m resolution. During the COSSMoSS cruise, repeated seismic sections, a radiator-style survey, canyon lines, XBT/XCTD casts, CTD sections, ALR measurements and mooring records were collected across the Brazil Current region near the continental slope. These observations reveal dynamic interior structures including filaments, lenses and fine-scale reflectors that evolve over short timescales.

My work focuses on reprocessing the seismic data and developing an amplitude-, timing- and polarity-aware workflow suitable for quantitative oceanographic interpretation. The processing includes filtering, direct-wave attenuation, amplitude correction, velocity analysis, stacking, migration testing and comparison with XBT/XCTD-derived synthetic seismograms. This provides the foundation for converting seismic reflectivity into high-resolution temperature, salinity and density fields.

Future work will use these calibrated seismic products to estimate internal-wave energy, turbulent dissipation rate and diapycnal diffusivity, and to identify mixing hotspots associated with fronts, lenses, topography and canyon structures. These seismic-derived thermohaline and mixing products will also provide high-resolution observational benchmarks for validating and potentially constraining ocean models. By linking seismic processing, hydrographic calibration, mixing diagnostics and model

validation, this work contributes to the broader COSSMoSS goal of understanding how interior submesoscale processes shape ocean energy pathways and tracer exchange.

Meyer, Meredith G.

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Spatial patterns in phytoplankton community composition and their influence on carbon export on the northwest Weddell Sea continental shelf

Typically, diatoms, haptophytes, and cryptophytes dominate phytoplankton biomass and abundance in the Southern Ocean, determining bloom dynamics and carbon transfer and respond to physical factors such as sea ice concentration and mixing. However, phytoplankton community composition remains understudied in many regions of the Southern Ocean. Here, we present pigment-based phytoplankton community-composition data from a summer cruise to the northwest Weddell Sea continental shelf. To our knowledge, these are the only pigment-based community composition data from this key region for deep-water formation and carbon transport. Taken together, the relative biomass of the three dominant phytoplankton groups (39.7% diatoms, 30.2% haptophytes, and 14.9% cryptophytes) explain the majority (R2 = 0.37 – 0.82) of carbon export to 150 m. These findings highlight the need to consider frequently overlooked phytoplankton types, alongside diatoms, in Southern Ocean models of carbon export due to the key, but differing, roles these groups play in production-export dynamics.

Meredith, Michael

Povl Abrahamsen; Amber Annett; Alexander Brearley; Lénaïg Brun; Filipa Carvalho; Jacob Connelly; Andreas Cziferszky; Elise Droste; Lewis Drysdale; Nathan Fenney; Andrew Fleming; Siobhán Foden; Neil Fraser; Oskar Głowacki; Romy Hall; Katharine Hendry; Anna Hogg; Mark Inall; Cíara McDonald; David Maxfield; Carlos Moffat; Dave Munday; Alex Murphy; Alberto Naveira Garabato; Kate Retallick; Katy Sheen; Katrien Van Landeghem; Julien Palmieri; Faron Quinn; Hugh Venables; Benjamin Wallis; Emma Young

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Polar Ocean Mixing by Internal Tsunamis – the POLOMINTS programme

Ocean mixing on the polar shelves is a key process that redistributes heat, freshwater, nutrients and other important substances, with significant impacts on glacier dynamics, sea ice formation/melt, biogeochemical cycling, and marine productivity. Consequently, this mixing has implications for global sea level, climate and ecosystems. The conventional paradigm was that this mixing is dominated by winds, tides, and buoyancy forcing. However, direct observations from the Antarctic Peninsula made before, during and after the calving of a marine-terminating glacier demonstrate that such calving can trigger internal tsunamis that propagate across the shelf, and that drive vigorous bursts of mixing when they break. Satellite analyses indicate that such calving events are widespread and frequent, and energy budget calculations suggest that these internal tsunamis are at least comparable to winds, and much more important than tides, in driving regional shelf mixing at the Peninsula. Further, they have potential relevance in other regions where marine-terminating glaciers calve, including the rest of Antarctica, Greenland, Alaska, Patagonia, and across the Arctic. It is possible that calving frequency/mass may change in future with higher ocean and air temperatures, suggesting possible shifts to internal tsunamigenesis and mixing in a warming climate. To advance this science, the NERC Large Grant-funded project “Polar Ocean Mixing by Internal Tsunamis (POLOMINTS)” has commenced, including extensive field observations, advanced numerical modelling and Earth Observation analyses. This poster will present the knowledge base behind POLOMINTS, and a synopsis of its aims and ongoing activities.

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Dissolved and particulate iron in the Southeast Pacific Sector of the Southern Ocean: Data from the NERC-CUSTARD project

The Southern Ocean is a major mixing zone for all the world's oceans and plays a key role in regulating the earth's climate. Any factors influencing carbon removal in this region are therefore strongly linked to climate regulation. Iron (Fe) is an essential nutrient for the growth of primary producers, however, its availability is limited in the Southern Ocean. This impacts the efficiency of the biological carbon pump thereby influencing climate. There is a general lack of Fe data for the Southern Ocean, especially for particulate phases, even though the supply, cycling and removal of dissolved-Fe is intrinsically linked to particles. Here we present our findings on the distribution and cycling of both dissolved and particulate Fe phases, along with other major and micro-nutrients, for the poorly studied southeast Pacific sector of the Southern Ocean.

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Seasonal Deep Water Oxygen Decline in a Fjordic System: The Clyde Sea

Fjordic basins are highly susceptible to deoxygenation because their deep waters lie below shallow sills, remain strongly stratified, and are ventilated only intermittently. The Clyde Sea is an ideal natural laboratory for investigating these processes: its deep basins sit far beneath the Great Plateau sill and modern observations show stronger stratification, reduced renewal frequency and progressive deep-water warming relative to historical conditions. These changes have increased the duration of stagnation periods during which oxygen is steadily consumed. Despite strong conceptual understanding of fjord circulation, key uncertainties remain regarding the relative contributions of deep-water renewal and diapycnal mixing to the oxygen budget, the sensitivity of renewal to changing density structure on the adjacent shelf and how climate-driven warming is altering the temperature and oxygen content of renewal waters.

This project addresses these gaps by quantifying the balance between renewal and vertical mixing in the Clyde Sea using high-resolution turbulent dissipation profiles and CTD casts collected during two RRS Discovery cruises. Turbulence-derived diffusivities will be used to estimate diapycnal oxygen fluxes, while density structure will be analysed to assess renewal potential relative to sill-controlled thresholds. These contemporary measurements will be compared with historical hydrographic datasets to evaluate long-term changes in stratification, renewal characteristics and deep-water oxygen supply.

The study will provide a physically based assessment of the mechanisms controlling deep-water oxygen variability in the Clyde Sea and will contribute new constraints on how climate-driven changes in stratification and mixing are reshaping ventilation in UK fjordic systems.

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Marine Ecosystem Recovery following the Permian-Triassic Mass Extinction

The Permian-Triassic mass extinction (PTME; occurring around 252 million years ago) was the most catastrophic biotic event of Earth's history resulting in up to 90% of marine animal species becoming extinct. While the taxonomic patterns of the PTME are well documented, the trajectory of marine ecosystem recovery, particularly the re-establishment of ecological structure and function, remains debated. It is argued whether ecological recovery occurred in a step-wise bottom-up manner, with full recovery occurring contemporaneously with recovery of taxonomic diversity by the Middle Triassic (some 5-8 million years after the PTME), or whether Early Triassic communities recovered rapidly albeit with markedly different structure to pre-extinction ecosystems. Using the fossil record, we recreated food web networks to explore marine community structure and function in the aftermath of the PTME. We show that marine communities ecologically recovered quickly, by marine genera occupying ecological niches albeit by few taxa, as well as increased generalist feeding. The Middle Triassic communities show a significant increase in diversity and vertical structure compared to Early Triassic communities. This suggests that alpha diversity recovered fully by the Middle Triassic, in line with global taxonomic diversity, but this recovery did not occur via a step-by-step rebuilding of marine ecosystems through the Early Triassic. This research helps clarify how marine ecosystems recover after rapid environmental upheaval, offering valuable insight into the modern climate crisis and the growing environmental pressures facing present-day oceanic species.

Nikolaus, Viktoria

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Tides, circulation, and water column variability under seasonal sea ice on the eastern Antarctic Peninsula shelf

Year-round observations beneath seasonal sea ice on the Antarctic shelf remain scarce, particularly along the eastern Antarctic Peninsula, where winter sea ice prevents ship access for extended periods. We present observations from a mooring deployed on the eastern Antarctic Peninsula shelf (64.5°S, 420 m) between February 2023 and February 2024 as part of the PICCOLO project. The mooring measured temperature, salinity, current velocity, dissolved oxygen, and particulate backscatter through a seasonal sea-ice cycle.

Sea ice strongly modified the physical environment at this location. Current direction shifts abruptly at sea ice formation and retreat. Current variability remains strongly tidal throughout the record, including periods of sea ice cover. During sea ice formation, brine rejection is consistent with enhanced mixing of the water column, reflected in the seasonal evolution of temperature, salinity, and dissolved oxygen. Particulate backscatter is elevated during periods of stronger tidal currents coincident with sea ice retreat, suggesting enhanced near-bed sediment resuspension.

Tidal analysis reveals a diurnally dominated field with O1 and K1 as the primary constituents. Although the flow remains strongly tidal throughout the year, the strength of the K1 tidal constituent varies through the record. These results provide a rare year-round characterisation of how seasonal sea ice modulates shelf circulation, vertical mixing, and near-bed particle dynamics along the eastern Antarctic Peninsula.

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The changing Southern Ocean nitrogen cycle and the biological carbon pump

Nitrogen is the key nutrient limiting primary production across most of the global ocean. The Southern Ocean (SO) acts as a hub, connecting deep, nutrient-rich waters which upwell in the SO with the major ocean basins. As such, the biological uptake and recycling of nitrate within the SO strongly influences global nitrate availability and the strength of the biological carbon pump. This work uses novel isotopic measurements of seawater nitrate (δ15NNO3 and δ18ONO3) to determine how continued warming, altered circulation and mixed-layer expansion in the SO, driven by global climate change, influence the balance between nitrate uptake and regeneration, and the export of nitrate from the region. These results will help to inform how the efficiency of the SO biological carbon pump may respond to ongoing climate change.

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Acceleration of the European Slope Current by residual tidal flow

The European Slope Current (ESC) flows along the continental slope around a segment of the continental shelf of North West Europe. Its driving mechanisms are thought to be associated with along-isobath density gradients and wind forcing. We examine acceleration of the ESC by the convergence of tidal momentum fluxes associated with the barotropic tide, using a global tidal model, multiple moored measurements, and reduced models. Emphasis is given to the tidal contribution to the ESC's cross-shelf structure off western Scotland and to the along-isobath variability of the tidal residual flow along the shelf edge. Off western Scotland, the net along-slope residual flow from major tidal constituents is southward, with a maximum of ~3 cm/s around the 400 m isobath (against the observed along-slope absolute geostrophic velocity observed by multi-year repeat glider measurements). The residual flow's along-isobath structure is dominated by the orientation between tidal ellipses and isobaths, and can be in either direction. Along-isobath divergence of the residual tidal flow may be important for preconditioning cross-isobath transport in locations with abrupt topography such as the Malin and Shetland Shelves. These results suggest that along-isobath divergence of residual tidal flow may be important in other continental margins with strong tides.

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Exploring circulation-linked proxies for ocean carbon sequestration

The Biological Carbon Pump (BCP) plays a central role in regulating atmospheric CO2 by exporting carbon from the surface to depth, where it can be sequestered on centennial to millennial timescales. However, the efficiency of the BCP is often assessed using export-based metrics alone, which do not capture carbon sequestration, as storage depends on ocean circulation and the timescales over which respired carbon is retained in the ocean interior.

Under climate change, increasing stratification is expected to reduce export production while increasing carbon residence times in the ocean interior. Reduced mixing prolongs the isolation of respired carbon from atmospheric exchange. Therefore, atmospheric CO2 uptake depends on both the ocean's storage capacity and the timescales over which carbon is retained in the interior.

Quantifying the relationship between ocean circulation and carbon sequestration remains challenging, as it often relies on computationally expensive adjoint approaches that track the pathways and residence times of remineralised carbon. This research aims to develop simplified, circulation-aware diagnostics of BCP-driven carbon storage.

Using Earth System Model experiments across different circulation regimes, this work derives a residence time of soft-tissue carbon (Csoft) in the ocean interior and evaluates its relationship with circulation-aware model variables. The aim is to identify robust proxies that capture both biological carbon storage and the circulation-driven timescales that determine its sequestration.

By linking ocean circulation to biological carbon storage, this research seeks to improve our ability to diagnose carbon sequestration, and to interpret changes in the BCP under a changing climate.

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AUV Observations of Submesoscale Currents in the South-West Atlantic

The processes driving mixing and stirring within the interior ocean are poorly understood, with implications for future climate variability prediction. In particular, the role of interior submesoscale currents, characterised by spatial scales of 10 m — 100 km, in bridging energy transfers between large scale flows and small-scale dissipation is not well observed or validated in models. Improved understanding of the generation, evolution and dissipation of interior submeoscale currents is therefore key to better quantifying energy and tracer transport in the ocean.

COSSMoSS (Capturing Oceanic Submesoscales, Stirring and Mixing with Sound and Simulations) is a pioneering experiment to observe and simulate interior submesoscale currents and their influence on mixing and tracer stirring. Fieldwork in January 2025 investigated such features along the continental slope close to the Brazil-Malvinas Confluence in the SW Atlantic. The region is a hotspot for mesoscale-submesoscale current generation and a key exchange gateway between the Antarctic Circumpolar Current and sub-tropical gyre circulation.

A suite of observational techniques were employed to measure physical and biogeochemistry fields, centred on using active acoustics to map thermohaline structures at order 10 m resolutions. Here, we present data collected using the autonomous sub-surface vehicle AutoSub Long Range (ALR), popularly known as Boaty McBoatface.

The ALR provided a unique platform for coincident hydrographic, current flow and biogeochemistry measurements to complement acoustic observations, as well as direct capture of turbulent energy dissipation. Initial work focusses on interior turbulent kinetic energy and thermal variance dissipation rates along the continental slope in the western boundary Brazil Current.

Pearson, Philip

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Remembered Lives: a tribute to the forgotten crew of the Challenger expedition

The poster will illustrate the theme of Remembered Lives, the heroic crew of the Challenger expedition.

Muster books and the crew's service records helped identify the 211 original seamen, Boys and marines, the focus of this study. Annotated photographs in the archive of naturalist Henry Moseley helped put a face to a name of 60 crew. Tracing their ancestors where possible revealed that many were indeed remembered in their family's oral history and memorabilia.

Discovery of letters, memoirs, poems and over 50 watercolours by seamen artists enriched an understanding of their experience and contributions to the voyage. Themes include the crew as bandsmen, explorers, stokers and boy sailoors.

Drawing on original sources and analysis, the presentation seeks to provide a more inclusive narrative and understanding of the renowned voyage of discovery.

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Marine Autonomous and Robotic Systems Available to Support the UK Marine Science Community

The widespread adoption and acceptance of Marine Autonomous Systems (MAS) have transformed ocean observation through autonomous, adaptive, and persistent monitoring, from the sea surface to the deepest and most remote regions of the global ocean.

To ensure the UK marine science community has broad access to MAS platforms, sensors and operational expertise, the Natural Environment Research Council (NERC) supports both the Marine Autonomous and Robotic Systems (MARS) fleet, hosted at the National Oceanography Centre (NOC), and the Scottish Marine Robotics Facility (SMRF), hosted at the Scottish Association for Marine Science (SAMS).

Together, these facilities form part of the National Marine Equipment Pool, providing a coordinated capability that includes autonomous underwater vehicles (AUVs), remotely operated vehicles (ROVs), underwater gliders and uncrewed surface vehicles (USVs). These systems support a broad range of scientific applications operations across diverse environments, from coastal waters to the open ocean, deep sea and polar regions.

Recent developments have focused on extending vehicle endurance, improving onboard autonomy, and enabling increasingly remote and over-the-horizon operations. Advances in command-and-control infrastructure, adaptive mission planning and near real-time data delivery are reducing operational overheads while increasing scientific flexibility, efficiency and responsiveness.

This poster will provide an overview of the MAS platforms and capabilities available to the UK marine science community, explain the process for requesting access in support of NERC and other funded research programmes, and identify key technical and scientific points of contact within both NOC and SAMS.

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How low can it go? Controls of phytoplankton community structure on silica and carbon export in the Labrador Sea

Phytoplankton community may strongly influence the efficiency of the biological carbon pump, particularly through large, heavily silicified diatoms that can sink rapidly and remineralise more slowly, thereby enhancing carbon export - known as ‘ballasting’. However, previous studies have produced contrasting results on the importance of diatoms in deep carbon export, including variation between diatom sub-groups, and across spatial scales. Such uncertainties limit understanding of how carbon cycling in the Labrador Sea, a region of significant export, may respond to future environmental changes.[FC1.1] This study aims to assess the role of ballasting on carbon export across the Labrador Sea, and its interactions with phytoplankton community structure.

Water samples were collected during a research cruise (JC282 - August 2025) in the Labrador Sea. Marine Snow Catchers were used to determine the sinking and attenuation of biogenic silica (BSi) and particulate organic carbon (POC), alongside Scanning Electron Microscopy (SEM) analysis of diatom community to investigate how community composition and silicification influence BSi:POC relationships and export attenuation across spatial and vertical gradients. Two incubation experiments were also conducted to quantify BSi/POC loss rates and assess changes in the phytoplankton composition and silicification (SEM) in contrasting productivity regimes. Preliminary SEM results indicate an initial greater abundance of pennate diatoms [FC2.1]at 40-90m in the higher-chlorophyll region; thus, potential differences in silicification and export between regions may occur. These observations will be integrated with CTD, nutrient and glider data from the ReBELS project to assess how phytoplankton community and silicification influence carbon export in the Labrador Sea.

Salian, Amisha

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Revisiting Light Attenuation in UK Estuaries: Spatial Variability in Kd Controls Across the Thames and Mersey

Light availability is a primary control on ecosystem production in turbid estuarine and coastal waters, where optically active constituents, including suspended particulate matter (SPM), coloured dissolved organic matter (CDOM), and phytoplankton, regulate the attenuation of photosynthetically active radiation (PAR). Previous studies in UK shelf and estuarine waters have identified SPM as a dominant control on the diffuse attenuation coefficient for PAR (Kd); however, emerging evidence indicates that the strength of this relationship varies regionally and seasonally, reflecting shifts in hydrographic and biogeochemical conditions.

This study reanalyses optical properties that influence light attenuation within the Thames and Mersey estuaries using observations collected between 2022 and 2026. Kd was derived from in situ PAR–depth profiles measured using depth profilers, calculated from ln(PAR) and depth, with quality control applied to ensure sufficient vertical resolution, depth range, and model fit. Station-level Kd estimates were linked to contemporaneous discrete measurements of SPM, CDOM, turbidity (FTU), and chlorophyll, enabling comparison of key optical drivers across spatial and seasonal gradients.

Preliminary analysis indicates that SPM remains a major control on Kd in both systems; however, the strength and form of this relationship vary spatially, with evidence that other optically active constituents exert a greater influence under hydrodynamic and biogeochemical conditions. Together, these findings provide an updated assessment of light attenuation processes in contrasting UK estuaries and help evaluate the continued applicability of established empirical relationships under contemporary conditions. This supports our understanding of key parameters influencing plankton community composition in these nutrient-enriched environments.

Schaap, Allison

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Fast in situ nitrate and phosphate sensors for glider deployments

Measuring the concentrations and distribution of nutrients in seawater is critical for understanding life in the oceans. In the open ocean, the growth of phytoplankton is often limited by the availability of the nutrients nitrate and phosphate, although these nutrients can be a pollutant in the coastal regions. Despite the importance of marine nutrients, our ability to easily and repeatedly measure them in the open seas is limited by a lack of fast, reliable, and accurate sensors that can be readily deployed on underwater autonomous vehicles.

Here we present two new sensors, developed to measure nitrate and phosphate respectively. These are new adapted versions of the National Oceanography Centre's "lab on chip" chemical sensors: autonomous chemical analysers that can implement spectrophotometric assays in situ to 6000 m depth. These new sensors are developed in the context of the NERC Future Marine Research Infrastructure (FMRI) programme.

The sensors are optimised specifically for application on mobile platforms such as gliders. They have been designed to increase the frequency at which they can measure nitrate or phosphate to < 3 minutes, to better enable vertical profiling. New optical designs will also improve their limit of detection to <100 nM, to study low-nutrient surface waters, and improvements to reliability, user-friendliness, and vehicle integration are also implemented.

In this poster we will show the technical developments and resulting performance to date, and outline the planned demonstrations on a glider field campaign in autumn 2026.

Schmidt, Katrin

Hauke Flores; Benoit Lebreton; Clara J. M. Hoppe; Katja Metfies; Ellen Oldenburg; Maria A. Van Leeuwe; Katyanne M. Shoemaker; Astrid Cornils; Barbara Niehoff; Wilhelm Hagen; Carin J. Ashjian; Angus Atkinson; Robert G. Campbell; Giulia Castellani; Kirsten

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Multifaceted benefits of sea ice for the Arctic fauna along the Transpolar Drift

How declining sea-ice will impact the central Arctic ecosystem remains largely unknown, with some studies predicting increases in secondary production fuelled by pelagic algae, while others are warning of major disruptions to the Arctic food web. Here we used the Transpolar Drift (MOSAiC expedition, 2019/2020) for a holistic view of the multiple benefits that sea ice provides to the Arctic fauna, setting a baseline before ice-free summers. Combining genetic sequencing, algal pigments, and 10 trophic markers, we identified terrigenous organic material, ice diatoms and aggregated metazoans as winter food, blooms of ice-inhabiting flagellates as spring food and aggregates of the ice-associated Melosira arctica as summer and autumn food. Sea-ice derived foods were used across surprisingly diverse zooplankton groups, including taxa that are deep living or considered carnivorous. Overall, the sea ice dependency was highest in zooplankton that lack lipid stores, use sea ice as a habitat, show high dietary dependency and low trophic flexibility. Based on these 4 criteria, one-third of the 27 studied taxa and life stages were categorised as sensitive to sea ice loss. By including these crucial, yet often overlooked sea-ice benefits, we are in a better position to project the future of the Arctic ecosystems.

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Using sediment geochemistry to investigate the carbon content of a seagrass meadow

Seagrass meadows are a blue carbon ecosystem, which sequester and store substantial amounts of organic carbon despite covering only a small global ocean area. It is important to understand how much organic carbon is being stored in seagrass meadows in order to protect and enhance storage and accumulation for mitigation of future climate change. This work investigates the carbon content in a seagrass meadow in Montrose Bay, northeast Scotland. It is part of a wider project looking at organic carbon accumulation around the UK coastline and the various factors controlling the amount of carbon stored. In particular, this work looks at how the inorganic geochemistry of the sediments can be used to predict carbon content and how the accumulation of various inorganic species impacts the carbon content; an area that has been less focussed on in other blue carbon work. It also aims to investigate how changing conditions in the bay, such as the dredging of the estuary and storm events, affect the organic carbon storage and accumulation rates. 10 cores were collected from the bay, 5 in a seagrass meadow and 5 controls from nearby mud flats. These were analysed using non-destructive XRF core scanning followed by particle size analysis, carbon and nitrogen content analysis and dating using radioisotopes including 210Pb. Preliminary results and analysis from these data will be presented.

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A Lagrangian Perspective on Net Heat Flux Features of Agulhas Waters

The Agulhas system influences global ocean circulation and regional ecosystems through vigorous mixing, inter-ocean exchange, and water-mass transformation. Surface heat exchange in Agulhas waters is a key component of this system, yet the pathways through which this heat is redistributed remain poorly constrained. Here, we use the Lagrangian particle-tracking tool Parcel to investigate net heat-flux features of Agulhas waters across the Agulhas system. Transport-weighted particles were released from the Agulhas Current at 32°S every five days from 1998 to 2016 and tracked for approximately four years, resulting in approximately 13.5 million particles. Particles initially located within the mixed layer were selected to diagnose freshwater flux, surface net heat flux, and subsequent subduction below the mixed layer. Our results show persistent cooling of Agulhas waters across most of the Agulhas system over the 23-year analysis period. Except heat losing from air-sea exchange, Agulhas waters still lose more than 250 W m^{-2} through mixing with surrounding waters, indicating substantial redistribution of heat within the ocean interior. Our results reveal how Agulhas surface heat transport through air–sea exchange, lateral and vertical mixing, and interior export.

Skein, Lisa

Unsworth, Christopher; McCarron, Connor; Van Landeghem, Katrien; Bricheno, Lucy; Rulent, Julia; Huvenne, Veerle

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Benthic habitat distributions under an expanding offshore wind sector: responses to changes in hydrodynamics and climate change

The UK is among the leading countries in the shift toward offshore renewable energy, with 14.7 GW currently generated through offshore windfarms (OWFs). The government has committed to ramp this up to 50 GW by 2030, and around 77 GW is currently planned for installation.

A key knowledge gap regarding the environmental impacts of this rapidly expanding sector is its influence on the spatial distribution of benthic communities at regional scale, whilst accounting for additional climate change effects. Artificial structures introduce novel hard substrata and substantially affect hydrodynamic properties, notably bed shear stress, which in turn can change the physical characteristics of seabed habitats.

The ECOWind-ACCELERATE project focuses on the Eastern Irish Sea where several OWFs are already operational, and more are planned. Through an extensive benthic imagery dataset, present-day epifaunal biotopes and their characteristic fauna were identified. State-of-the-art hydrodynamic and climate models were used to estimate, in high spatial resolution, physical environmental changes resulting from both the introduction of OWF monopiles and climate change. The influence of these changing environmental conditions on the present and future (up to ~2090) distribution of benthic biotopes was then estimated through fine-scale Random Forest Species Distribution Models. Temperature, bottom current velocity, bed shear stress and turbulence were among the most influential variables driving the distributions of benthic biotopes. Here, we share the model outputs and predictive maps and offer insights into the likely impacts of climate change and OWFs on benthic communities, including changes in their future distributions across the Eastern Irish Sea.

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Upscaling Autonomy, Upscaling Opportunities with FMRI

The UKRI-NERC Future Marine Research Infrastructure (FMRI) programme is seeking to provide the marine science community with a future-proofed marine research infrastructure, integrating cutting-edge technologies into proven autonomous platforms to increase the UK's capabilities in marine science. This change will maintain the UK's position as a world leader in marine science in the decades to come and represents an emerging opportunity for the future marine workforce to upskill within the autonomy field.

For the full benefit of FMRI to be realised, the scientific community needs to be ready and able to use the new capabilities. Whilst core technologies for autonomous infrastructure are proven and readily available, and the skilled workforce to support this is present, to take advantage of the emerging technology we need to adapt our skillsets. We want to ensure that science users are equipped to exploit the opportunities created by this investment, and the potential for new and different science.

FMRI recognises the importance of investing in skills for science that uses autonomy. The programme envisages both formal training and science demonstrator missions linked to the validation of new technologies. This will encompass upskilling both existing staff and new users – i.e., from the current ECR community – providing opportunities to shape the culture around the adoption of new capabilities. This poster aims to start a discussion with the ECR community on what skills they feel they require, what barriers may be faced and how FMRI investment can best be used to maximise scientific impact.

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A taxa-specific morphology tool for extracting key shape and size metrics from Imaging FlowCytobot (IFCB) images

Plankton comprise a diverse group of organisms that underpin all aquatic ecosystems. Understanding which species are present, and how their occurrence changes over time, is critical for assessing ecosystem health and for reversing the ongoing threats of biodiversity loss.

Plymouth Marine Laboratory (PML) has a long history of plankton monitoring in the Western English Channel to quantify community structure and biodiversity change on a weekly basis. However, traditional methods can be slow and labor intensive while new imaging technologies are transformational, providing a 100-fold increase in the rate of biodiversity data generation. At PML we have added an Imaging FlowCytobot (IFCB) to the Western Channel Observatory's weekly phytoplankton monitoring at Station L4.

It can be challenging to extract taxa-specific information from IFCB images without using established tools that can be expensive and complex to use. Additional information on morphology of organisms captured in IFCB images is a valuable addition to machine learning models, for example in PML's DEcentralised Learning (DEAL) for automated image analysis and biodiversity monitoring application, which is working to automatically classify IFCB images.

The taxa-specific morphology tool provides a simple way to process a large volume of IFCB images, extracting key morphological properties. The tool uses this information to calculate taxa-specific biovolume estimates and convert to carbon biomass. Here we present the details of the tool and outline its role in refining IFCB image analysis for the diverse plankton community at PML's monitoring station, L4. Thereby, improving the efficiency, comparability and scalability of image based plankton monitoring.

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Controls of global and regional stratification change using Potential Energy Anomaly budget

Stratification can be quantified with the Potential Energy Anomaly (PEA), an integrated counterpart to mixed layer depth or buoyancy frequency, which also places stratification and tendencies thereof in an energetics framework. Here, we investigate global and regional changes in ocean stratification over the 1993-2016 period using the ECCOv4r4 ocean state estimate. We quantify the processes controlling stratification variability through a closed PEA budget integrated to 2000 m depth at monthly resolution. The budget separates the contributions from advection, diffusion, and surface forcing, together with their thermal and haline components and subcomponents related to wind stress, kenetic energy conversion, and different mixing processes.

Globally, stratification, as measured by the PEA, increased at a rate of 1% per decade, consistent with observations and ocean heat content increase. Diffusion and surface salinity fluxes act overall to reduce stratification, whereas advection contributes positively to the long-term increase in stratification. This net advective contribution arises primarily from the haline component, while the thermal component of advection acts to destratify the ocean. The stratification evolution shows strong regional disparities, namely stratification has weakened in the deep convection regions of the subpolar north Atlantic and Nordic seas, while increasing in the Arctic Ocean and Indo-Pacific tropical regions. We further link the PEA evolution in key regions to the global overturning circulation.

These results demonstrate the relevance of the PEA framework for diagnosing large-scale ocean stratification changes and provide new insight into the physical processes controlling stratification variability across global and regional scales.

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Wintertime cruise and time series sampling near Rothera, Antarctic Peninsula

The Rothera Time Series has collected oceanographic data from Ryder Bay since 1998. This period has spanned large variability in sea ice, giving an insight into the oceanographic and biogeochemical responses to different sea ice conditions. In two recent winters, 2022 and 2025, there was no significant sea ice formation at all, further changing the controls on key processes. In wintertime, less sea ice allows increased mixing due to the sea surface being exposed to the winds. This has direct impacts as the deep mixing reaches the old, warm and carbon rich layer of modified Circumpolar Deep Water (mCDW) leading to increased loss of heat and carbon to the atmosphere. Changes also follow through to reduced stratification and a deeper thermocline the following summer, increasing heat uptake in the surface 100m, but reducing heat content below that.

In May/June 2025 a winter cruise on the Sir David Attenborough allowed further study of these processes, closer to the glacier than the time series site until almost midwinter. These profiles contrast with glider data from the summer seasons before and after, with less meltwater but still with layers of enhanced turbidity, though likely through resuspension of moraine materials, which are recently exposed by the retreat of the glacier. Together, the winter cruise, Rothera Time Series, glider deployments and POLOMINTS sampling are giving a fuller picture of both the causes and consequences of glacial melt and calving on the physical and biogeochemical properties of Ryder Bay.

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Evaluation of the role Jersey's seagrass meadows play in climate change mitigation

Greenhouse gas (GHG) inventories are intended to support policy and monitor global progress in carbon dioxide reductions towards limiting temperature increase to less than 1.5 °C above preindustrial levels. Coastal wetlands, including seagrass meadows are ecologically important for climate change mitigation, due to their capacity to reduce GHG emissions. Following the framework within the 2013 IPCC supplement for coastal wetlands this study assesses the potential of Jersey's managed Zostera sp. seagrass when compiling an inventory. Managed seagrass meadows, protected or restored, are a net sink for carbon dioxide, often represented quantitatively by a soil organic carbon accumulation rate (OCAR). In national GHG inventories a globally collated OCAR of 0.43 t C ha^{-1} yr^{-1} can be used if a country does not have national data, when this OCAR is employed, the country is categorised as using a simple Tier 1 approach. Given Jersey houses Zostera sp. meadows the use of a Tier 1 value that includes data from all seagrass species may not be appropriate. This study assembled a regional Zostera sp. OCAR of 0.18 t C ha^{-1} yr^{-1} (0.13 0.25 95% CI), which is both more conservative, spatially and species-specific. When utilised, the OCAR is multiplied by managed seagrass meadow extent. The 393 ha of actively managed seagrass meadows on Jersey represent a sink of ~259.6 t CO_2eq yr^{-1}, 0.07% of Jersey's 2023 GHG emissions. Jersey's seagrass, while offering a limited contribution to delivering net zero, play a fundamental role in aligning efforts towards nature based solutions to combat climate change.

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A Framework for Independent Seismic Mapping of Ocean Temperature, Salinity and Turbulence

Seismic Oceanography (SO) is a unique technique observing the ocean with unprecedented spatial resolution. Its ability to map ocean temperature, salinity, and turbulence at a resolution of O(10) m makes it an ideal tool for studying submesoscale processes. Despite two decades of development, SO remains underexploited by the broader oceanographic community. This issue stems from a steep learning curve rooted in geophysical jargon and complex data processing, further obscured by a lack of standardized workflows and uncertainty quantification. To bridge this gap, we propose a new framework that employs seismic supergather as a key data processing component to resolve two major challenges in SO: noise contamination and the construction of initial sound speed model for temperature and salinity inversion. We further demonstrate the potential of this framework in achieving automation of the full-stack data processing pipeline, which could facilitate wider adoption of SO in physical oceanography. To demonstrate its capability, we present preliminary results investigating the spatial distribution and variability of turbulent mixing processes around the East Antarctic shelf seas.

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Global Coastal Oxygen: Current Status and Future Outlook

Oxygen is fundamental to marine ecosystem health, yet widespread declines in dissolved oxygen are increasingly threatening coastal ocean systems where biological productivity, biodiversity, and fisheries are concentrated. Despite its importance, observational coverage of oxygen in the global coastal ocean remains sparse and heterogeneous. Here we show that only 38% of the global coastal ocean has at least one recorded oxygen measurement, and nearly half of these observed locations have experienced concentrations below 6 mg L^{-1}, a threshold associated with ecological stress in many marine species.

In this study, we combine in situ observations from global databases with a high-resolution shelf-enabled global biogeochemical model (SENEMO-ERSEM) to characterise the current state of coastal oxygen variability and assess potential future changes. We introduce a novel classification framework to describe oxygen behaviour across coastal and shelf seas, capturing persistent, seasonal, and intermittent low-oxygen conditions.

Model evaluation demonstrates good agreement with observed spatial patterns and seasonal dynamics in many regions, particularly the Atlantic, providing confidence for future projections, although discrepancies remain in poorly represented systems such as semi-enclosed seas. Climate scenario simulations indicate a continued expansion of oxygen-deficient conditions, with intermittently affected regions increasingly transitioning toward persistent low-oxygen states. Our findings highlight both the vulnerability of coastal oxygen systems to climate change and the urgent need for improved observations to better constrain and predict future deoxygenation.

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Linking organic matter cycling to carbon storage: a globally integrated steady-state model of the Biological Carbon Pump

The Biological Carbon Pump (BCP) stores the equivalent of 150-200 ppm of atmospheric CO2 as regenerated Dissolved Inorganic Carbon (DICreg). Atmospheric CO2 is sensitive to changes in globally integrated DICreg which can be driven by changes in organic matter cycling, such as changes in export production and the attenuation of organic matter remineralisation. However, predicting these changes in DICreg typically requires a biogeochemical model to resolve the impact of nutrient cycle feedbacks on export production.

Here we derive a steady-state model of globally integrated DICreg as a function of export production and the vertical profile of remineralisation, and which resolves a nutrient cycle feedback by considering preformed nutrients. We show that two key parameters, the preformed residence time and the fraction of upwelled nutrients routed to organic matter export, vary minimally when varying organic matter cycling in an Earth System model. As such, the dynamics of DICreg can be reasonably approximated by diagnosing these two parameters for a given ocean circulation state. The steady-state global model provides a simple framework for interpreting the BCP and demonstrates some key constraints on the dynamics of carbon storage.

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Decomposing oceanic temperature and carbon changes to assess *p*CO_2 fields in the Southern Ocean

Carbon dioxide plays a central role in ocean biogeochemical cycles and in regulating climate through the oceanic uptake of anthropogenic CO_2. The Southern Ocean is a key component of the global carbon cycle, accounting for a disproportionate fraction of the oceanic uptake of atmospheric CO_2 due to its intense air–sea exchange and deep-water ventilation. Over recent decades, surface ocean pCO_2 in the Southern Ocean has evolved in response to both increasing atmospheric CO_2 and changes in ocean circulation, temperature, and biological activity. However, the relative contribution of the processes driving pCO_2 variability and long-term trends remains poorly constrained. Changes in oceanic pCO_2 can arise from several mechanisms, including (i) temperature-driven changes in CO_2 solubility, (ii) variations in dissolved inorganic carbon linked to biological production and remineralisation, and (iii) circulation-driven changes in carbon supply associated with the upwelling and transport of carbon-rich deep waters. Disentangling the magnitude of these processes is challenging because they occur simultaneously and interactively. Here, we describe and apply a decomposition framework to separate changes in surface ocean pCO_2 into contributions associated with thermal effects and carbon-driven processes. By linking variations in pCO_2 to concomitant changes in temperature and dissolved inorganic carbon, this approach enables us to quantify the relative importance of physical and biogeochemical drivers of carbon variability.

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Global dual cascade of oceanic kinetic energy revealed by surface drifters

Oceanic kinetic energy (KE) cascades play a crucial role in the transfer of energy across various spatial scales in the upper ocean. At the mesoscale (approximately 100-300 km), KE is predominantly transferred to larger-scale ocean currents (inverse cascades). In contrast, at the submesoscale (approximately 1-10 km), both forward (downscale) and inverse (upscale) cascades occur. Understanding these KE cascades is essential for comprehending the formation and evolution of ocean currents, and the overall dynamics of ocean circulation. Previous studies have primarily investigated ocean surface KE cascades using numerical simulations or regional observations, resulting in a lack of comprehensive global assessments. In this study, we analyze in situ velocity measurements from surface drifters to characterize the global distribution of dual KE injection and cascade. KE is primarily injected at smaller scales (e.g., < 50 km via submesoscale instabilities in higher latitudes) and extracted at larger mesoscale scales (200–300 km) through eddy merging and mean flow absorption. Western boundary currents regions exhibit pronounced inverse and forward KE cascade magnitudes. It indicates that eddy generated from eastern boundary moved westward. In submesoscale, eddy will interact with topography then dissipation, which caused KE transferring to smaller scale. Meanwhile, eddy can transport KE to larger scale via eddy-eddy triad interaction. These insights contribute to a more comprehensive understanding of global ocean surface dynamics and energy transfer processes.

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North Atlantic Particle Export Responses to Marine Heatwaves

Marine HeatWaves (MHW) are increasing in frequency and intensity in the North Atlantic, impacting biogeochemical and carbon cycles. However, their effect on carbon export is relatively unexamined, largely due to the sparse observations of particle export. In recent years, the number of backscattering profiles from BioGeoChemical Argo (BGC-Argo) floats have increased in the North Atlantic. Using a method developed by Briggs et al. (2020), we estimated the particle export fluxes of ~2300 profiles in the North Atlantic between 2010 and 2025. Compared to non-MHW periods (~1400 profiles), we find that particle export tend to be reduced during MHW (~800 profiles) in the Iceland Basin and the North Atlantic Current regions. In the Labrador and Irminger seas, the export response is seasonally dependent, exhibiting both increases and decreases over the spring and summer months. As MHW become more frequent with ocean warming, these contrasting regional responses suggest that MHW may substantially alter the North Atlantic biological carbon pump and, consequently, the ocean carbon sink.