

ENCONTRO DE OCEANOGRAFIA

Peniche, 2024

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LIVRO DE RESUMOS | ABSTRACT BOOK



APOIOS | SUPPORTS



Constituída em 2013 por reformulação da antiga Associação Portuguesa de Paleoceanografia, a **Associação Portuguesa de Oceanografia** (APOCEAN) é uma sociedade científica cujos principais objetivos são:

- O intercâmbio científico através de encontros e workshops;
- Diagnosticar e encontrar soluções para os problemas comuns a quem investiga o oceano;
- Promover a interdisciplinaridade juntando cientistas de várias áreas;
- Apoiar a internacionalização da oceanografia portuguesa, interagindo com associações similares de outros países e com organismos internacionais;
- Apoiar a divulgação para o público da investigação praticada em Portugal;
- Contribuir para uma melhor formação em oceanografia junto das Universidades;
- Divulgar a importância social e económica do estudo dos oceanos;
- Promover uma visão atual, integrada e cientificamente fundamentada da oceanografia;
- Participar na definição de políticas de investigação dos oceanos;
- Contribuir para a representação portuguesa em organismos internacionais de investigação e exploração dos oceanos.

A associação está representada em instituições, Laboratórios e Unidades de Investigação com atividade no domínio da Oceanografia ou em campos de investigação ligados ao oceano.

Este ano a **APOCEAN** promove o Encontro Nacional de Oceanografia, nos dias 3 e 4 de maio em Peniche.

Esperamos por si!



Established in 2013 by restructuring the former Portuguese Association of Paleoceanography, the Portuguese Association of Oceanography (APOCEAN) is a scientific society whose main objectives are:

- Scientific exchange through meetings and workshops;
- Diagnose and find solutions to common problems among those who study the ocean;
- Promote interdisciplinarity by bringing together scientists from various fields;
- Support the internationalization of Portuguese oceanography, interacting with similar associations from other countries and with international bodies;
- Support the dissemination to the public of the research conducted in Portugal;
- Contribute to improved training in oceanography at universities;
- Publicize the social and economic importance of studying the oceans;
- Promote a current, integrated, and scientifically based view of oceanography;
- Participate in defining research policies for the oceans;
- Contribute to the Portuguese representation in international research and exploration bodies of the oceans.

The association is represented in institutions, laboratories, and research units active in the field of Oceanography or in research fields related to the ocean.

This year, APOCEAN is hosting the National Oceanography Meeting on May 3rd and 4th in Peniche.

We look forward to seeing you!



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Invited Speakers

11. Mission, ongoing work, and preliminary results of project PASSAGE in the SW Iberian margin

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The SW Iberian margin is pivotal for our understanding of past global climate changes. However, recent studies suggest that some sediment components commonly used as climate proxies are displaced to a considerable extent by advection. The latter raises important questions on the fidelity of the climate reconstructions derived from such proxy-bearing particles. A direct assessment of particle provenance and transport pathways has remained elusive to date. To tackle this knowledge gap, we recently deployed two mooring lines in the SW Iberian margin during PASSAGE23 cruise aboard B/O Ramón Margalef. Each mooring hosts two sediment traps programmed to bi-monthly capture particles of export production related to upwelling processes and particles advected by lateral transport. Given the importance of the hydrographic conditions in defining different modes of advection, each trap houses a current meter to record changes in current speed, a temperature and salinity sensor, and a seapoint turbidity meter. Here, we will present the mission, ongoing work, and preliminary results of the PASSAGE project, which explores processes from the sea surface to the deep-sea sediments. This project aims to improve our ability to reliably interpret short-term climate variability by gaining detailed knowledge on particle transport modes and assessing their potential to bias inferred climate signals.



12. The imprint of anthropogenic climate change in the SW Iberian Upwelling System: a warmer, more acidic and less oxygenated ocean.

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The imprint of anthropogenic climate change on the ocean is unequivocal. Warming, acidification, and deoxygenation stand out as the main biogeochemical stressors at global scale. At regional scale, Eastern Boundary Upwelling Systems are hotspots of change due to anthropogenic influence, threatening their valuable ecosystem services. In this study, we assessed the changes in biogeochemical stressors in the Southwest Iberian Peninsula in the last three decades (1989-2022). Recent high-quality observations confirm that the surface-intensified anthropogenic imprint is widespread until 2000 meters depth. The uptake and advection of heat and anthropogenic carbon, coupled with reductions in ventilation, are the forcing drivers. Warming, acidification, and deoxygenation align closely with the burden of anthropogenic carbon.

Highlight Presentation

H1. Carbon production and export at the Iberian margin: a multiproxy reconstruction since the last glacial maximum

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Human activities have increased atmospheric CO₂ to unprecedented levels, affecting the climate and ocean systems and impacting life on Earth. The only natural tool for climate remediation is carbon sequestration, which is a consequence of primary production (PP). Half of the global net PP comes from marine photosynthesis, and substantially from the microscopic marine realm of coastal upwelling regions ^[1]. The West Iberian margin is ideal to study the impact of long-term climate variability on ocean carbon sequestration ^[2]. Previous studies showed PP and export production to be affected by climate change, while also revealed the proxies' sensitivity to dissolution/preservation conditions ^[3]; a possible decoupling between carbon fixation and sequestration ^[2]; and an under-representation of subsurface and intermediate depth processes. To evaluate the impact of climate change on the effectiveness of marine carbon sequestration, project IRMAPEX will characterize the Iberian margin subsurface and intermediate water conditions for time-slices of specific climatic boundary conditions since the Last Glacial Maximum. A multiproxy approach combines new with existing datasets to reconstruct the history of PP export by integrating: diatoms assemblages and accumulation rate, coccolithophores accumulation rate and trace elements; planktonic foraminifera transfer functions ^[3]; Ba/Ca ratios on planktonic and benthic foraminifera species, and cold-water corals ^[4]; total organic carbon concentration and mass accumulation rate. Modern data for the NW Iberian margin suggest that coastal upwelling-related planktonic foraminifera species ^[5] register the increase in water Ba/Ca, accompanying the upwelling center. Elementary changes found between surface and deeper species may reflect carbon export along the water column. Additionally, preliminary cold-water coral Ba/Ca appears to record the expected glacial-interglacial PP export decrease to intermediate water depths, though a possible circulation-effect needs further investigation. IRMAPEX integrative approach shall provide essential understanding of marine carbon fixation and sequestration processes over West Iberia.

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H2. Operational Modeling of the Algarve Coast and Monitoring with Autonomous Underwater Vehicles (AUVs) to Evaluate Risk Spots for Submerged Cultural Heritage

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Submerged underwater cultural heritage provide insight into past human behavior and history ^[1] and thus the preservation of these artifacts at the site of discovery is crucial. However, marine environmental conditions such as physical processes, chemical conditions, and biological factors directly impact the preservation and degradation of these underwater historical sites ^[2]. Hydrodynamic conditions are particularly important for structures placed in a high-energy environment where physical processes are the most significant factors contributing to site deterioration ^[3]. The focus of this work is to analyze the physical processes that can put submerged cultural heritage at risk such as waves, currents, and sediment abrasion. The risk assessment will be applied to a specific site in the Algarve where a WWII American B24 bomber plane was sunk approximately three kilometers offshore of Praia de Faro, Portugal. It is the aim of this work to analyze and predict the physical processes that serve as risk factors for underwater cultural heritage. Furthermore, it aims at developing methodologies that allow the evaluation of the risk in real time, and allow early warning in case of emergency situations. To accomplish this, an operational wave model will be developed and coupled to an existing operational hydrodynamic model, to run a non-cohesive sediment transport model. This system will be used to evaluate risk spots for submerged cultural heritage. The hydrodynamic model comes from the Algarve Operational Modeling and Monitoring System (SOMA) which simulates only hydrodynamic conditions off the coast of the Algarve ^[4], without considering the wave forcing. The main objectives of this work will be met by accomplishing five main tasks: 1) Create an operational wave model for the SOMA domain based on the SWAN model; 2) Couple the wave model with the hydrodynamic model; 3) Implement a non-cohesive (sand) sediment transport model for the SOMA domain; 4) Run the non-cohesive sediment transport model with the wave-hydrodynamic coupled structure; and 5) Use the model to evaluate risk spots for submerged cultural heritage.



Oral Presentations

O1.Plataforma Digital SOMOSATLÂNTICO: Uma Nova Era na Disponibilização de Dados Oceanográficos em Portugal

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A observação do Oceano é um dos pilares fundamentais no conhecimento do sistema terrestre, destacando-se o Instituto Português do Mar e da Atmosfera, I.P. (IPMA) como uma entidade de referência no acervo de dados do meio marinho. A observação regular, sistemática e continuada é fundamental para a monitorização dos parâmetros meteo-oceanográficos, e consiste na única forma de detetar padrões e tendências a várias escalas espaço-temporais. Nesse sentido, surge a plataforma SOMOSATLÂNTICO, que corresponde a uma infraestrutura de investigação observacional do Oceano. Tem como objetivo a agregação e disponibilização de dados e informação do IPMA e de outras entidades que trabalham na bacia do Atlântico, garantindo a sua integridade, perpetuidade e interoperabilidade, de acordo com os Princípios FAIR (*Findable, Accessible, Interoperable, Reusable*) e seguindo as boas práticas mais relevantes da União Europeia, como a Diretiva Inspire. A ‘somosatlântico’ decorre da execução do Projeto “Observatório do Atlântico - Infraestrutura de Dados e Monitorização”, financiado pelos EEA Grants, e cujos objetivos visam potenciar a investigação e monitorização do Oceano, respondendo às necessidades e lacunas da ciência, tecnologia e sociedade. A plataforma constitui um elemento fundamental na cadeia de valor da observação do Oceano, fomentando o princípio “medir uma vez, utilizar várias vezes”, funcionando como ponte entre os observatórios e os utilizadores finais, valorizando os dados e a sua integração a vários níveis da sociedade, desde a investigação e desenvolvimento, à educação e literacia, aos setores da economia azul e à administração pública. A interface com os utilizadores faz-se através do catálogo de metadados e dos visualizadores, onde a informação é disponibilizada, agregada por temas, incluindo observatórios *in situ*, dados de cruzeiros ou modelos de previsão e reanálise.

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O2. Project RAMONES: Radioactivity Monitoring in Ocean Ecosystems

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Natural radioactivity in the marine environment has been present since the Earth's formation, while artificial radionuclides were introduced into the oceans in 1944. More recent direct sources exist that feed the oceans, such as low-level liquid discharges from reprocessing plants, large-scale releases due to disasters (e.g., Fukushima hit by the tsunami in 2011), and smaller-scale radiological events. Exploration of submarine environments should consider the existence of radioactivity in terms of its short- and long-term impact on marine and coastal ecosystems, also in correlation to natural hazards, such as seismic activity over submarine faults. RAMONES aims to offer new and efficient solutions for in situ, continuous, long-term monitoring of radioactivity in harsh subsea environments. A new generation of submarine radiation-sensing instruments, assisted by SoA robotics and artificial intelligence (AI), is being developed towards understanding radiation related risks near and far from coastal areas, while providing data towards shaping new policies and guidelines for environmental sustainability, economic growth and human health. RAMONES assets consist of a fixed benthic station, two underwater gliders, an autonomous surface vehicle, acting as the main communications hub in the network, and a mission control station, located either on shore or on a crewed surface vessel. The multitude of custom radiation sensors include i) mobile γ -Sniffers, GASPARG, and SUGI, built for the detection and monitoring of gamma radiation, offering spectroscopy and imaging capabilities; ii) α SPECT, a novel and innovative solution for the underwater detection of alpha particles; iii) CHERI, which aims to detect Cherenkov radiation in underwater environments via highly sensitive camera systems. This communication will report on the latest developments of the marine robotics solutions, marinized sensors, field trials, and preliminary results within project RAMONES, as it reaches its final year.



O3. Benthic foraminifera response to changing bottom water oxygenation across the Early to Middle Pleistocene Transition in the Gulf of Cadiz

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Oceanic oxygen levels have decreased over the past few decades due to several factors, including ocean warming, increase in productivity, and decrease in ventilation. These drivers influence ocean deoxygenation at various timescales and in different degrees. This study is based on sediment samples from IODP Site U1387 (559 m water depth), which is currently bathed by the Mediterranean Outflow Water (MOW). The MOW, with lower oxygen concentration than surrounding North Atlantic waters, may have had its properties like bottom current velocity and oxygen levels influenced by factors such as past solar insolation changes. Using the unique hydrographic setting in the Gulf of Cadiz and to better understand regional oceanographic dynamics, we are analyzing the benthic foraminifera fauna, to reconstruct oxygen levels, bottom current velocity, and productivity across the Early to Middle Pleistocene Transition (EMPT, 1200-700 ky) from Marine Isotope Stage (MIS) 32 to MIS 18 (1100-790 ky). Oxygen concentration is a key factor controlling benthic foraminifera distribution, abundance, and diversity. In addition, they can also be strongly affected by the quantity and quality of food and current velocity as indicated by the abundance of the 'elevated epifauna' group. Our focus here is to estimate dissolved oxygen levels from the assemblage data, as well as to evaluate the difference in carbon isotope signals between, which reflects past organic matter fluxes. At the onset of MIS 25, there is an increase in abundances of deep infaunal (anoxic) species, potentially favored by low oxygen conditions, as evidenced by the carbon isotope difference, and the dissolved oxygen level estimates. In contrast, during early MIS 21 to late MIS 19, low relative abundances of deep infaunal species, high dissolved oxygen levels, and high relative abundances of oxic species reveal several periods with high oxygen content. Through trace element analyses over the next year, we will improve our understanding of benthic foraminifera ecology as well as paleoceanography during the EMPT.

O4. Is top to bottom mixing possible in coastal regions?

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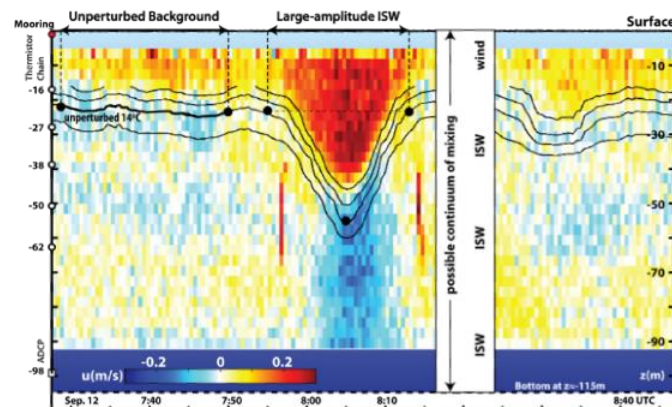
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Well-developed surface mixed layers up to 10 meters (or more) are known to result from strong winds. In addition, Internal Solitary Waves (ISWs) in coastal regions have already been shown to induce strong mixing in both intermediate and bottom depths, and recent evidence suggests them to also increase surface wave breaking. Altogether, it can be wondered if mixing from wind and ISWs combined can exceed that of their individual contributions? This possibility could ultimately mean a top to bottom continuum of vertical mixing in the water column with yet unforeseen implications ranging from mixing parametrizations in ocean models to our current understanding of biogeochemical processes relying in diapycnal mixing. We add to this possibility via a large sample of ISWs collected during 12 days with moored instrumentation off the Portuguese (Iberian) Coast. Richardson numbers are used to show that high winds and ISWs are associated with a higher frequency and larger-scale shear-instabilities and temperature overturns connecting surface to intermediate depths.





O5. Use of Probiotics to Stimulate the Success of Seagrass Restoration

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Seagrass meadows are globally declining due to anthropogenic stressors. Therefore, urgent restoration efforts are required to recover and expand these crucial ecosystems. In the last decades, the role and importance of the seagrass microbiome has gained more attention. As soil bacteria have been leveraged to enhance crop productivity for many years, growth-promoting bacteria are now proposed as a tool for improving seagrass health and recovery. This project investigates the role of the microbiome in seagrass health, growth, and resilience. We aim to identify and characterize novel and known bacterial isolates to expand the list of putative beneficial microbes associated with seagrass roots. These can be used as probiotics to facilitate seed viability, stimulate the health and growth of transplanted seagrass shoots, and thus promote the success of seagrass restoration. We determined the microbial diversity on all vegetative parts of the seagrass *Ruppia maritima* and isolated bacteria from five marine macrophyte root systems. These bacteria were barcoded using the total 16S rRNA region. Subsequently, we performed whole genome sequencing on a selected set of isolates and tested their role in germination and early-stage development of *R. maritima* seeds in a laboratory experiment with *Bacilli* sp. increasing both germination and growth.



O6. New insights about transport and currents on the NW Portuguese shelf

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The study presented here aims to enhance the actual understanding of the seasonal circulation on the NW Portuguese shelf. It was developed using results from ROMS 3D numerical model, applied to the western Iberia, and obtained after a 15-year realistic simulation. The results focus on the seasonal dynamics of the shelf, identifying its main oceanographic features and their monthly evolution throughout the year. Particularly, they emphasize the along shore and cross shore transport patterns, recurrent eddies, and typical meandering circulation on the shelf. Special attention is given to the transition months between the well-known Summer and Winter seasonal regimes, extensively described in literature as characterized, respectively, by upwelling and downwelling type circulation. It is expected to further produce a conceptual scheme illustrating the average dynamic characteristics, as well as its evolution along the year. The hypothesis put forward is that these features may be mechanisms influencing the dispersion and the definition of retention areas of small pelagic fish eggs and larvae, thus setting the basis for integrating the obtained results into a comprehensive biophysical dispersion model capable of simulating their transport, retention, and survival in the NW Iberian shelf.



O7. Oceanografia - Desafios da Integração, Inclusão e Inovação

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Será abordada uma estratégia para o desenvolvimento sustentável dos Oceanos e Zonas Costeiras e a adaptação à mudança climática, através da ação comunitária e do reforço da cooperação internacional em linha com a ambição da Agenda 2030. Através da identificação de atividades prioritárias e exequíveis ao nível local, mas simultaneamente capazes de promover uma rede global, promovem-se efeitos relevantes e de compromisso por parte da comunidade. Para operacionalizar esta estratégia, é desenvolvida uma operação com vista a implementar projetos e fornecer serviços de uma forma programática. A *Operação Bartolomeu (OpBart)*, para além da oportunidade em homenagear um notável explorador português, proporciona aos modernos exploradores, investigadores e cidadãos comuns, uma oportunidade para enfrentar desafios, desenvolver competências e aprender a superar problemas que afetam o Oceano e, consequentemente, nós próprios. Esta experiência reforçará a confiança e a consciência do importante papel da ciência cidadã no mar. Integrada na *OpBart*, encontra-se em desenvolvimento uma iniciativa que tem por objetivo a capacitação multinível centrada nas PME, nas ONG, nos aglomerados populacionais locais e no cidadão comum, permitindo a recolha, o acesso e a partilha de informação e dados sobre o Oceano, visando alavancar a contribuição da Ciência Cidadã para a monitorização colaborativa e a sensibilização acerca dos oceanos, em linha com os objetivos estratégicos estabelecidos no Pacto Ecológico Europeu. A área oceânica dos Estados-Membros costeiros da UE no Atlântico Norte é de cerca de 6,15 milhões de km², e será ainda maior com a extensão da plataforma continental. Isto significa uma média de 13,1km² por habitante. Porém, para o cidadão português, essa média é 12 vezes superior, devendo duplicar com referida extensão. Por isso, impõem-se ações perspicazes na assunção das responsabilidades no mar e na forma de o fazer. A ação comunitária pode contribuir para os processos e propósitos da sua monitorização, complementando a observação remota e *in situ*, tripulada ou não-tripulada, e robotizada das entidades públicas, afirmando o papel da ciência cidadã, em particular nas zonas costeiras. A embarcação *Libries* constitui um passo desta visão, tendo sido adaptada para apoio à oceanografia costeira, podendo operar sensores e outro equipamento, bem como apoiar operações de mergulho científico. Além disso, visa explorar outros serviços, como o turismo científico e a aventura.



O8. The role of the Ocean in Carbon Sequestration: Advances and Challenges in the Pursuit of Carbon Neutrality

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The Ocean plays a vital role in the carbon cycle, primarily by absorbing large quantities of CO₂ from the atmosphere, acting as a carbon "sink", being a crucial contributor to Earth's climate stability. However, the rapid increase in anthropogenic CO₂ emissions has created an imbalance in the carbon cycle that cannot be naturally offset. Reducing CO₂ emissions is no longer enough to reach CO₂ neutrality. The severity of the problem now requires the use of an array of carbon sequestration techniques, such as Carbon Dioxide Capture and Storage (CCS) and Carbon Dioxide Removal (CDR), where the ocean and its ecosystems can play a significant role due to its large potential for CO₂ removal and storage. Consequently, numerous studies have been trying to develop new methods and technologies that can safely and effectively capture and sequester large quantities of CO₂. Mineral carbonation has been drawing attention as a potentially sustainable technology to safely store CO₂ as stable carbonate minerals over a long period of time. Many recent studies have thus focused on characterizing the chemical reactions that occur during mineral carbonation and developing methods to improve its efficiency. However, there's still a lack of stress on the importance of mineral carbonation as an effective approach for both CCS and CDR. This work provides a general overview of the most important findings regarding the use of mineral carbonation as a method for carbon sequestration, highlighting the main benefits and pitfalls of this strategy, and raising attention to the major challenges that still need to be overcome. To demonstrate the ocean's potential on carbon sequestration, this work shows a distinctive case where mineral carbonation occurs naturally as authigenic carbonate minerals – the Mariana forearc large serpentinite mud volcanoes. Here, the decoupling between hydration and carbonation reactions occurs naturally, constituting a unique opportunity to study mineral carbonation processes.



O9. Four months of high-resolution observations of the upper ocean south of Cape São Vicente, northwestern margin of the Gulf of Cadiz

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The IbMa-CSV oceanographic observatory was deployed from the R/V Mário Ruivo at the CCMAR TUPEM (Título de Utilização Permanente do Espaço Marítimo), located at the shelf break >20 km south of Cape São Vicente. This deployment was carried out in collaboration with the Instituto Português do Mar e da Atmosfera (IPMA) as part of the European Multidisciplinary Seafloor and Water Column Observatory (EMSO-ERIC). The station comprised a vertical wave-powered profiler (Wirewalker), an acoustic-doppler current profiler (ADCP), and an EMSO Generic Instrument Module (EGIM). The instruments operated for a period of four months during the summer 2022, from 150 m to near-surface, 150 m, and 200 m, respectively. A time series of high resolution (2 Hz) and high temporal density (5-6 profiles/hour) of vertical profiles of temperature, salinity, Chl-*a*, turbidity and dissolved oxygen was acquired, along with the vertical description of the horizontal velocity. During a five days period in June, an abrupt temperature and salinity increase was detected at depths between 20-140 m, appearing as a “blob” of water from a different origin, resembling the signature of Mediterranean Water (MW). Furthermore, a decrease in chlorophyll concentration was observed in this period, an indicator for MW. Ahead, an increase in westward current from averaged 0.09 ms⁻¹ to 0.39 ms⁻¹ was observed, followed by a sudden change in direction towards the east at the time of the event, suggesting the appearance of a shallow eddy carrying MW in its core. These findings suggest that a sub-mesoscale eddy detached from the shallow vein of MW that is known to lean along the continental slope, shoaling upwards reaching the upper 20-140 m layer. The rough topography of the Portimão Canyon, as well as the Ekman suction, characteristic of the enhanced upwelling off Cape São Vicente, are candidates to explain this feature and must be further investigated. The IbMa-CSV moored observatory offers great opportunities to acquire long-term and continuous water column data, able to capture sudden events such as the one described here and provides valuable datasets for model validation.



O10. Contributing for the understanding of the ocean with acoustic data

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The oceans play a crucial role in regulating Earth's temperature by acting as a significant thermal reservoir, absorbing, and retaining substantial amounts of heat. However, we have a limited understanding of ocean dynamics at spatial scales ranging from 1 to 10 km as there are considerable challenges in directly and comprehensively sampling the ocean. Seismic oceanography (SO) uses common multichannel seismic reflection data to retrieve high resolution images of the ocean. This innovative imaging technique facilitates the examination of fine-scale oceanic processes across extensive distances. This method capitalizes on the variations in temperature and salinity within the ocean, which influence the seismic acoustic response. The resulting images track the interfaces between those thermohaline layers both laterally and in depth. We used three parallel 2-D seismic sections obtained by the Portuguese Task Force for the Extension of the Continental Shelf in the Madeira abyssal plain (MAP), from June 2006. Each section spans ~300 km in the E-W direction. Jointly with the seismic sections, we interpreted conductivity-temperature-depth probes (CTDs) from 2002 to 2009 acquired by Poseidon research vessel. The MAP region is influenced by the warm and salty Mediterranean Outflow water, contrasting with the Atlantic water. The integration of the two data sources allows us to better understand and identify the ocean processes occurring in the region, such as the manifestation of thermohaline staircases stable in space, time, and depth. These structures were confirmed to exhibit double-diffusion characteristics through the Turner angle and Density Ratio at corresponding depths and were identified in the SO data as parallel reflections which extend along the length of the survey, that in other case, this spatial coherence would be hard to confirm with discrete and sparse T-S profiles obtained from CTD casts. In this study, we provide new evidence of the coherence of double-diffusive homogenous layers couple direct and indirect observations of the ocean. Besides, we provide a coherent quantitative method to estimate the depth of thermohaline staircases from SO data.



O11. Decoding major Climate Mysteries over the last 1.5 million years: Sea Surface Temperature Reconstruction at IODP Site U1385, Iberian Margin.

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The Iberian Margin provides a remarkably accurate record of millennial-scale climate variability, making it an invaluable site for deciphering historical changes in climate and oceanography. This region's exceptional sensitivity to high latitude processes, such as meltwater discharges into the Northeast Atlantic, significantly influence ocean dynamics, nutrient supply, and climate change impacts. These processes play a pivotal role in understanding the complex interplay between the ocean, ice, and climate systems. IODP 339 Site U1385, also known as the "Shackleton site", drilled at a water depth of 2582 mbsl, reaching a total depth of 155.9 m below the seafloor. The oxygen isotope and carbon isotope records confirm that Site U1385 contains a continuous hemipelagic sedimentation from the Holocene to 1.45 million years (MIS 47), providing a reference record of millennial-scale climate variability. Here, we present a high-resolution Sea Surface Temperature (SST) record that unveils the climate variability over the last 1.45 million years. This dataset provides a comprehensive record of the millennial climate variability including major climatic disruptions, namely the Mid Brunhes Event and Mid Pleistocene Transition (MPT). It reveals a clear shift in the SST, driven by orbital forcing at from 1200 to 800 ka, thereby contributing to our understanding the underlying mechanisms on glacial/interglacial and centennial to millennial scales. Furthermore, the SST record shows extreme cold events occurred not only after the MPT but also during and after this enigmatic period. The highest temperatures in the overall record were recorded during Interglacial periods, and were coincident with maximum insolation (precession minimum), suggesting an orbital dependence of the Sea Surface Temperature (SST) over the past 1.45 million years. This SST record significantly contribute to documenting the major climate shifts and their relation to global climate change. This becomes particularly crucial as the upcoming IODP Expedition 397 is set to extend this remarkable sediment into the Pliocene.



O12. Satellite-based SST validation using in-situ data from the Portuguese Coastal Monitoring Network (MONIZEE)

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The Portuguese Coastal Monitoring Network (MONIZEE), overseen by Instituto Hidrográfico (IH) and national partners, comprises a set of in-situ sensors ^[1] and remote systems to deliver near-real-time oceanographic and meteorological data crucial for naval missions, maritime activities, and model predictions. MONIZEE's data contributes to European infrastructures like EMODnet Physics, EuroGOOS, and JERICO-RI, and is integrated into the Copernicus Marine Service In Situ TAC. IH's extensive ocean database, alongside its real-time monitoring capabilities, offers an opportunity to independently assess the quality of ocean products, such as the ones made available by Copernicus. This presentation focuses on IH's role as a member of the Sentinel-3 Validation Team (S3VT) and as a beta-tester for the European Space Agency's Sea Surface Temperature Climate Change Initiative (ESA SST CCI) ^[2]. The satellite-based sea surface temperature (SST) is validated using in-situ data from the MONIZEE buoys. As these in-situ data are not part of the products calibration procedures, they serve as unique and independent source to validate SST products across the NE Atlantic, where in-situ data are scarce. IH's involvement in S3VT includes not only statistical comparisons between S3-derived SST data and historical MONIZEE in-situ data but also the development of an operational near-real-time monitoring service accessible via Hidrografico+, IH's marine data infrastructure. This service facilitates systematic inter-comparison between near-real-time S3 data and in-situ measurements, offering valuable insights for monitoring purposes.

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O13. Data Assimilation Tools Towards Coastal Operational Models

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Data assimilation (DA) is a set of methods used to estimate the state of a dynamical system, by combining numerical model's data with observations. By assimilating real-world data into the ocean modelling framework, model results can be improved, thus enabling more accurate simulations of oceanic processes, climate patterns, and the behaviour of marine ecosystems. DA processes take observational data, such as sea surface temperatures, ocean currents, and satellite measurements, into numerical models to adjust and refine their initial conditions and parameters. Therefore, the utilization of DA is indispensable for advancing our understanding of ocean dynamics, facilitating informed decision-making in marine resource management, and predicting the impact of climate change on the world's oceans. This research aims to integrate DA methodologies with coastal ocean models, by creating the backbone of a modern DA system linked to the existent SOMA Forecasting System ^{[1], [2]}. This system will benefit greatly from the implementation of a DA method in its forecasts cycle, increasing its accuracy while paving the way to support the development of novel ocean products for the region. DA applications can be computationally quite expensive; thus, the Ensemble Optimal Interpolation (EnOI) scheme was chosen ^{[3], [4]}, which applies the approximation of time-invariant error statistics. The last meaning that the analysis is done only in the spatial dimension and comes at a small computational overhead. Furthermore, the new DA tool coupled with SOMA system, is also being used to implement an Observing System Simulation Experiments (OSSE) ^{[5], [6]} within the framework of NAUTILOS, an H. Europe project. As DA is effective to enhance in-situ and remote sensing observations carried out within the scope of operational physical oceanography, allowing their extension in space and time, it will be possible to determine the most interesting locations where the new observation instruments developed in NAUTILOS should be deployed.

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O14. Fluctuations in pH Across the Previous and Current Interglacial periods along the Western Iberian Margin

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The interplay among atmospheric CO₂ concentrations, surface ocean pH, and its impact on marine ecosystems is crucial within the context of contemporary climate change. The natural atmospheric CO₂ variability has been significantly disrupted due to the surge in anthropogenic CO₂ emissions over recent decades. According to the Intergovernmental Panel on Climate Change, if global atmospheric CO₂ concentrations continue to rise at the current rate, the average ocean pH will decrease by 0.3 pH units in surface waters by the end of this century, exacerbating impacts on marine calcifying organisms. This study aims to reconstruct surface ocean pH using boron isotopes in planktonic foraminifera. Focusing on the Iberian margin, a seasonal upwelling region, we examine two distinct interglacial periods: the Marine Isotopic Stage 5e (MIS 5e), the last interglacial, and the Holocene, the present interglacial. Preliminary findings reveal a pH difference between MIS 5e and the Holocene, with lower pH values during the latter. It is suggested that increased wind intensity during the Holocene may have triggered strong and persistent upwelling, enhancing productivity and consequently the respiration, thus leading to lower pH levels. Additionally, the increase in atmospheric CO₂, reconstructed from Antarctic ice cores during this period, may have contributed to ocean pH reduction. Variations in upwelling and atmospheric CO₂ could be pivotal factors influencing observed pH differences. A better understanding of the natural pH variations on the western Iberian margin is expected to be achieved through the integration of our B data with other multi-proxy environmental data, such as the reconstruction of the Sea Surface Temperature and productivity for both periods.



O15. Ao sabor da corrente: Dispersão de biqueirão no ecossistema Ibérico

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Ao contrário de outras zonas de afloramento, onde as espécies de sardinha e biqueirão dominam os ecossistemas pelágicos, o ecossistema da Costa Oeste Ibérica tem sido consistentemente dominado pela sardinha europeia, enquanto o biqueirão tinha uma presença residual, desde o início dos levantamentos acústicos em 1989 até 2014. Desde 2016, a abundância de biqueirão aumentou acentuadamente e continua a registar uma tendência crescente. Não é claro se este aumento resulta da dispersão a partir de áreas de recrutamento próximas, de taxas de sobrevivência mais elevadas das primeiras fases de vida devido a condições ambientais favoráveis, ou de ambas. Este estudo utilizou um conjunto de modelos para simular a dispersão e a sobrevivência das primeiras fases de vida do biqueirão na região ibérica para os anos que precederam o aumento da abundância de biqueirão na área. Uma simulação com modelo oceânico CROCO (IB2v2) forneceu os campos de correntes e temperatura usados para correr as simulações Lagrangianas, acopladas a um modelo com base no indivíduo (IBM) de ovos e larvas de biqueirão. Simulámos os anos de 2013, 2014 e 2015, e os resultados mostram que em 2014 e 2015 um padrão anómalo de circulação do oceano superficial com correntes fortes e persistentes para leste transportou um grande número de ovos e larvas do Golfo da Biscaia (BoB) ao longo da margem norte da Península Ibérica. O transporte máximo ocorreu em junho/julho de 2015, quando 8%/4%, respetivamente, dos ovos desovados na BoB chegaram à costa ocidental ibérica como larvas. Este processo poderá explicar o aumento da abundância de biqueirão no ecossistema da Costa Oeste Ibérica. Os resultados do estudo mostram que os padrões de conectividade têm uma grande variabilidade no tempo, e que episódios de circulação oceânica anómalos, quando coincidentes com uma presença de ovos elevada, podem levar à colonização de novas áreas. This work was funded by the Portuguese Fundação para a Ciência e a Tecnologia (FCT) I.P./MCTES through national funds (PIDDAC) – UIDB/50019/2020 (<https://doi.org/10.54499/UIDB/50019/2020>), UIDP/50019/2020 (<https://doi.org/10.54499/UIDP/50019/2020>) and LA/P/0068/2020 (<https://doi.org/10.54499/LA/P/0068/2020>).



O16. Unveiling the Ocean's Plastic Pathways: insights from the PLESS Tool

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Marine litter is a global challenge that significantly affects both marine and freshwater ecosystems. Plastics constitute the majority of marine litter, as highlighted by the OSPAR commission. Scientists predict that plastic waste in the ocean will reach 250 million tons by 2025^[1]. The impact of plastic litter is enormous. The United Nations estimates that plastic marine litter causes \$13 billion in financial damage to marine ecosystems annually. Marine animals often suffer injury or death due to entanglement in derelict fishing nets or ingestion of plastic. Additionally, marine litter imposes substantial clean-up costs on beaches and profoundly impacts tourism. Moreover, it is increasingly becoming a concern for human health, as seafood can become contaminated with harmful plastic particles and pollutants. Despite these negative consequences, there is limited available data on marine litter concentrations. Innovative solutions are crucial to address the challenges presented by marine litter, particularly plastic pollution in our water bodies. One of the goals of the Plastic-Less Society (PLESS) project was the development of a tool that combines satellite data and oceanographic models to produce value-added reports within the marine litter domain, useful for decision-making and practitioners. The PLESS tool combines satellite-based data (Sentinel 2 and machine-learning techniques) for detecting, identifying, and classifying marine litter, particularly plastics, with oceanographic models (hydrodynamic and Lagrangian tracer models) to assess marine litter journeys. This integrated approach informs our understanding of plastic debris distribution and movement in the oceans. In the present work, preliminary results of the application of the tool are shown. Three distinct services were tested: marine plastic detection, marine plastic tracking, and a single order request, providing continuous monitoring, short-term predictions, and identifying areas at high risk for plastic accumulation. The results obtained are promising and demonstrate the tool's ability to provide these services.

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O17. Inhibiting and stimulating effects of space weather on marine biotoxins: a review of similarities in Iberian and North American time-series

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Solar-derived geomagnetic activity (GMA) has been related to effects on living beings, mainly in the medical field ^[1]. Biological time series only sparsely have been related to the 11-year sunspot cycle (SC). Blooms of toxic phytoplankton and the respective accumulation of paralytic shellfish poisoning toxins (PSTs) in bivalves present large intra-annual variability worldwide. In Portugal, outbreaks of PSTs attributed to *Gymnodinium catenatum* displayed the highest inter-annual maxima coincidental with minima of the SC during 1986-2023 ^[2]. Solar radio flux (SRF) was used as a proxy for energy fluctuations associated with sunspots. The relation of PSTs in North America with astronomical variables was not very successful ^[3]. Nevertheless, several of the PSTs outbreaks in the Bay of Fundy, Canada coincided with low SRF in the period 1944-2012. In the 1996-2020 time-series of PSTs from Galicia, Spain, episodes were more intense during the minima of SC #23 and #24 ^[4]. The exceptions were derived from the accumulation of *Alexandrium*, but not *G. catenatum* toxins. In Portuguese bivalves, accumulation of amnesic shellfish poisoning toxins (ASTs) during 1997-2023 was positively related to both SRF and GMA, but the correlation was stronger with GMA. GMA presents annual maxima during the equinoxes and ASTs also presented their highest maxima following the spring equinox (in April and May), and a secondary maximum following the autumnal equinox (in October). ASTs surpassed 5 µg/g in 46% of these months when GMA was above average (18.5 nT), but only in 18% when GMA was below average. ASTs in Galicia peaked during the equinox period between 1995-2020 and presented 4- and 11-year periodicities, the last one was similar to the SC ^[6]. In the Pacific USA coast, ASTs were related to warmer waters ^[7]. However, models failed to explain the absence of toxins during some warm periods, probably because these were also coincidental with low GMA. Consecutive low GMA levels during 2007-2011 coincided with consecutively low ASTs in both the Portuguese Atlantic coast's and the USA Pacific coast's bivalves.

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O18. Fortnightly variability of the residual circulation and its drivers at the Guadiana Estuary

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This study addresses the temporal variability of the residual circulation in estuaries based on ADCP observations at the Guadiana Estuary. The dataset comes from 6 seabed moorings (July-August 2023) near the mouth and 15 km upstream, completed by tidal cycles surveys at both neap (27 July) and spring (03 August) tides. These observations show that the cross-channel structure of (along-channel) residual flows varies between a (vertically sheared) 2-layer exchange flow at neap tide and vertically homogeneous outflows or inflows, with significant lateral shear, at spring tide. Comparisons with the lateral residual structure from previous analytical studies suggest a switch between the dominant forcing at neap (density driven) and spring (tidally driven). In support, a principal component analysis of the moored time series indicates distinct trends for the main residual flow variability when the tidal velocity amplitude is weaker or larger than 0.6 m/s. To investigate this behavior, the salinity distribution along the estuary at both neap and spring tide is derived from previous measurements (under similar low river discharge conditions) to estimate the ratio of the barotropic and baroclinic forcings (expressed through the tidal Froude number). The ratio depicts a fortnightly alternance between tidally- and density-driven flows which is concordant with observations. This temporal variability relates to strong fluctuations of the horizontal density gradient between neap and spring tide, induced by significant differences in the seawater intrusion length along the channel. At spring tide, the horizontal density gradient is negligible at the lower estuary, due to the extensive (> 10 km) seawater intrusion, and the tidal forcing dominates. At neap tide, seawater hardly intrudes the estuary, resulting in a strong horizontal density gradient which dominates the tidal forcing. Overall, this study reports that, at some settings, the drivers of the residual circulation may change between neap and spring tide, contrarily to usual assumptions. The residual flow dynamics is particularly sensitive to the variability of seawater intrusion along the channel.



O19. A Rede de Observação do Oceano com Embarcações de Pesca: uma Rede Global Colaborativa Emergente#

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Existe uma crescente necessidade de melhorar as observações costeiras de superfície e subsuperfície para possibilitar a modelação com assimilação de dados e ferramentas de suporte à decisão. As embarcações de pesca podem servir como plataformas para implantar uma variedade de instrumentação oceanográfica. Para além disso, o facto de muitas artes de pesca já atravessarem a coluna de água oferece uma oportunidade única de recolha de dados subsuperficiais. A integração destas observações em sistemas globais de observação (e.g., o GOOS), complementam as redes de observação já existentes, permitindo uma observação de baixo custo da superfície e subsuperfície do oceano costeiro, o que aumenta significativamente a cobertura em regiões com poucos dados. Contra intuitivamente, as regiões da plataforma continental (i.e., costeiras), onde ocorre a maioria das actividades humanas (e.g., as pescas) estão entre as mais carentes de dados, nomeadamente para dados subsuperficiais, que as embarcações de pesca são tão adequadas para recolher. Estes dados podem beneficiar a ciência pesqueira, fornecendo dados ambientais associados às capturas, melhorar modelos oceanográficos costeiros e oceânicos e promover a participação dos intervenientes na pesca no processo científico. Assim, este sistema de observação do oceano é uma situação vantajosa para ambas as partes, pois a indústria pesqueira pode usar esses dados para adoptar soluções



inovadoras para melhorar a sustentabilidade, o lucro e a resiliência da comunidade pesqueira. Para maximizar esses benefícios e complementar as redes de observação oceânica existentes, uma rede global emergente foi formada: a Rede de Observação do Oceano com Embarcações de Pesca (FVON-Fishing Vessel Ocean Observing Network), com o objetivo de promover a proliferação da recolha de dados oceanográficos de uma maneira colaborativa e relativamente económica, democratizar as observações do oceano, estabelecer padrões e as melhores práticas de recolha de dados e facilitar a assimilação de dados para melhorar as previsões oceânicas, ao mesmo tempo que promove uma pesca sustentável.



O20. Major hydroclimate shifts during two key glacial periods (MIS 16 and MIS 12) in southwestern Europe

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One of the biggest threats of global warming is the hastening of North Hemisphere ice sheets melting that are provoking a massive reduction of the Atlantic Meridional Overturning Circulation (AMOC) (e.g., Ceasar et al., 2018; Thornalley et al., 2018; Boers, 2021). Recent research advances further indicate that the present-day AMOC is on route to tipping (Van Westen et al., 2024) and predict its collapse around mid-century under the current scenario of future warming (Ditlevsen and Ditlevsen, 2023). AMOC collapse would have a great impact on the dynamics of the atmospheric circulation, by preventing moisture supply to W Europe causing an increase in frequency, duration, and intensity of droughts with amplified risk of fires in vulnerable regions, such as the Mediterranean region (Liu et al., 2017). To better understand the impact of a reduced/collapsed AMOC on the atmosphere dynamics and explore the eventual processes of moisture transfer to Europe, it is also crucial understand coupled ocean-atmosphere changes during some key glacial periods with similar AMOC scenario. Thus, we focused our research, using a direct sea-land comparison approach (pollen, alkenone derived SST, % C37:4 and benthic $\delta^{18}\text{O}$) on site U1385 (W Iberian Margin) to explore the distribution of precipitation in Europe under AMOC reduction/collapse conditions during two distinct glacial periods, as the Marine Isotopic Stages (MIS) 16 (621–676 ka) and MIS 12 (424–478 ka). Our data show both glacials are marked by 3 main episodes of semi-desert plants expansion (dry conditions) intercalated by two episodes of heathland expansion (wet conditions), with a periodicity of ~ 21 ky demonstrating that major vegetation changes are mainly controlled by precession in the western Iberian Peninsula. We will also show that the distribution of moisture across North Atlantic region is complex and mainly controlled by the meridional thermal contrast



between North Atlantic (NA) high- and mid-latitudes which will modulate in turn the strength and position and of both the arctic front and polar jet stream.

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O21. Trends of Marine HeatWaves in the Canary EBUs over the satellite period

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In the last decades, an increasing trend of the Sea Surface Temperature has been observed in most offshore and coastal regions all around the globe, with extreme temperature events (Marine Heatwaves, MHW) becoming more frequent, longer lasting and more extensive ^[1]. Located on the eastern North Atlantic coast, the Canary upwelling region constitutes one of the four major Eastern Boundary Upwelling (EBU) systems and is characterized by a discontinuity imposed by the Gibraltar Strait which connects the Atlantic Ocean and the Mediterranean Sea ^[2,3]. Past observations indicate that the Canary upwelling region has been warming at both local and regional scales since the early 1980s, increasing on average the frequency of extremely hot days along the eastern Atlantic margin by 8.4+-6.6 additional hot days per decade ^[4]. In fact, it has warmed the fastest of all the EBUs ^[5]. In this study, SST data incorporating observations from satellites, ships, buoys and Argo floats, interpolated to a 1/4° regular global grid, is used to analyze extreme temperature events over the period 1982-2023 (National Oceanic and Atmospheric Administration, <https://www.ncei.noaa.gov/products/optimum-interpolation-sst>). The results show that the cumulative intensity of the MHW increased ~6 °C day per decade, being 2023 the most harmful year of the analyzed period. This work was funded by the Portuguese Fundação para a Ciência e a Tecnologia (FCT) I.P./MCTES through national funds (PIDDAC) – UIDB/50019/2020 (<https://doi.org/10.54499/UIDB/50019/2020>), UIDP/50019/2020 (<https://doi.org/10.54499/UIDP/50019/2020>) and LA/P/0068/2020 (<https://doi.org/10.54499/LA/P/0068/2020>).

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O22. Internal waves playing with the sea surface: what have we learned from satellite?

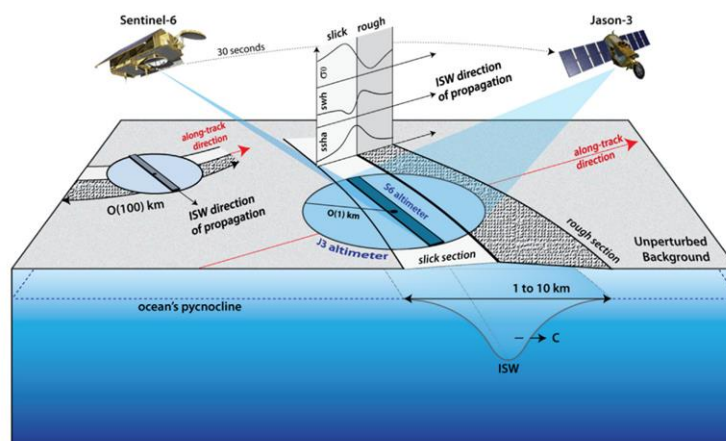
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Internal waves can be simply thought of as the analogue of surface waves propagating along the oceans' inner stratification. Their scales however are very different. They can reach vertical amplitudes of more than a hundred meters, last for tens of minutes, and their typical velocities (of a 1 m/s or more) are so strong that they modulate the sea surface. Recent findings using recent advances in remote sensing are now showing new ways internal waves can affect sea surface properties including increased surface wave breaking. A review of these new findings is attempted with a special focus on possible physical and biogeochemical processes.





O23. Untangling jellyfish dynamics: Insights from GelAvista citizen science data and oceanographic perspectives

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The global increase in jellyfish and the potential impacts on zooplankton communities and marine ecosystems are relevant themes in marine ecology studies, particularly in the context of climate change and anthropogenic impacts on the ocean ^[1]. As integral components of oceanic food webs, gelatinous zooplankton hold considerable ecological importance ^[2]. Understanding their dynamics and the impact of environmental and oceanic factors on their occurrence and dispersal is becoming increasingly urgent. Our knowledge of jellyfish remains incomplete, leaving fundamental questions unanswered for many species. Sudden and seemingly irregular surges in jellyfish abundance under favourable environmental conditions, contribute significantly to the biomass input in oceans, with potential adverse effects on economic and recreational human activities ^[3]. The citizen science program GelAvista has been monitoring jellyfish in Portuguese waters since 2016, collecting data on biodiversity, as well as seasonal, temporal and spatial distribution for several species. Citizen science initiatives have proven effective in spatially and temporally extensive jellyfish monitoring, facilitating data collection. GelAvista has contributed with new and relevant knowledge on jellyfish dynamics. Recent findings of the program will be presented and oceanographic insights into jellyfish dynamics discussed regarding the distribution of the species and the mechanisms that may drive the transport towards the coast.

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O24. Three-dimensional modeling of hydrodynamics and salinity in Aveiro Lagoon

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Estuarine environments exhibit dynamic morphologies, influenced by both natural variability and human actions, that are likely to change tidal and salt propagation, and, consequently, the ecological equilibrium of estuarine habitats. Indeed, such variations in tidal and transport properties may be of critical concern for the development and survival of certain species. In this way, hydrodynamic models are crucial tools to understand and predict flow movement behaviour. These predictions can have a huge impact on our society, enabling government authorities to adopt a wide spectrum of control measures. Here, Aveiro Lagoon stands out as a significant natural system because it is recognized as the most important wetland of Northern Portugal, with a high ecological importance, and it has been exposed to several geomorphological modifications. It is also a shallow water lagoon with an intricate network of branches and floodways between the marshes, which represents a noticeable challenge for modelers. In this work, it is described the implementation, calibration, and validation of a novel 3-D hydrodynamic model for Aveiro Lagoon, DFlow-FM. This is a state-of-the-art, open-source numerical model, that allows a flexible combination of unstructured grids (Kernkamp, 2011). These grids differ from former structured grids developed for Aveiro Lagoon, because they allow the use of quadrangles aligned with the main flow directions, resulting in less courant issues and more precise results. On the other hand, triangles can be applied at grid connections, mainly at intertidal areas characterized by irregular shapes and complex flows. The unstructured mesh developed in this study enables variable horizontal resolution (10 – 100 m) within the lagoon. In the vertical, 60 Z-layers were employed with a fixed resolution of 0.5 m. The model simulates well tidal and salt propagation, with a coefficient of determination (r^2) higher than 0.885 for water level and 0.665 for salinity. Predicted results are consistent with those reported for similar systems (Conroy et. al, 2020), showing that DFlow-FM is a feasible tool to study flow and transport phenomena in Aveiro Lagoon.

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O25. O Projeto RECAP (Reduzir o carbono atmosférico através do aumento da alcalinidade em ambientes intermareais: Potencialidades e impactos)

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Reduzir as concentrações atmosféricas de dióxido de carbono (CO₂) para combater o aquecimento global e as alterações ambientais associadas é um dos maiores desafios da humanidade. O processo natural de meteorização de minerais e o consequente aumento de alcalinidade nos oceanos remove CO₂ da atmosfera à escala do tempo geológico. Estudos recentes de modelação e em laboratório mostram que este processo pode ser acelerado pela adição de minerais alcalinos ao oceano/zonas costeiras, a fim de atenuar as alterações climáticas em escalas temporais mais curtas. No entanto, são necessárias experiências de campo em condições naturais para avaliar o potencial de sequestro de CO₂, as alterações biogeoquímicas associadas e os impactos ecológicos do aumento da alcalinidade. O projeto RECAP (PTDC/CTA-CLI/1065/2021) tem como objetivo contribuir para responder a estas questões, através de uma experiência *in-situ* na Ria Formosa, a primeira realizada a nível europeu, monitorizada durante dois anos. A experiência foi instalada numa zona não perturbada colonizada por *Spartina maritima*, em setembro de 2022, incluiu três replicados, cada um com cinco tratamentos que incluem olivina e basalto (com duas granulometrias grosseira e fina) e um controlo sem tratamento. A água da Ria Formosa, água intersticial e sobrenadante sobre os sedimentos são amostradas todos os meses, é feita caracterização *in-situ* de temperatura, salinidade, oxigénio, pH, análise de alcalinidade total, nutrientes (NO₃, NH₄, PO₄ e Si(OH)₄) e metais vestigiais (Ni, Cu, Cr). Após a adição dos minerais, os dados dos primeiros meses mostraram um aumento da alcalinidade na água intersticial e na água sobrenadante, tendo estabilizado para valores semelhantes aos do controlo no final dos primeiros seis meses. Para monitorizar as potenciais alterações da biodiversidade, as amostras de sedimentos são analisadas para a composição floral e faunística, incluindo macrofauna, meiofauna, microfauna (foraminíferos bentónicos),



diatomáceas e bactérias, de três em três meses. Os resultados desta experiência de campo fornecerão conhecimentos estratégicos sobre os benefícios e riscos do aumento da alcalinidade em ambientes intermareais.



O26. Hurricanes activity effect on phytoplankton blooms in 2 Northern Atlantic regions

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Hurricane activity is able to introduce vertical motions within the top of the ocean water column, through high surface waves and strong winds. The vertical mixing leads to an increase in the nutrient availability in the upper part of the euphotic zone together with the fact that phytoplankton cells are also significantly displaced in the vertical. The combined effect stimulates ocean primary productivity and phytoplankton growth. This work focuses on the effects of hurricane activity (Ophelia (2017) and Lorenzo (2019)) on near surface chlorophyll values in the NE Atlantic region. In both events, and in two different regions, the effects were similar, with phytoplankton increases of up to 60% even 1–2 weeks after the hurricane activity, suggesting that hurricane impact on phytoplankton might be more significant in some oceanic regions. These results are particularly relevant in the context of global climate change, where ocean phytoplankton is the major player for the atmospheric carbon uptake, and especially in areas that were not, in general and till recently, Hurricane affected, as the North Eastern region of the Atlantic Ocean.



O27. Improving Oceanographic Science Communication: Bridging Science and Society

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The quantity of scientific articles and sources has increased in recent years. The world-wide availability of information is the highest in history due to the internet and open access. However, most scientific information does not reach society, as scientists are accustomed to mainly communicating with other scientists from within the same discipline, e.g., oceanography. The scientific community plays a significant role in generating crucial information to enable sustainable development. However, scientists also have the responsibility of ensuring that this information is accessible to those who can use it and benefit from it. This ideally supports policy makers in making informed decisions and contributes to improving the quality of both current and future lives, both for the individual level and society as a whole. The lack of communication and collaboration between scientists and society is a barrier to sustainable coastal development. Many social, economic, and political activities intersect in coastal areas, so their assessment is complex. A framework that facilitates holistic coastal assessments by scientists and facilitates communication with the public and decision-makers is under development. It is based on the “Circles of Coastal Sustainability” concept. The main objective is to engage scientists from different disciplines (environment, ecology, economics, among others) to work in a holistic assessment framework and to communicate the results for the general understanding of the diverse stakeholders. The framework is divided into four domains, considering the environment-ecological and socio-economic systems. Each one of the domains has five categories that can be locally adapted for different coastal settings. These categories and domains are evaluated using a global score system related to sustainable development. Currently, the global score system is underdevelopment, as it requires robust research on the meaning of sustainability in the context of coastal social-ecological systems. The focus of this presentation is to introduce the holistic framework and assessment to the oceanographic community.

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O28. *In Situ* and Satellite Characterization of Meddies' Structures in Open Ocean NE Atlantic: NA-VICE cruise (2012), Azores to Iceland

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The Northeast Atlantic is impacted by unique features that form due to the influx of Mediterranean Water into the Atlantic. These features are known as Mediterranean Water Eddies or meddies and they are mostly characterized by deep anticyclonic lenses of warm and saline water. One meddy was found at 41.3° N and 27.1° W during the R/V Knorr cruise KN207-03 that took place from the Azores to Iceland in the summer of 2012 within the framework of the international project NA-VICE. *In situ* data (CTD and ADCP) revealed the meddy's main physical properties and characteristics: salinity and temperature anomalies of 0.24 and 2.18 °C, respectively, with zonal velocities up to 0.35 m s⁻¹. These values were compared with criteria described by previous authors to ensure that this feature, located further north than most observations, could be classified as a meddy. The data also showed a cyclonic eddy with Mediterranean Water characteristics interacting with the meddy, and their relation as baroclinic dipoles was discussed. The meddy's surface expression was analyzed using altimetry data with a resolution of 0.25°×0.25°, combined with an eddy detection algorithm. At the time of the cruise, its Sea Level Anomaly was 15 cm above Mean Sea Surface Height, and it presented a 100 km radius. This data was used to track the meddy's path by following its signal, giving a general idea of the generation and dissipation instants. The results lead to the hypothesis that the locations previously identified by other authors do not encompass all the possible meddy generation sites. This research offers another valuable direct observation of meddies, which are relatively rare despite the perceived abundance of these mesoscale eddies in the Northeast Atlantic each year. Furthermore, it provides novel insights into the mechanisms underlying the generation of meddies. Continuing this research is vital for fully comprehending the pivotal role of meddies in oceanic biogeochemical processes and their salt and heat transport into the northeast Atlantic. This knowledge is essential for improving models and predictions of ocean dynamics, climate, and ecosystems.

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O29. Reconstruction of past climate dynamics during the early Pleistocene (1.5-1.28 Ma): Evidence from planktonic foraminifera and sea surface temperature records from the southern Iberian margin

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Prior to 1.25 Ma, obliquity (41 kyr) dominated the cyclicity of climatic variations during the early Pleistocene, resulting in glacial and interglacial cycles. A significant change occurred between 1.25 Ma and 0.7 Ma, which altered the dominant frequency from 41 kyr to 100 kyr. This transition period is known as the Mid-Pleistocene Transition (MPT). Despite several climate models have focused on the MPT, our understanding of the impact of 41 kyr-world climatic variations on planktonic foraminiferal fauna and their response to sea surface temperature (SST) oscillations remains limited. Here, we analyze planktonic foraminifera and *G. bulloides* stable isotope data from southern Iberian margin IODP Site U1387-(36°48.3'N 7°43.1'W, 559 water depth), aiming to reconstruct SST trends and infer ecological changes from Marine Isotope Stage (MIS) 50 to MIS 40 (1.5-1.28 Ma). Planktonic foraminifera patterns reflect North Atlantic surface circulation changes. Interglacial MIS 49, MIS 47, MIS 43, and MIS 41 exhibit warm, oligotrophic waters with subtropical species abundance from 35% to 65%. SSTs reached ~23.7°C in summer and 18.5°C in winter, correlating with insolation peaks. In cooler MIS 45, subtropical species decrease to 20%, with SSTs ~21°C in summer and 16°C in winter, indicating a less intense interglacial period. Glacial periods (MIS 50, 48, 46, 44) witnessed short-duration extreme cold events, with distinct terminal stadial events in MIS-50 and MIS 48. Abundance of polar species *N. pachyderma* increases abruptly to 40-65%, and SSTs dropped to 8°C in summer and 5°C in winter. Coldest temperatures occurred during MIS 48, consistent with alkenone-derived SST data. The faunal record, including the increase in cold water calcareous nannofossil taxa, indicate southward displacement of subpolar waters and contraction of the subtropical gyre at least until MIS 44. MIS 42 and MIS 40 revealed a drastic decrease in polar species to 0.5% and warmer summer and winter temperatures (18.5°C and 13°C respectively). Overall, our findings confirm millennial-scale climate variability impacting planktonic foraminifera fauna and the North Atlantic subtropical gyre dimension.



O30. Inorganic biogenic carbon redistribution and transport in marine sediments shown by first radiocarbon ages of coccoliths

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Coccolithophores are marine phytoplankton that produce calcite plates (coccoliths), which constitute a major component of the marine sediments. Coccolithophores contribute to the global carbon cycle via photosynthesis and precipitation of calcium carbonate. Here, we show the first coccoliths radiocarbon (¹⁴C) ages of four coccolith size fractions: 8-11 μm, 5-8 μm, 3-5 μm, and 2-3 μm, in five depth intervals on a sediment core recovered from SHAK06-5K site, off the Iberian Margin. We explore the influence of size-dependent coccolith sorting and transport, redistribution, and fate in marine sediments. Furthermore, we evaluate the feasibility of Flow Cytometry (FC) to isolate coccoliths from marine sediments, in addition to the conventional methods (e.g., dry sieving, microfiltration, centrifugation, and settling) used in this study for coccolith size separation. A relationship between coccolith ¹⁴C age and coccolith size is apparent in all samples, with the smallest size class recording the youngest ages and the largest coccoliths, the oldest. The latter suggests that hydrodynamic sorting largely influences coccolith redistribution, where larger coccoliths are more mobile, and prone to resuspension than smaller coccoliths that tend to show cohesive behaviour. The ¹⁴C ages of coccoliths are older than those of co-deposited planktic foraminifera, bulk organic carbon (OC), long-chain fatty acids (LCFA), and alkenones. Coccoliths within the 2-3 μm size class show ¹⁴C ages comparable to those of OC in all samples. Such a pattern indicates similar transport mechanisms for both the smallest coccoliths and OC, and that the majority of carbonate in the 2-3 μm size fraction, including the non-coccolith particles, is predominantly derived from marine primary production, thus, of biogenic origin. FC trials proved promising in isolating coccoliths. Our study carries implications for palaeoceanographic studies using coccoliths as paleo-productivity and geochemical proxies.



O31. The unexpected thermohaline properties of the ENACW observed in the Iberian coastal ocean in August 2022

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The EUROFLEETS+ CARBO-ACID cruise was carried out in 2-11 August 2022, in the Iberian coastal ocean, onboard the R/V Ramón Margalef, from the Instituto Español de Oceanografía. Seven CTD stations were conducted along two transects off the Iberian margin: four stations in the northern transect, offshore Cape Finisterra ($\approx 43^\circ$ N), and three stations in a southern transect at latitude of Cape Roca ($\approx 39^\circ$ N). The CTD profiles and the potential temperature-salinity (θ/S) diagrams allowed to identify the main water masses present in the Iberian coastal ocean: the Eastern North Atlantic Central Water with subtropical (ENACWst: 18.50°C ; 36.75) and subpolar origin (ENACWsp: 10.00°C ; 35.40), the intermediate Mediterranean Overflow Water (MOW) and, at deeper levels, the Labrador Sea Water (LSW) and the North Atlantic Deep Water (NADW). At both transects, the central water mass presented thermohaline properties shifted to the left of the Fiúza's (1984) ENACW reference curve, thus indicating a slightly cold and less saline ENACW. This occurs for the first time, after a period of 60 years (1955-2016) where hydrological profiles, collected in the Iberian coastal ocean, were analyzed, and a tendency for θ/S points be shifted to the right of the reference curve was observed on a decadal time scale (Valente et al., 2019). Additional datasets collected in the same region, obtained with CTD and ARGO floats in the period 2016-2022, were analyzed to investigate whether and when the change in the ENACW properties took place.

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Poster Presentations

P1. An Overview of the Partnership for Observation of the Global Ocean (POGO)

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The global ocean is experiencing extensive and dramatic changes, driven by anthropogenic activities and climate change. The changes occurring in many coastal ocean ecosystems have significant repercussions on both ecosystem services and the well-being of human populations. There is a need to be more continuously aware of how and why the ocean is changing, so that we can predict the reciprocal impacts between the ocean and people. Making high quality ocean measurements with global coverage, in a continuous and coordinated manner is now a pressing priority. Achieving this critical objective demands international collaboration and capacity development. This imperative has led the major ocean research institutions worldwide to unite and form the Partnership for Observation of the Global Ocean (POGO). Founded in 1999 by Directors of these oceanographic institutions, POGO serves as a collaborative platform dedicated to advancing and promoting observation of the global ocean for societal benefit. Today, POGO brings together 57 oceanographic institutes from 32 countries. Over the years, POGO has developed and supported projects on technological innovation; fostered working groups on specific aspects, priorities or challenges related to ocean observing; provided training and capacity development opportunities for over 1,200 early-career scientists in developing countries; created and nurtured an alumni network; highlighted the need for ocean observations to policymakers, the general public and schools, through publications, high-level declarations, public events and citizen science, education and outreach projects. This presentation will provide an overview of POGO's key initiatives, training programmes, collaboration opportunities, and means through which Portuguese ocean research institutions can actively engage with POGO.



P2. C3-4Ocean - Command and Control Center for Unmanned Vehicles to Support Bioeconomy Offshore Activities

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Este resumo visa apresentar o projeto do Centro de Comando e Controle (C3-4Ocean) de veículos não tripulados para apoio a atividades de mar e da Bioeconomia Azul (Polo Leixões II), parte integrante do programa HUB AZUL - Rede de Infraestruturas para a Economia Azul, e inscreve-se no Programa de Recuperação e Resiliência. Este projeto visa contribuir para consolidar e projetar esta capacidade de afirmação da tecnologia nacional para o futuro neste mundo de evolução exponencial, o que requer agilidade, rapidez, e desenvolvimento estratégico. Em particular, pretende contribuir para apoiar uma presença sustentada e economicamente sustentável no triângulo nacional do oceano Atlântico. O C3-4Ocean será um centro ao nível do estado da arte, que visa suportar operações 24/7, centrando-se na implementação de uma sala de controlo de operações que será baseada em equipamento computacional e de comunicações estado da arte, que integrará o software de planeamento e controlo de execução do LSTS, que será devidamente adaptado para o efeito, para suporte de todas as operações. Será também um polo europeu de referência para desenvolver e testar, em ambiente real, produtos e serviços tecnológicos de ponta para o sector marítimo. O C3-4Ocean terá ao seu dispor veículos não tripulados multi-domínio (sub-superfície, superfície e aéreos), equipados com sensores para a medição de Essential Ocean Variables (EOV), bem como outras variáveis relevantes para a Bioeconomia que, para tal, serão comandados a partir do C3 proposto.



P3. Revealing Subtropical climate shifts: Biomarker-based sea surface temperature reconstruction in the Blake Outer Ridge

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Located in the Blake Outer Ridge region beneath the Gulf Stream, Ocean Drilling Program (ODP) Site 1058 is pivotal within the Hydroshifts project, aiming to investigate climate variations in the western subtropical Atlantic during abrupt glacial terminations TV (~430 kyrs) and TVII (~625 kyrs). These transitions, between glacial and interglacial conditions, mark significant changes in ocean circulation and sea surface temperatures (SSTs), crucial for understanding future climate variations and mitigating global climate change impacts. Our research focuses on elucidating relationships among SSTs, surface circulation patterns, and climatic events during glacial terminations in the North Atlantic region. Using biogeochemical analyses of marine sediment samples, including the quantification of alkenones—an organic compound synthesized by coccolithophores—to accurately reconstruct past surface temperatures. Additionally, we aim to investigate meridional (mid- to high-latitudes) and zonal (W to E mid-latitudes) thermal contrast in the North Atlantic, essential for understanding the complex interplay of oceanic and atmospheric processes that govern regional climate variability, ocean circulation, and atmospheric processes. Our preliminary results indicate SSTs ranging between 16°C and 25°C, supporting the presence of Gulf Stream waters at the surface. These conditions may have implications for tropical storm development under favorable atmospheric conditions. Further analysis will focus on identifying storm persistence and flooding along the southeast coast of the United States and the impact on the western North Atlantic.



P4. A maximum sea surface salinity tongue in the North Brazil continental shelf

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The Atlantic Meridional Overturning Circulation (AMOC) connects the ocean surface and deep waters. The heat transport of the AMOC is a complex system involving exchanges with the atmosphere, which maintain a milder winter climate in Europe. The North Brazil Current (NBC) is a fundamental part of AMOC, transporting heat and salt northward across the Equator. Salinity may have an indirect impact on ocean circulation by changing sea water density and pressure. Changes in the inter-hemispheric transports of heat and salt may disturb the AMOC, with possibly important consequences for the global climate (e.g., Buckley and Marshall, 2016). In this study several data sets were used: (1) images of Sea Surface Salinity (SSS) from the SMOS satellite; (2) in situ data from the “Camadas Finas III” cruise in the region of the NBC; (3) reanalysis from 2 different products of Copernicus Marine Service (CORA and GLORYS12). Results reveal the presence of an unexpected local salinity maximum in the NBC region, located in the upper layer, close to the Amazon River mouth. This maximum was first seen as a high salinity tongue ($S > 36.5$) in the data from “Camadas Finas III” cruise. In SMOS satellite data, the tongue of high salinity is a seasonal feature in the period 2011-2019 with largest area from October to December, between the equator and 5°N. In the CORA reanalysis, at 4.5°N, the maximum also appears every year but during a shorter time period. The annual cycle of the salinity tongue suggests that the physical processes behind it have a similar seasonality. Annual variations in the NBC’s transport (Johns et al, 1998) may be related to changes in salinity. It is worth noting that the maximum’s peak coincides with the annual minimum of Amazon River discharge. Further studies are needed to clarify the mechanisms behind the salinity maximum, and to answer other questions: How does climate change impact salinity in the NBC region? Does it affect salinity transports to the North Atlantic Ocean?

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P5. The iFADO PAAnoramic mission: the first European Atlantic area international multi-platform ocean monitoring mission

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The aim of the European Union's ambitious Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC) is to protect more effectively the marine environment across Europe. Its implementation in the European Atlantic Region (EAR) and the need to extend periodic monitoring programs to offshore waters is very challenging due to its surface extension and large deep-water areas. To overcome these difficulties, the iFADO project (innovation in the Framework of the Atlantic Deep Ocean; www.ifado.eu; 2017-2023) combined traditional monitoring with cost-effective state-of-the-art technologies: remote sensing, numerical modelling and emerging observation platforms such as gliders and oceanic buoys. After several successful international glider missions, the consortium proposed a flagship action for the project's final year: the PAAnoramic mission. The PAAnoramic mission covered the European Atlantic façade using autonomous underwater vehicles combined with in-situ monitoring cruises and supported by satellite imagery and operational numerical modelling. The PAAnoramic glider mission was divided into three sections: Marine Institute covered a return transect from the initial release point and the Porcupine Abyssal Plain Sustained Observatory (PAP-SO); National Oceanographic Centre covered the section from the Irish coast to Portugal; IPMA and PLOCAN designed a mission in Western Iberia from the open ocean to the coastal area. The first two gliders were deployed next to the Irish coast on early December 2022, while a third one was launched in mainland Portugal in April 2023. The scientific payload sensors installed in the glider allowed the collection of physical and biogeochemical essential ocean variables. The PAAnoramic mission involved participation iFADO partners from four Atlantic Area countries (Ireland, UK, Portugal and Spain) and two non-iFADO project partners: Cyprus Subsea (Cyprus) and Instituto Hidrográfico (Portugal). The mission's main goal was to demonstrate how



international collaboration is key for implementing MSFD and UN Sustainable Development goals and to set a milestone for a future Atlantic Area international unmanned monitoring strategy.



P6. Exploring Ria Formosa Salt marsh: High School Students' Hands-on Engagement and Geoscience Learning

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Hands-on activities beyond the traditional classroom enhance students' motivation and understanding of science. It plays a fundamental role in observing and understanding the coastal areas, including their processes, dynamics and evolution. This experimental knowledge increases awareness of the importance of these environments and motivates students to engage in their conservation. The EDUCOAST project (funded by EEAGrants) promotes "hands-on" learning in a section of Ria Formosa near the IPMA station in Tavira, southern Portugal. The environmental setting includes a barrier island (Cabanas), the channel and a developed salt marsh. While students are more familiar with barrier islands, it is important to emphasize that salt marshes also play a crucial role in maintaining water quality and carbon sequestration. From November 2023 to January 2024, three classes of the 10th and 12th grade participated in this program to learn more about the salt marsh environment, with a total of 55 students. The activities focused on the characterization of the morphological and sedimentological features and were divided in three modules, each lasting one day, namely: (1) Field work - topographic data collection and sampling of sediment (small cores) and plants; (2) Laboratory work - core description, grain-size analysis and creation of an herbarium; (3) Data processing - salt marsh topographic profile and the grain-size results including the corresponding statistical parameters. Anonymous surveys were conducted after each module, revealing very positive feedback from students regarding this hands-on learning experience, highlighting the significant contribution of hands-on approaches to science education, especially those focused on the coastal environments. This is a contribution of the EDUCOAST (EEAGrants, PT-INNOVATION-0067) and EMSO-PT (PINFRA /22157/2016) projects.



P7. Macrofauna Community patterns in the North Atlantic Iberian upwelling ecosystem

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Benthic macrofauna plays a crucial role in marine ecosystems, linking primary production to higher trophic levels, promoting seafloor oxygenation and organic matter decomposition. Numerous environmental factors, including temperature, dissolved oxygen levels, surface productivity, seasonal productivity variations, and salinity, contribute to biodiversity patterns. This study along two areas in the Portuguese coast investigates the macrofaunal community structure in those areas and its relationship with various oceanographic variables. Samples were collected during a 2022 Eurofleets campaign in Sines and Faro areas (NW Atlantic). A total of 9 box-corer samples were collected, sorted, and identified to the lowest possible taxonomic level. In addition, oceanographic data (temperature, current velocity, oxygen concentration, nutrients (phosphate and nitrate), phytoplankton, and pH) was retrieved from the Copernicus Marine Service platform models. Oceanographic results as temperature differences between nearshore and offshore confirmed the occurrence of coastal upwelling along the coast. Temperature and phytoplankton decreased with depth; nutrient concentration increased with depth. A total of 2998 individuals from 8 Phyla were identified. Analyses revealed distinct macrofaunal communities between Faro and Sines areas. In the Faro stations, characterized by proximity to the coast and shallower depths, the abundance of specimens decreased with increasing depth. Conversely, at the Sines stations, there was an initial increase in the abundance of specimens with depth, peaking around approximately 2000 meters, followed by a decline at greater depths. In all stations, Phyla Annelida (namely Polychaeta) and Nematoda were the dominant taxa. Among polychaetes, Paraonidae and Spionidae were the most abundant families. The best predictive variables explaining community variation in different sampling stations were determined to be current velocity and nutrients (phosphate and nitrate). This study shed light on how oceanographic variables can shape benthic communities along the Portuguese coast, essential for informing future predictions in the context of upwelling.

P8. Little Ice Age: paleoceanographic evidences on the portuguese margin

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The Little Ice Age (LIA - AD 1350–190), is the coldest period of the last 4000 years. Although there is much information about the temperatures recorded during the LIA, many uncertainties exist regarding the mechanisms that triggered those low temperatures across Europe. Solar intensity and Atlantic Meridional Overturning Circulation (AMOC) decreased during LIA, and the North Atlantic Oscillation (NAO) index was negative, thus decreasing the coastal upwelling and increasing the winter storms and river discharge. Coastal upwelling regions, such as the Portuguese Margin, are characterized by high primary production and sedimentation rates. These unique characteristics enable reconstructing oceanographic conditions with a high temporal resolution. This study aims to improve our understanding of the oceanographic variability during the LIA. To achieve this, we analyzed the relative abundance of planktonic foraminifera preserved in two sedimentary sequences recovered off Porto, 64-PE332 3/7 and PO287-6G, at 2000 and 80 m water depth, respectively. We then compared these data with previously published information for the region (Abrantes *et al.*, 2011). Planktonic foraminifera results show a higher relative abundance of *Globigerina bulloides* and colder temperatures estimated by SIMMAX 28 (the foraminifera transfer function) in the inshore core at AD 1491 as compared to the offshore position, possibly due to coastal upwelling intensification and consequent occurrence of cold waters and high primary production. Moreover, the increase in the abundance of *Turborotalia quinqueloba* and *Neogoboquadrina pachyderma*, together with the foraminifera estimated productivity, and alkanes concentration from 1460 to 1680 CE in the inner core, indicates the presence of cold and nutrient-rich fresh-water, suggesting a significant river discharge. Contrarily, the offshore core reflects the subsurface currents in the region, and the high abundance of tropical and subtropical species, accompanied by the decrease in abundance of the Portugal Current species, highlights the intensification of an offshore subtropical Iberian Poleward Current during the LIA (IPC, Peliz *et al.*, 2005).

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P9. Air-sea CO₂ fluxes in the Southwest Iberian Upwelling System during the EUROFLEETS+ SINES cruise in September 2022

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The ocean can be a source or a sink of carbon dioxide (CO₂). Whether it acts as source or sink depends on several hydrographical variables: from water temperature and salinity (varying CO₂ solubility), to biological CO₂ uptake or mixing of water masses. The robust assessment of air-sea CO₂ fluxes in space and time is a key knowledge to elaborate global carbon budgets. This is relevant as inform-based decisions to mitigate climate change require well constrained carbon budgets. Here we quantified the air-sea CO₂ flux of the southwest coast of the Iberian Peninsula (42.5-37.3°N, 12.5-7.5°W) in September 2022. Partial pressure of carbon dioxide in surface seawater (pCO₂^{sw}) has been obtained from the quality controlled underway surface pCO₂^{sw} dataset gathered during the EUROFLEETS+ SINES cruise (10-21 September 2022). The fluxes of carbon dioxide (FCO₂) take into account the partial pressure of carbon dioxide in the atmosphere (pCO₂^{atm}) from nearby stations, the wind speed at 10 m depth from the Cross-Calibrated Multi-Platform (CCMP) Analysis Product and a gas transfer coefficient with a quadratic dependence on wind speed. Results shows that FCO₂ varies between 8.4 and -20.7 mol C m⁻²d⁻¹, with the largest positive values in offshore areas, and significant negative values on the Algarve shelf (36.7-37.3°N, 9.0-7.5°W). In general, the ocean acted as a source of CO₂, with the exception of the Algarve area, where pCO₂^{sw} showed a tight relationship with low temperatures (<16°C) and salinities (<36). While the ocean source behavior is in accordance with previous summer-autumn studies in the zone, the Algarve shelf was unexpectedly a strong sink, at least temporarily. During the study days, a short-live event of high wind speed, which coincided with low pCO₂^{sw}, increased the sink strength on the Algarve coast. This large uptake events during summer are unaccounted for in current coastal ocean resolving pCO₂-products.



P10. - CHUVA Project -

Land-Sea dynamics in East Asia: Deciphering the impact of high-latitude versus tropical forcing

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The East Asian Monsoon (EAM) is a complex climate system involving coupled ocean-atmosphere-land interactions that exerts a major impact on the daily-life of billions of inhabitants. Yet, future of monsoon rainfalls remains poorly constrained by climate models despite the growing need of truthful predictions at regional scale. In East Asia, uncertainties are accentuated by the northern distribution of the EAM, which is the unique monsoon system extending to the subtropics. This particular feature reinforces the EAM sensitivity to temperate climate variability and considerably increases the challenge of identifying its low versus high latitude climatic controls. To fill this gap, the project CHUVA (2022.03976.CEECIND) aims at providing new insights on the EAM natural variability in order to decipher the respective influence of regional, tropical and high-latitudes climate forcing in East Asia. One of CHUVA's main goals is to reconstruct the sea surface changes in the East Sea (=Japan Sea) and its impacts on the hydroclimate variability across the last 5 Ma. This jointed sea-land-reconstruction will be crucial to assess potential regional oceanic feedbacks on the frequency and amplitude of monsoonal rainfall changes. CHUVA will also attempt to identify the EAM sensitivity to changes in external forcing to the Earth's climate system and other internal processes (ice volume, CO₂) leading to decipher major mechanisms behind monsoon climate changes. To do that, CHUVA will be mostly based on the examination of microfossils from two neighboring deep-sea sequences collected in the East Sea, namely IODP Site U1425 and core ES14-GC01. The originality of the project relies on an innovative palynological approach, combining systematically a jointed-analysis of marine (i.e., dinocysts) and terrestrial (i.e., pollen grains) palynomorphs, which is the rare way to explore through the same analysis the interactions of the ocean-land-atmosphere- systems without chronological ambiguities. CHUVA will focus on specific time intervals including the present-day interglacial and its best analogs. This approach will help future climatic experiments.



P11. Forcings and dynamics of Indian hydroclimate and vegetation during glacial MIS 16

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The Indian Summer Monsoon (ISM) accounts for ~90% of Central India's annual precipitation yet understanding its natural variability during past glacial periods remains a challenge in paleoclimate research. Despite considerable documentation of ISM dynamics during the Last Glacial Maximum (LGM), debates persist regarding the role of the primary forcings, including boreal summer insolation, North Atlantic circulation, ice volume, atmospheric CO₂, and Southern Hemisphere heat export. Hence, pre-LGM paleorecords are crucially needed to evaluate ISM's impact on fragile ecosystems, such as India's forests and savannas. Here, we focus on MIS 16 (676-621 ka), a severe Quaternary glacial period marked by the first instabilities of the Laurentide ice sheet leading to the development of Heinrich layers in the North Atlantic. We present the first MIS 16 vegetation reconstruction from India's Core Monsoon Zone based on pollen analysis from IODP Site U1446 strategically recovered at the exit of the Mahanadi River to capture a robust signal of the ISM rainfall. Our findings indicate the prevalence of grassland and low tropical forest abundance during MIS 16, indicating overall dry conditions and reduced ISM activity. Furthermore, a progressive expansion of semi-arid vegetation suggests long-term glacial aridification associated with ISM weakening. Intra-glacial variability exhibits alternating wetter/drier phases, linked to ISM strength. Vegetation and hydroclimate changes are primarily controlled by the summer inter-tropical insolation gradient (SITIG), peaking during mid-MIS 16. Conversely, late-MIS 16 ISM weakening suggests that SITIG forcing is overshadowed by the impact of maximum ice volume and millennial-scale variability. Three major dryland expansions reflect ISM responses to millennial ice rafting events and AMOC reductions. This study highlights the complex interplay of forcings driving past glacial ISM variability, crucial for understanding its impact on Indian ecosystems.



P12. Adição de minerais alcalinos como forma de mitigação da acidificação dos oceanos - Influência no fluxo de nutrientes na interface sedimento-água da Ria Formosa

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As lagoas costeiras são ecossistemas muito produtivos, mas também vulneráveis às alterações globais. A Ria Formosa, tal como outras lagoas costeiras pouco profundas, é influenciada por várias fontes de nutrientes, nomeadamente a partir da sua difusão através dos sedimentos. O projeto RECAP, tem como principal objetivo contribuir para a redução das concentrações atmosféricas de CO₂ através do aumento da alcalinidade dos sedimentos. Para tal, foi realizada uma experiência com aplicação de dois tipos de minerais básicos (olivina e basalto) com granulometrias diferentes (grosseira e fina) nos sedimentos numa área de sapal na Ria Formosa, colonizada por *Spartina maritima*. O objetivo deste trabalho foi avaliar a influência da adição destes minerais sobre o fluxo de nutrientes, entre os sedimentos e a água sobrenadante comparativamente com sedimentos sem adição de minerais, tal como avaliar a evolução temporal ao longo das últimas décadas. Foram estimados os fluxos mensais de amónia, nitratos + nitritos, fosfatos e silicatos, através da Lei de Fick, ao longo de um ano (setembro de 2022 a agosto de 2023). Os resultados confirmam que, a água intersticial é uma fonte de nutrientes para a coluna de água, particularmente mais evidente para os sedimentos com adição de minerais. Relativamente à situação de controlo, sem adição de minerais, verificou-se uma diminuição de nutrientes, em particular da amónia, em comparação com dados dos anos 90 noutros locais da Ria Formosa (Falcão, 1997; Falcão e Vale, 1998; Serpa et al., 2007). Nos locais onde foram colocados os minerais, houve um aumento do fluxo de nutrientes para a coluna de água, com exceção do nitrato, sugerindo que os minerais adicionados contribuem como fonte de nutrientes e/ou porque devido a uma maior compactação dos sedimentos existiu maior quantidade de matéria orgânica que aí foi remineralizada, disponibilizando nutrientes para a coluna de água. Dos minerais estudados, a olivina foi aquela que representou a maior fonte de nutrientes, apesar da diferença não ser significativa entre minerais, tal como não existiu entre granulometrias.

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P13. SeaCard Game: Fostering Interdisciplinary Learning for Marine Science and Engineering

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SeaCard Game is tailored for university and graduate-level students and strategically positioned to address the growing demand for interdisciplinary skills in marine science and engineering. It offers a dynamic card-based experience fostering the exploration of oceanographic research complexities while cultivating critical thinking, decision-making, and collaboration skills essential for the technologically advanced landscape of tomorrow. Rooted in experiential learning principles, SeaCard Game is an engaging platform for students/players to assume the roles of aspiring marine scientists. By strategically managing limited resources and making informed choices, participants will acquire systems, sensors, and other tools (as cards) to conduct their research, emphasizing the importance of teamwork in scientific exploration. Students need to design a scientific campaign to study oceanographic phenomena like upwelling, eddies, and more, having access to all kinds of equipment, from AUVs and gliders to sensors like CTDs and ADCPs. Key Rules:

1. **Objective:** strategize and make scientific choices to prepare and deliver a compelling final presentation on the chosen oceanographic phenomena.
2. **Players and Teams:** Players are divided into teams, each representing a group of marine scientists or researchers. Each team starts with 200 sea coins.
3. **Cards and Availability:** The game includes a limited number of each specific card. Teams can buy cards from the bank anytime during the game as long as the cards are available.
4. **Trading and Team-Up:** Teams can trade cards with other teams to enhance their capabilities. Collaborations and team-ups between teams are encouraged to pool resources and diversify expertise.
5. **Strategic Choices:** Teams need to make strategic choices when purchasing cards, considering their research objectives, available resources, and the limited availability of certain cards.

6. Final Presentation: teams showcase their research rationale, choices, and findings. The focus is on presenting a well-structured, scientifically grounded, and convincing argument.

Feedback from the pilot implementation at the Marine Robotics Summer School 2023 will be presented.





P14. Short term high resolution physical chemical biological coupled observations on the inner shelf of the Northern Margin of the Gulf of Cadiz

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The relationship between currents shifts at an artificial reef in the shallow inner-shelf waters (~20 m) of Cacela Velha (South Portugal) and the impact on phytoplankton development was examined through a high-intensity observational experiment lasting for 12 days during April 2022. A wave-powered vertical profiler logged an average of ~120 high-resolution profiles (2 Hz) every hour achieving an unprecedented description of the changing water column properties (temperature, salinity, dissolved oxygen, turbidity, and chlorophyll-*a*, Chl-*a*). Additionally, hourly current and local wind velocities were respectively retrieved from an Acoustic Doppler Current Profiler (ADCP) moored nearby and from the ERA 5 Reanalysis database. While a 6-day upwelling event was observed, the surface current intensity was the highest (0.4 m s^{-1}), with a mixed water column, and typical low phytoplankton concentration levels ($< 1.5 \text{ mg m}^{-3}$). High spring seasonal levels of Chl-*a* ($3\text{-}4 \text{ mg m}^{-3}$) were observed during a 4-day event of upwelling relaxation and a 20h current inversion to a south-westward alongshore flow, both driven by wind relaxation. The relaxation setup was synonym of a reduction of the dominant north-eastward alongshore flow (0.2 m s^{-1} at surface), when an intermittent thermal stratification was found. Then, a thermal gradient of up to $2.5 \text{ }^{\circ}\text{C}$ along the water column partially resulted in the localized increase in phytoplankton biomass bellow the warmer strata, along with afternoon land-breezes enhancing cross-shelf mixing. Strong midday irradiance inhibited phytoplankton development, that systematically dropped at midday and increased only after 3 pm. The Chl-*a* concentration appeared homogeneously mixed in the water column only when the alongshore current reversed to a westward flow, suggesting the westward advection of phytoplankton-rich waters from the retention “shadow” area in the vicinity of the Guadiana River. These data demonstrate the importance of high-resolution observational systems in productive coastal areas, contributing to better understanding the processes involved.

P15. Model4GES – First approach for environmental assessment

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To achieve and maintain a Good Environmental Status (GES) of the marine ecosystem, Portugal is guided by the descriptors outlined in the Marine Strategy Directive Framework (MSFD). Eutrophication is one of the anthropogenic pressures damaging coastal ecosystems worldwide¹. In Portugal, coastal waters influenced by the presence of the plumes of the Douro, Vouga and Guadiana rivers have been slightly eutrophicated². The main objective of the study is to assess the nutrient fluxes in the Portuguese continental shelf, with a focus on separating natural and anthropogenic enrichment sources, through the implementation of a numerical biogeochemical model together with a pre-existing hydrodynamic model: IBv2.0 (ROMS/CROCO)³. A preliminary comparison of the IBv2 model solutions for 2019 was conducted with in-situ data from IPMA surveys (DEPM19 and PELAGO19), for the Northwest Iberian region. The results show that the model could realistically represent the sea surface temperature patterns. However, the model salinities close to the river mouths (Minho, Douro, and Mondego) were higher than in situ data. To investigate the causes for the observed differences, and increase the model performance, the river input was reevaluated. Daily mean flow data from the Minho, Douro, and Mondego rivers was obtained from the SNIRH database and compared with the GloFAS and EFAS hydrological models to choose the most appropriate dataset to represent the river discharge forcing in the physical model. It is expected that the use of the river discharge from the hydrological models will yield more realistic ROMS/CROCO solutions, serving as a basis for future simulations to study the processes regulating nutrient fluxes between rivers and coastal regions.

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P16. Impact of climate warming in the coastal upwelling system and primary production off Portugal (ICW3P): lipid biomarkers, stable isotopes and elemental perspective

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To assess warming impacts primary production (PP) along the Iberian Margin, this study analysed lipid biomarkers, stable isotopes of organic matter, and elemental analysis of sediment records spanning the last 1,000 yrs. We assessed sites offshore the Douro and Tagus rivers, and on the Algarve continental shelf, observing significant differences in organic matter contributions among them. During the Medieval Climate Anomaly (MCA: 850-1300 CE), characterized by warmer surface seawater, at the Douro site, an increase in Ca/Fe, $\delta^{15}\text{N}$, marine lipids, TOC, and TON occurred, notably ~1150-1190 CE. Conversely, at the Tagus site, decreases in TOC, TON, C/N, $\delta^{13}\text{C}$ and marine lipids were accompanied by strong increases in Ca/Fe and $\delta^{15}\text{N}$, with a PP peak at ~1140CE. At the Algarve site Ca/Fe and $\delta^{13}\text{C}$ decreased, while TOC, TON and $\delta^{15}\text{N}$ increased, C/N and lipids remained stable. The Little Ice Age (LIA: 1350-1850 CE), marked by a 1°C average cooling in seawater temperature at IM, showed distinct patterns. At the Douro site, declines in TOC, TON, and C/N, along with decreases in Ca/Fe and marine lipids until ~1570 CE, were followed by increases, notably in Ca/Fe ~1600-1700 CE, reflecting PP rise. At the Tagus site, Ca/Fe decreased strongly, while TLIP, TOC, TON, and $\delta^{15}\text{N}$ increased. At the Algarve site there was a pronounced peak in Ca/Fe ~1500-1800 CE, a decline in marine lipids and $\delta^{15}\text{N}$ until ~1500 CE, followed by gradual increases in TOC, TON, C/N and $\delta^{13}\text{C}$. In the Industrial Era (IE: post 1850 CE), marked by rising seawater temperatures since ~1980 CE, trends persisted. At the Douro site, Ca/Fe, marine lipids, $\delta^{13}\text{C}$, and $\delta^{15}\text{N}$ rise slowly, while TOC, TON, and C/N declined. At the Tagus site, Ca/Fe and lipids declined until ~1980 CE, then gradually raised again, while TOC, TON, C/N, $\delta^{13}\text{C}$, and $\delta^{15}\text{N}$ increased steadily. At the Algarve site, Ca/Fe, lipids, TOC, and TON increased, while C/N, $\delta^{15}\text{N}$, and $\delta^{13}\text{C}$ decreased. In conclusion, PP increased in the Algarve and Douro regions since the middle of the LIA, accentually since ~1980 CE. Contributions of land-derived organic matter were particularly significant in certain periods at Tagus and Douro sites, linked to flood events ^[1].

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P17. Numerical investigation of the residual circulation variability in narrow estuaries

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This study investigates the temporal and spatial variability of the axial residual circulation in estuaries through 3D process-oriented numerical simulations with simplified geometry. The hydrodynamic model (Delft3D) features a 80 km long semi-closed channel with a Gaussian-shaped cross-section of 1 km. A series of 20 six-month runs was conducted to explore the influence of depth, river discharge and M2 tidal amplitude on the lateral structure of residual flows. The latter was conveniently represented by γ , a non-dimensional parameter grounded on the thalweg inflow transport geometry. Based on these results, a neap-spring cycle experiment was executed with depth (10 m) and river discharge (50 m³/s) settings that result in variable transverse residual flow distributions. Near the outlet, the ratio of barotropic and baroclinic forces along the thalweg indicates a fortnightly transition of drivers between spring (barotropic) and neap (baroclinic) tides, with lateral residual structures that conform to theory. Spatial variability in the transverse residual circulation is also evidenced along the salinity intrusion length for intermediate tidal forcing (i.e., at the transition between spring to neap tides). In summary, this numerical study supports the hypothesis that the drivers of the residual circulation at some narrow estuaries may switch between tidally-driven and density-driven along the channel and over the spring-neap cycle, depending on the balance between the baroclinic and barotropic forcings.

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P18. Documenting abrupt climate shifts in the North Atlantic region during two distinct glacial terminations (T): TV and TVII

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Over the past 800,000 years, there has been an abrupt rise in temperature and CO₂ levels occurring every 100,000 years during transitions between glacial to interglacial periods, commonly referred to as glacial terminations (T). These glacial terminations also record abrupt climatic variations on millennial and centennial scales, reflecting the nonlinear behavior of the climate system. Furthermore, glacial terminations exhibit striking similarities with current global warming, including sharp increases in temperatures, CO₂ levels, and sea level due to the melting of glacier caps and sea ice. By comparing past climatic conditions with those observed today, it is possible to assess the extent and speed of changes relative to historical and geological patterns. This is crucial to understand the impact of human activities on the global climate and to develop effective mitigation and adaptation strategies. Our study is part of the Hydroshifts project and focuses on the North Atlantic. Our main goal includes detecting major climatic events and extreme cold episodes associated with ice iceberg discharges and melting. With this purpose, a high-resolution temporal study is being conducted from the IODP site U1314 (56° 21.8' N, 27° 53.3' W) covering key glacial terminations: TV, ~430,000 years, and TVII, ~625,000 years). For this, we extracted organic compounds – biomarkers, particularly alkenones. Alkenones, produced by coccolithophores, allow for the estimation of Sea Surface Temperatures (SST) during the time of their synthesis through their identification and quantification. Preliminary results show clear evidence of environments with colder SST, characterized by a dominance of more unsaturated alkenone compounds, normally produced under cold environmental conditions, and the evidence of a large percentage of tetra-unsaturated compounds suggests the presence of cold and less saline waters at the surface during TV. These compounds are typically associated with events of Icebergs melting, however, considering the location of the study site (~56°N), they may also be associated with dominance of sea ice in the region.



P19. Investigating the potential of Rare Earth Elements (REEs) as productivity indicators along western Iberian Margin

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The carbon dioxide (CO₂) emitted into the atmosphere since the Industrial Revolution has led to an unprecedented increase in its concentration from 280 ppm to over 400 ppm worldwide. Around 30% of this CO₂ excess has been absorbed by the ocean, causing dramatic impacts on the marine ecosystems, including changes in productivity. Among the world's most productive ocean ecosystems are the Eastern Boundary Upwelling Systems (EBUS), with a primordial role in sequestering atmospheric CO₂. While three out of the four global EBUS are already experiencing intensified winds due to climate change with, the implications for the Canary/Iberian EBUS remain uncertain. The Iberian EBUS sustains large communities dependent of its resources, emphasizing the urgency of understanding its response to climate-driven changes and forecasting its future scenarios. Productivity tracers offer a means to differentiate between anthropogenic and natural climate variability, yet existing methods for reconstructing productivity have their limitations. Hence, the search for more robust, high-fidelity productivity proxies persists. Rare earth elements (REEs) have been recognized as having the potential to reconstruct past ocean conditions, but consensus on the most efficient methodology for REEs measurements remains unclear. To address this, we propose to evaluate four cleaning procedures: 1) oxidation; 2) oxidation and reduction using hydrazine; 3) oxidation and reduction with sodium acetate, 3) oxidation, reduction using hydrazine and alkaline chelation with DTPA. We selected four common planktonic foraminifera species from the western Iberian Margin and subjected them to these cleaning protocols. Each sample underwent 3 to 5 repetitions of the cleaning process before analysis with ICP-MS at the IPMA clean laboratory. Our results suggest that the oxidation protocol yields the most varied results, while the 2nd and 3rd protocols exhibit similar outcomes. Although the 4th protocol results are comparable to the 2nd and 3rd protocol it has the lowest Mg/Ca values (temperature proxy used as validation). Future measurements in surface samples will allow to evaluate the reduction and DTPA effects on Ba/Ca and Mg/Ca.

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P20. AQUASERV – Research Infrastructure Services for Sustainable Aquaculture, Fisheries and the Blue economy

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AQUASERV is an European Research Area (ERA)-embedded instrument to further scientific advance and promote, contribute, and facilitate the implementation of the European Common Fisheries Policy, the Farm to Fork Strategy, the Sustainable Blue Economy, the European Green Deal and EU Mission "Restore our Ocean and Waters by 2030" through the provision of transnational (on-site or remote) and/or virtual access from a catalogue of customized services combining workflows of multiple services from multiple RIs, as well as training, and with an ambitious outreach programme and engagement plan directed at research communities from the public and private sector, including from Ukraine. We here present opportunities for researchers to apply to the open calls that are open in permanence that aim for challenge-driven multidisciplinary and/or synergistic projects open to academics and industry aimed at contributing to the advancement of frontier knowledge driven by EU policies and Mission "Restore our Ocean and Waters 2030". To complement, we will open a challenge-driven call based on specific themes that specifically address the main challenges and EU priorities object of the HORIZON-INFRA-2023-SERV-01-01 call (e.g., specific frontier fields/programmes, training for early-stage scientists, cross-RI topics). The goal of these challenge topics is to support projects that show high complementarity to ongoing frontier projects from the open calls.



P21. Nutrient Calibration off West Iberian margin: multi-proxy approach

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Coastal upwelling regions are considered areas of significant biological productivity in Eastern Boundary Current Systems, representing 80 to 90% of the new production. These areas are considered as key locations to understand the linkage between the biological pump, or export productivity and climate in the past, which is essential for simulating future climate. However, the accuracy of these paleoreconstructions depends on the data set and calibration quality. Several calibration works have been defining and improving the use of proxies for productivity and nutrient cycling parameters, but along Iberian margin, little work has been done combining hydrographic and biogeochemical conditions with the past oceanic or climate conditions. In order to minimize this lack of the information from the upper water column productivity point of view, we investigate trace elements and stable isotopes in planktonic foraminifera (PF) species, PF fauna, Ba concentration, together with Total Organic Carbon from a large set of core-top sediment samples from the West Iberian margin. Sediment data are compared with chlorophyll's satellite data and present-day water column data (e.g. trace elements, stable isotopes, and phosphate concentration). In the sediments, Cd/Ca shows only high values on *G. bulloides* (upwelling related species for the region) close to the coast, reflecting the intense upwelling (high chlorophyll a concentrations). High Ba/Ca of *G. inflata*, deep-dwelling species, in sediments is in agreement with water Ba/Ca, showing a clear increase in Ba/Ca from the surface to the deep water, that is correlated with spring/early fall phosphate concentrations. This study contributes to CALIBERIA, CARBO-ACID, IRMAPEX; and ICW3P's Projects.



P22. Assessing Sea Surface Temperature Dynamics in the SW Iberian Margin Using Alkenone Biomarkers

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The SW Iberian margin, located in the NE Atlantic Ocean, undergoes seasonal circulation shifts driven by regional atmospheric changes, in turn affecting upwelling dynamics and regional sea surface temperature (SST). This study delves into the climate conditions of the region and aims to assess how well alkenones from surface sediments capture the annual/seasonal sea surface temperature. Here, we focus on the U_{37}^K index derived from the relative abundances of two long chain C_{37} alkenones, which serve as robust biomarkers for paleothermometry in marine sedimentary records. We present results from >16 surface sediment samples, retrieved by mono corer aboard the R/V Ramón Margalef during Cruise PASSAGE23. Freeze dried sediments were weighted and extracted using a microwave digestion system with solvents. The total lipid extract was further separated into three fractions using column chromatography. The F2 fraction, containing the alkenones, was analyzed by gas chromatography with flame ionization detection to determine alkenone abundances and U_{37}^K ratios. Alkenone derived SST is compared with annual mean SST from the World Ocean Atlas. Differences between both datasets are interpreted in terms of seasonal production, preferential degradation of the tri unsaturated C_{37} alkenone, or potential transport of allochthonous alkenones. Ultimately, this research aims to enhance our knowledge of well established proxies used as paleothermometers (i.e., alkenones) in the targeted marine region.

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P23. HowMOW – How salty was the Mediterranean Outflow Water?

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Salinity plays a key role in the global ocean circulation constituting together with temperature the two parameters forcing the density driven circulation. Their variation regulates the water mass and circulation pathways forming a vertical mixing process: thermohaline circulation (THC). Despite its importance, past seawater salinity is one of the long-lasting unknowns in paleoclimate and paleoceanography studies ^[1]. In this project, we aim to develop a new direct proxy using trace element (namely Na/Ca) composition of deep-sea benthic foraminifers to explore the role of salinity variation in the intermediate depth THC during the major climate shifts in the geological record. As the first step, we will use modern sediment samples from the Gulf of Cadiz (GoC) and Portuguese margin to generate a calibration equation that reflects the relationship between the water salinity and foraminiferal Na/Ca. Because in that region vigorous mixing between the adjacent water masses modifies the properties of the Mediterranean Outflow Water (MOW). MOW is a salt injector to the global THC due to its high salinity (~37) and thus is a trackable intermediate to deep-water mass in the GoC by being separated from the Atlantic water mass (~35.5). As the second step, we will test the efficiency of deep-sea benthic foraminiferal Na/Ca through geological timescales by applying the calibration equation to fossil foraminifer samples from IODP site U1387, drilled into the Faro Drift. For this step, we have chosen a specific geological time interval with an abrupt climate shift called Early-Middle Pleistocene Transition (EMPT) that spans from ~1.2 to ~0.7 Ma when symmetric 41-kyr interglacial-glacial cycles were replaced with 100-kyr abrupt and asymmetric cycles ^[2]. MOW influences the THC due to its density and we expect that it played a significant role in the past in regulating ocean-climate dynamics. The EMPT, as a well-studied climate shift phase, and the location of the sampling sites with vast amounts of data available, are an excellent combination to test this hypothesis. If successful, a new independent proxy for past seawater salinities will be achieved.

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P24. Unraveling paleoenvironmental trends: Benthic foraminiferal records from the late Eocene to early Miocene in the NW South America

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The strategic importance of the oceanic basins of the Central American Seaway (CAS) lies in their role in global oceanic circulation and their impact on marine ecosystems throughout the Cenozoic. Paleoenvironmental reconstruction is crucial for understanding how deep tropical ecosystems respond to global climate changes and regional tectonics. We present a benthic foraminiferal record from the late Eocene – lower Miocene in an offshore sequence in northwestern South America on its Caribbean margin. This record shows changes in the behavior of benthic communities interpreted as variations in nutrient inputs, bottom currents, and carbonate compensation depth (CCD). The upper Eocene interval comprises two environments, one at the base of the well, characterized by shallower conditions, energetic environments, and relatively well-oxygenated waters with a constant flow of nutrients, and the other, a deeper environment with a high abundance of agglutinated and epifaunal taxa indicating nutrient pulses that might have been stimulated by volcanic activity and/or from the influx of nutrients through riverine systems in the SW Caribbean. Also, the high abundances of *Psammosiphonella cylindrica* suggest more intense and corrosive bottom currents in this interval. At the beginning of the Oligocene, a marked change in productivity and a deepening of the CCD led to a predominance of calcareous-walled foraminifera, coinciding with global changes associated with the Eocene-Oligocene Transition. During the Oligocene, benthic foraminiferal communities appear to be controlled by the seasonal delivery of nutrients likely from different fluvial systems positioned along NW South America. The upper Oligocene and lower Miocene interval records a remarkable increase in paleoproductivity that may be related to the one documented in the Atlantic Ocean in response to cooling at high latitudes. This research enhances understanding of paleoenvironmental history in NW South America and the role of benthic foraminiferal communities as proxies for tectonic, climatic, and oceanographic changes in this tropical region during the late Paleogene and early Neogene.



P25. Open Access Ocean Models: A Case Study in Cold-Water-Coral Ecology

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In marine research, ocean models are essential for understanding ocean dynamics when data access is limited. By assimilating data and simulating missing points in time and space, these model products offer a comprehensive depiction of real-world ocean conditions. The objective of this study is to introduce a novel method for acquiring essential data in the absence of observational records. It is tailored for researchers seeking efficient data extraction methods without advanced modeling techniques. By using the new user-friendly Marine Toolbox by Copernicus Marine Service, we illustrate a straightforward methodology for accessing and analyzing ocean data. This case study will focus on the widespread cold-water coral (CWC) species *Lophelia pertusa*. Reef-building CWC are engineer species that create 3D structures providing shelter for many organisms in the mostly barren seafloor landscape, making them important hotspots of biodiversity in the deep sea. Natural climatic cycles change CWC living conditions, affecting their habitat suitability through the ages. As human-induced global warming intensifies, understanding the impact of these changes on deep-sea ecosystems becomes increasingly important. By coupling occurrences data with extracted temperature from the Global Ocean Physics Reanalysis model, we can draw valuable conclusions about the thermal amplitude that the species can withstand and its potential adaptation over time. In conclusion, our research underscores the effectiveness of integrating open-source ocean model products into species studies, presenting an accessible pathway for researchers across disciplines to access vast amounts of data.



P26. Evolução da circulação atmosférica no Atlântico Nordeste

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O regime de vento na costa ocidental da Península Ibérica e na costa noroeste da África, essencial para o afloramento costeiro, depende fortemente da intensidade e localização do anticiclone dos Açores e das depressões térmicas da Península Ibérica e do Saara. Simulações numéricas globais EC-EARTH3 são aqui utilizadas para avaliar o comportamento destes dois sistemas de pressão, até ao final do século XXI, considerando dois cenários IPCC. Adicionalmente, uma simulação atmosférica WRF de alta resolução centrada na ilha da Madeira é utilizada para avaliar a influência, de ambos os cenários, no vento de superfície em redor da ilha, uma região onde frequentemente se observar um escoamento perturbado. Em geral, no Atlântico Norte os resultados indicam uma diminuição da intensidade média do vento devido a um anticiclone dos Açores com gradientes de pressão menos intensos. No entanto, a intensificação prevista das depressões térmicas na Península Ibérica e no Saara durante os meses de Verão impõem um aumento da intensidade do vento junto à costa oeste da Península Ibérica e junto à costa noroeste de África, o que possivelmente implicará uma intensificação do afloramento costeiro, nestas regiões. A sudoeste da Península Ibérica, a ilha da Madeira também deverá experimentar uma intensificação dos seus jatos junto aos extremos Este e Oeste da ilha, principalmente nos meses de Verão.

P27. Sedimentary fluid escape structures at the Portuguese Margin: sources and sinks of carbon

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The Portuguese margin is prone of sedimentary fluid migration and escape structures. Up to 2020, 79 mud volcanoes and mud diapirs were confirmed, through sampling, in the Gulf of Cadiz [1, 2]. Shallow occurrences of gas hydrates were found at many of these mud volcanoes [1-3] or associated with faults controlling their emplacement [4]. Fossil cold seeps show past occurrence of gas hydrates along the upper and middle slope of the south Portuguese margin, as revealed by their methane-derived authigenic carbonates [5]. Pockmarks and shallow gassy sediments were recognized, not only in the Gulf of Cadiz [4], but also in the Estremadura Spur [6, 7]. Shallow gassy sediments on the continental shelf are found associated with the Tagus prodelta [8] or at estuaries like at Ria de Aveiro [9]. These various forms of shallow gas in seabed strata and in the water column result, or from the degradation of recently deposit organic matter or, in minor amount, from the migration of deep sourced thermogenic hydrocarbons. The understanding of the role of these systems as sources or as sinks of methane is a fundamental question that will be addressed in this work. Facing the present-day scenarios of climatic changes and global warming, these systems can have an important role in the global methane, and carbon, cycle.

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P28. Planktonic foraminifera reveal changes in ocean circulation at the Iberian margin across the Pliocene- Pleistocene transition

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The Pliocene epoch stands out by its notably warm climate with high atmospheric CO₂ levels, and its end (at ~2.6 Ma) is marked by the onset and intensification of the Northern Hemisphere Glaciation, which led to a global climate impacted by severe glaciations. Upwelling systems, like the one of the Iberian margin, are the most productive regions of the world's oceans with broad implications for feeding human populations. However, these systems are vulnerable to the impacts of climate change, highlighting the urgent need to explore their dynamics under different climatic regimes. We studied planktonic foraminifer assemblages from the IODP Site U1391 (37°21.5'N; 9°24.6'W, 1085 m water depth), recovered from the SW Iberian margin during the Integrated Ocean Drilling Program Expedition 339, to reconstruct changes in surface water temperature, productivity, seasonality, and ecological diversity between 3.23 and 2.43 Ma. Foraminifer assemblages show a marked change between MIS G10 (~2.80 Ma) and MIS G6-4 (~2.73 Ma), coinciding with the intensification of the Northern Hemisphere Glaciation (iNHG). Prior to the iNHG, assemblages show high abundance of tropical-subtropical species, particularly during interglacial periods. During these periods, surface waters were warm, stratified, and less productive, probably reflecting the increased influence of the Paleo-Azores Current in the studied area. During glacial periods, conditions were more variable, namely during MIS G16 when the assemblages were dominated by *N. incompta*, probably reflecting colder temperatures and/or increased productivity. After the iNHG, planktonic foraminifer assemblages show a decrease in the abundance of tropical-subtropical taxa, an increase of the cold-water taxa (*N. pachyderma* and *T. quinqueloba*), and an increase in the abundance of *N. incompta* and *G. bulloides*. Foraminifers indicate colder surface waters and stronger surface water column mixing. Moreover, the high abundance of *G. bulloides* indicates enhanced productivity, likely as a consequence of the strengthening of coastal upwelling resulting from the interaction of N winds and the Portugal Coastal Current after the iNHG.



P29. SMS-Coastal, a New Python Tool to Manage MOHID-Based Coastal Operational Models

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This work presents the Simulation Management System for Operational Coastal Hydrodynamic Models, or SMS-Coastal, and its novel methodology designed to automate forecast simulations of coastal models. The working principle of this system is based on a generic framework that can be easily configured for other applications. It is implemented using the Python programming language for higher flexibility and simplicity. The system consists of three main components: the Forcing Processor, Simulation Manager, and Data Converter, which perform operations such as the management of forecast runs and the download and conversion of external forcing data. The SMSCoastal was tested on two coastal forecasting systems using the MOHID model: SOMA, the operational model of the Algarve Coast in Portugal ^[1], and BASIC, the operational model of the Cartagena Bay in Colombia ^[2]. The tool proved to be generic enough to handle the different aspects of the models, being able to manage both forecast cycles.

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P30. Evolution of West-East contrast in the subarctic Pacific gyre during the Plio-Pleistocene based on palynological evidence at ODP Sites 882 and 887

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New palynological data encompassing the Pliocene and Pleistocene at ODP Site 882 in the northwest Pacific document sea-surface conditions from dinoflagellate cysts in addition to atmospheric trajectories from pollen and spores. The comparison of the Site 882 record with that of Site 887 from the northeast Pacific also permits documenting West to East contrasts across the subarctic North Pacific. The dinocyst assemblages at the two sites indicate strong temperature contrasts until 4.2 Ma, with much warmer conditions in the East. From 4.2 to 2.7 Ma, dinocyst assemblages of both sites are characterized by alternated dominance of the extinct taxa *Habibacysta tectata* and *Impagidinium detroitense* suggesting homogenous and cool conditions across the subarctic Pacific gyre. A major transition is recorded in the palynological assemblages at Site 882 around 2.7 Ma. It is marked the highest occurrence of *Habibacysta tectata* and a significant reduction of pollen and spores from adjacent land, likely resulting from a southward shift of westerly winds. After 2.7 Ma, high percentages of thermophilic dinocyst suggest warmer conditions in upper water masses due to reinforced stratification, which supports the hypothesis of high evaporation at the origin of atmospheric moisture supply to high latitudes. During the Middle Pleistocene transition, the increase of *Operculodinium centrocarpum* relative to *Nematosphaeropsis labyrinthus* is interpreted as a reinforced influence of the Kuroshio waters to the subarctic Pacific. Hence, we suggest that the warm surface ocean fostered the inception and growth of northwestern North American ice sheets during the Pliocene and Pleistocene.

P31. Detecção remota de lentes de baixa salinidade de origem fluvial

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Neste trabalho apresentam-se os resultados do estudo da aplicabilidade dos dados de satélite para caracterização da variabilidade espaço-temporal das lentes de baixa salinidade de origem fluvial, na costa noroeste da Península Ibérica. O trabalho enquadra-se nas atividades do projecto DiadSea (EAPA_0011/2022 Interreg Atlantic Area) que tem como objectivo geral melhorar a gestão sustentável e a conservação de peixes diádromos no meio marinho. Para tal, importa quantificar as condições ambientais da área adjacente à foz dos rios nos quais os peixes anádromos migram para completar o seu ciclo de vida. Nesta primeira fase, são analisados os resultados da aplicação de diferentes metodologias para a identificação das plumas túrbidas, tendo por base as utilizadas em trabalhos anteriores sobre dos principais rios da costa oeste de Portugal Continental ^[1,2,3]. A análise é feita utilizando os dados de alta resolução do sensor Ocean and Land Colour Instrument (OLCI) instalado a bordo dos satélites Sentinel-3, nomeadamente os dados de reflectância normalizada (*Normalised Water-Leaving Reflectance*) assim como de produtos multi-satélite e multi-espectrais. Os períodos analisados abrangem as datas da realização de campanhas de monitorização do IPMA, e da disponibilidade de dados de instrumentação fundeada, por forma a avaliar a relação entre a salinidade medida in situ e a distribuição das plumas túrbidas determinadas utilizando limiares de reflectância e critérios de atenuação dos valores medidos por satélite em função da distância à embocadura dos rios.

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P32. Development and validation of a hydrodynamic model of Mar Menor coastal lagoon (Región de Murcia, Spain)

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Coastal lagoons are complex and extremely rich interface environments that suffer crescent pressure from anthropogenic actions. Restricted lagoons, such as Mar Menor (a microtidal coastal lagoon located in the southeast coast of Spain), are especially vulnerable to human actions. This lagoon has been subject to intensive pressure from neighbor agriculture activities that illegally catch water from the Campo de Cartagena – Mar Menor aquifer, as well as some wastewater discharge ^[1–3], resulting in nutrient contamination of the groundwater and surface water that flows into Mar Menor. This, combined with the high residence time of the water inside the lagoon ^[4], resulted in a serious problem of water eutrophication that has negative impacts for the biological communities that live inside the lagoon and reduces its aesthetic value. In this scope, this work aims to present the results of the development of a numerical model as a tool to reproduce Mar Menor dynamics, that will be the basis to predict the dispersion of contaminants and to help the timely management of pollution risks. To achieve this goal, a numerical implementation of Mar Menor was developed using the ROMS model, and the years of 2021 and 2022 were used for validation. Despite the complexity of the coastal lagoon and the high number of forcing factors, the model implementation revealed high accuracy in reproducing the tides inside the lagoon, as well as the exchange between the Mar Menor and the Mediterranean Sea through the Gola del Estacio, Gola de Marchamalo and Las Encañizadas channels. A good match between the model results and the observed water temperature and salinity vertical structure was obtained, with low RMSE and high predictive Skill values, showing that the aforementioned implementation is trustable and can be used as a tool to further study the lagoon's dynamics under different conditions, and, when coupled with a water quality module and a forecast atmospheric model, can be the core of a modelling system that can timely predict the dispersion of contaminants inside the lagoon.

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P33. Plastisphere, the plastic microcities colonized by harmful microalgae

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The increasing occurrence of microplastics in the marine environment has provided significant surface area for potential colonization by benthic harmful microalgae and for the adsorption of their lipophilic toxic compounds, such as diarrhetic shellfish toxins produced by *Prorocentrum lima*. Furthermore, floating plastics are expected to substantially expand the substrate area available for benthic microalgae in the ocean, intensifying the transfer of potent toxins through pelagic food webs. In order to further explore this possibility, we conducted a microcosm experiment over seven days, assessing the colonization of *P. lima* cells on microplastics of different shapes (750- μm spheres, 600x680x380- μm irregular fragments, and 11,350x25- μm cylindrical filaments) exhibiting equivalent surface areas. Our results showed that cell colonization depended on the exposure period, the abundance of microalgae, and the shape of the microplastic. We found that microalgal cells colonized more densely fragments (26–60 cells mm^{-2}) and spheres (19–31 cells mm^{-2}), compared to filaments (4.1–6.2 cells mm^{-2}) after seven days. Moreover, microalgae aggregated together with fragments or spheres, causing a change in particle/aggregate density, and settled on the bottom of the culture flasks within a few days of exposure, further increasing the contact with benthic cells on the bottom. Differently, filaments were poorly colonized by microalgae, and remained at the surface. Our research indicates that surface area plays an important role in the colonization potential of microalgae, with cohesive power being enhanced by more spheroid rather than linear, thin particles. Additionally, we highlight that plastic pollution can exacerbate the negative impacts of harmful benthic algae proliferation to marine organisms. During toxic blooms, microplastic particles and aggregates that are covered by harmful algae may end up in benthic compartments, making them more accessible to epifaunal and infaunal animals that usually have limited access to microalgal cells and their toxins.



P34. Impacts of the recent North Atlantic cold blob on seawater isotope signatures along the GO-SHIP A25/OVIDE transect

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Since 2010 seawater samples for stable carbon and water isotope measurements were collected during various hydrographic cruises along the OVIDE/BOCATS (A25) transect between Portugal and Greenland. The samples cover the complete depth range at the respective station. For all samples $\delta^{18}\text{O}$ was analyzed, whereas $\delta^2\text{H}$ (δD) measurements were more limited and mainly focused on the wide range of water masses encountered along the transect. Carbon isotope values for the dissolved inorganic carbon ($\delta^{13}\text{C-DIC}$) were monitored over several years at selected stations. Changes in the $\delta^{18}\text{O}/\delta^2\text{H}$ data are mostly linked to the subpolar gyre and water mass changes associated with the “North Atlantic cold blob” between winter 2013-2014 and 2016. The presence of surface and subsurface waters with lower isotopic signals clearly tracks the eastward displacement of the subarctic front in 2014 and 2016. Likewise, the front’s subsequent retraction to the west is reflected in the data from 2018 and 2021. Low $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values in depths down to 300 m in the region between the Rockall Plateau and the Reykjanes ridge also clearly distinguish the subpolar mode water formed during the previous “cold blob” winters. On the other hand, and in agreement with the $\delta^{13}\text{C-DIC}$ evidence, hardly any isotope signal changes are observed in the depths of the North Atlantic Deep Water (NADW) and the Northeast Atlantic Bottom Water (NEABW). The $\delta^{13}\text{C-DIC}$ profiles show a clear signal of anthropogenic carbon entering the water column in the NE Atlantic and leading to lower isotopic values. Whereas data obtained for samples collected in 2010 more or less agree with the data from previous decades (GLODAP database), shifts to lower values became apparent in the subsurface waters already in 2012. The signal transfer is accelerated in the subsequent years with data from 2016 onwards, i.e., after the “cold blob” related convection events in the Irminger basin, showing penetration of anthropogenic carbon down to 2000 m.



P35. GMT, mais fácil e poderoso via *Julia*

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A linguagem *Julia* é uma linguagem de uso geral conhecida pelas suas excelentes capacidades de computação numérica. Oferece um elevado desempenho, comparável, ou mesmo mais rápido, ao das linguagens nativas compiladas estaticamente e é relativamente fácil de aprender, especialmente para quem está familiarizado com MATLAB, Fortran ou Python. O pacote GMT.jl é um *wrapper* da linha de comando do Generic Mapping Tools (GMT), que permite aceder a todos os módulos GMT a partir da linguagem *Julia*. Matrizes, vectores e dados texto podem ser passados de forma transparente entre os dois ambientes usando tipos de dados definidos em *Julia*, que são basicamente estruturas organizando os dados e metadados necessários. Encapsular os módulos GMT em *Julia* serve dois propósitos principais: 1) Por um lado, fornece aos utilizadores da *Julia* o acesso a uma ferramenta amplamente utilizada nas geociências, conhecida principalmente pelas suas capacidades de mapeamento com qualidade de publicação; 2) por outro lado, a linguagem *Julia* é utilizada para contribuir para o GMT, fornecendo uma interface de utilizador moderna que utiliza uma sintaxe mais *palavrosa*, mas também muito mais fácil de aprender e compreender, composta por opções com nomes longos, em vez da sintaxe algo enigmática pela qual o GMT é conhecido e que dificulta a aprendizagem por parte de novos utilizadores. Além disso, o poder e a simplicidade da linguagem *Julia* permitem-nos também combinar módulos e recriar, por exemplo, o equivalente ao *contourf*, *pcolor*, *triplot* do MATLAB, só para mencionar alguns. O *wrapper* está disponível para todos os sistemas operativos e é muito facilmente instalável a partir do sistema de instalador de pacotes da *Julia* e tem um manual extenso disponível em https://www.generic-mapping-tools.org/GMTjl_doc/

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P36. Extreme water levels and water quality in the Tagus estuary: the CONNECT Tagus service

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The Tagus Estuary holds an important natural reserve and a major harbor. Its margins are intensively occupied by about 1.5 million inhabitants and support diverse uses, which gives rise to the onset of several water quality problems. The margins of the estuary and its adjacent coasts are also prone to inundation from various sources, a problem exacerbated by sea level rise. Anticipating how human-induced or climate drivers influence extreme water levels and the water quality in the Tagus estuary is essential to support its management and the implementation of European directives and policies (e.g., WFD, MSFD, Floods Directive). The CONNECT Tagus service combines model-based forecasts and in-situ and remote observations to provide physical and biogeochemical data on the Tagus estuary and to integrate it in the Copernicus Marine Service (CMEMS). The service is powered by the CONNECT operational coastal service and integrates: i) shelf-to-estuary quality operational modeling with SCHISM (Zhang et al., 2016) in 2D barotropic (including waves) and 3D baroclinic modes (including biogeochemistry) to produce daily forecasts of local physical and biogeochemical variables. The operational models are powered by WIFF (Fortunato et al., 2017) and OPENCoastS (Oliveira et al., 2020, 2021) services and downscale CMEMS predictions of the Iberia-Biscaya regional model. At the Tagus River boundary, freshwater flows are imposed using observations; predictions from Artificial Intelligence models are also available; ii) real-time physical and biogeochemical data acquisition from in-situ observation networks, including data from the COASTNET monitoring infrastructure (Castellanos et al. 2021; França et al. 2021), and Earth-observation data from CMEMS; iii) indicators (e.g., statistics, physiochemical ratios, ecological quality ratio, trophic index) and weekly reports of the modeled and observed variables that summarize both the physical behavior and the water quality status of the estuary. The data is shared through a dedicated webGIS portal (connect-portal.lnec.pt) enhancing the management, monitoring and forecasting of the water quality and coastal inundation in the Tagus estuary.

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P37. Lessons from the Microbial Composition within Seagrass Rhizosphere during Restoration

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Seagrasses form critical marine habitats lining coastlines worldwide. They are facing alarming declines due to various human-induced impacts. Along with ongoing efforts to mitigate the effects of global and local stressors, seagrass restoration projects encounter crucial knowledge gaps for future success. Recently, research focussed on the seagrass-associated microbiome and its importance for fostering seagrass vitality gained more attention. It is known that the microbiome significantly contributes to seagrass resilience after disturbance. Investigating this microbiome holds promise in unravelling its impact on the success of seagrass restoration efforts. The predominant technique for seagrass restoration remains shoot-based transplantation from donor areas to designated restoration sites. The objective of this project was to assess the adaptability of bacterial communities to novel environmental conditions following an experimental transplant. *Zostera marina* shoots and *Zostera noltei* sods were transplanted in Ria Formosa, Faro, in winter and spring seasons and DNA samples were collected from the microbial communities in the sediment, and on seagrass roots and leaves. 16S rRNA gene amplicon Illumina sequencing was performed to enable the comparison of bacterial community dynamics and diversity before and after transplantation. The outcome of this research elucidates microbial composition of healthy and compromised seagrass community states after restoration practices.



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