# XIII Conferência Polar Portuguesa

29 - 30 novembro 2021    CIIMAR - Porto

# PROGRAMA e LIVRO DE RESUMOS
## PROGRAMME and ABSTRACT BOOK

PROPOLAR
Programa Polar Português

ciimar
Centro Interdisciplinar de Investigação
Marinha e Ambiental

Organização e apoios | *Organization and support*

CCMAR

MARE
centro de
ciências do mar
e do ambiente

TÉCNICO
LISBOA

FCT
Fundação para a Ciência e a Tecnologia

CEG
Centro de Estudos
Geográficos

IGOT
Instituto de Geografia
e Ordenamento do Território
UNIVERSIDADE DE LISBOA

U
LISBOA
UNIVERSIDADE
DE LISBOA

CQE
Química Estrutural

APECS
Association of Polar
Early Career Scientists
Portugal

# 13ª Conferência Polar Portuguesa

## 13th Portuguese Polar Conference

XIII Conferência Polar Portuguesa

29 - 30 novembro 2021    CIIMAR - Porto

## Antecipando um mundo em mudança

### *Anticipating a changing world*

29-30 de novembro de 2021

*29-30th November 2021*

### Organização | Organization

Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR), Universidade do Porto

### Contactos | Contacts

ptpolarconf@gmail.com

# ÍNDICE | TABLE OF CONTENTS

# APRESENTAÇÃO

As regiões polares são particularmente frágeis e devido às alterações climáticas torna-se importante monitorizar e compreender o seu funcionamento. O mais recente relatório do Painel Intergovernamental sobre Alterações Climáticas (IPCC) enfatiza que a temperatura global da superfície terrestre irá continuar a aumentar, aumento esse que irá certamente ultrapassar os 2 °C num futuro próximo. Com o aumento progressivo das temperaturas os ambientes polares estão sujeitos a algumas das alterações mais drásticas do nosso planeta, apesar de os dois pólos apresentarem realidades muito diferentes. Deste modo, tornou-se cada vez mais evidente a importância da investigação científica polar no aumento da compreensão dos processos atmosféricos, biológicos, criosféricos, geológicos e oceânicos, que ocorrem nas regiões polares e que afetam todo o planeta. A adaptação a todas estas mudanças, enquanto seres humanos, será testada num futuro próximo e a nossa capacidade de responder rapidamente às mudanças profundas será posta à prova.

As parcerias científicas são fundamentais para consolidar conhecimentos, antecipar cenários e agir preventivamente em relação às alterações climáticas, de modo a evitar catástrofes para a biosfera terrestre. É com o espírito de interdisciplinaridade que o Programa Polar Português (PROPOLAR) com o apoio da Fundação para a Ciência e a Tecnologia (FCT) promove, anualmente, a Conferência Portuguesa de Ciências Polares, onde cientistas Portugueses, e seus parceiros internacionais, que trabalham nas regiões polares discutem ideias, partilham resultados e fomentam parcerias. Este ano, sob o lema *"Antecipando um mundo em mudança"* pretendemos enfatizar as soluções e as propostas que não se esgotam na projecção de um futuro diferente mas também contribuir com conhecimento e valor para dar respostas eficazes e atempadas às necessidades do nosso planeta e das suas sociedades.

A XIII Conferência Portuguesa de Ciências Polares será realizada nos dias 29 e 30 de Novembro de 2021 no Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR), Matosinhos, em formato presencial e online.

Esperamos assim contar com a vossa presença,

*A comissão organizadora*

# FOREWORD

Polar regions are particularly fragile and due to climate change, it is important to monitor and understand their functions. The most recent report by the Intergovernmental Panel on Climate Change (IPCC) emphasizes that the global temperature of the Earth's surface will continue to increase, an increase that will certainly exceed 2°C in the near future. With the progressive increase in temperatures polar environments are subject to some of the most drastic changes on our planet, despite the fact that the two poles present very different realities. Thus, the importance of polar scientific research in increasing the understanding of atmospheric, biological, cryospheric, geological, and oceanic processes that occur in the polar regions and that affect the entire planet has become increasingly evident. Our ability to adapt to all these changes as human beings will be tested in the near future and our capacity to quickly respond to these profound changes will be tested.

Scientific partnerships are essential to consolidate knowledge, anticipate scenarios and act preventively in relation to climate change to avoid catastrophes for the Earth's biosphere. It is with the spirit of interdisciplinarity that the Portuguese Polar Program (PROPOLAR), with the support of the Foundation for Science and Technology (FCT), annually promotes the Portuguese Conference on Polar Sciences, where Portuguese scientists and their international partners that work in the polar regions discuss ideas, share results, and foster partnerships. This year, under the theme *"Anticipating a changing world"* we intend to emphasize the solutions and proposals for a different future, and contribute with knowledge and value to provide effective and timely responses to the needs of our planet and their societies.

The XIII Portuguese Conference on Polar Sciences will be held on the 29th and 30th of November 2021 at the Interdisciplinary Center for Marine and Environmental Research (CIIMAR), Matosinhos, in person and online format.

We look forward to your presence at this event,

*The organizing committee*

## ORGANIZAÇÃO | ORGANIZATION

Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR), Universidade do Porto.

## COMISSÃO ORGANIZADORA | ORGANIZING COMMITTEE

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Pedro Pina, IA/DCT-UC
Pedro Silva, ISPA – Instituto Universitário
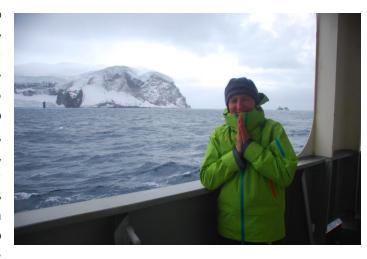Rui Fernandes, Universidade da Beira Interior, SEGAL-UBI
Sara Pedro, ULaval
Teresa Cabrita, CEG/IGOT-ULISBOA

# ORADORES CONVIDADOS | KEYNOTE SPEAKERS
## IRINA GORODETSKAYA

Irina Gorodetskaya é investigadora do Centro de Estudos Ambientais e Marinhos (CESAM) da Universidade de Aveiro, Portugal. Ela é meteorologista polar e cientista do clima, tem interesse no ciclo hidrológico nas regiões polares, incluindo na humidade nos pólos, transporte de calor e processos de precipitação e impactos nas mudanças climáticas. Ela utiliza uma variedade de metodologias, incluindo observações *in-situ* e de sensoriamento remoto, analisando e avaliando reanálises e modelos globais acoplados e modelagem climática regional. Já participou em expedições nos Mares Nórdicos, Oceano Austral e na Antártica. Atualmente, ela co-lidera a equipa de Tarefas do Período Especial de Observação de Inverno de Previsão do Polar na região da Península Antártica. É membro do comité diretivo do Programa de Pesquisa Científica da SCAR "Variabilidade e Previsão do Sistema Climático Antártico a Curto Prazo" (AntClimNow). Ela é a autora principal do 6º Relatório de Avaliação do IPCC sobre Mudanças Climáticas 2021: A Base das Ciências Físicas e na sua palestra irá falar sobre as conclusões do relatório do IPCC sobre as regiões polares.

*Irina Gorodetskaya is a researcher at the Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Portugal. She is a polar meteorologist and climate scientist, particularly interested in the hydrological cycle in the polar regions, including poleward moisture and heat transport and precipitation processes and impacts in the changing climate. She is using a range of methodologies, including* in-situ *and remote sensing observations, analyzing and evaluating re-analyses and global coupled model and regional climate modelling. She participated in expeditions in the Nordic Seas, Southern Ocean and Antarctica. Currently, she is co-leading the Year of Polar Prediction winter Special Observing Period Task Team in the Antarctic Peninsula region. She is also a member of the steering committee of SCAR's Scientific Research Programme "Near-Term Variability and Prediction of the Antarctic Climate System" (AntClimNow). She is a lead author of the IPCC 6th Assessment Report Climate Change 2021: The Physical Science Basis and in her keynote talk she will speak about the IPCC report conclusions regarding the polar regions.*

# PHILIPP ASSMY

Philipp Assmy tem uma vasta formação científica em ecologia pelágica e do gelo marinho e biogeoquímica, tanto do Oceano Antártico quanto do Oceano Ártico, com ênfase particular na ecologia do fitoplâncton e das algas do gelo. Ele participou em vários cruzeiros de pesquisa interdisciplinares e grandes projetos de pesquisa internacionais, como o projeto Nansen Legacy e as expedições de deriva de gelo marinho norueguês jovem (N-ICE2015) e MOSAiC.



*Philipp Assmy has a broad scientific background in pelagic and sea ice ecology and biogeochemistry from both the Southern Ocean and Arctic Ocean with a particular emphasis on phytoplankton and ice algal ecology. He participated in several interdisciplinary research cruises and large international research projects such as the Nansen Legacy project and the Norwegian young sea ICE (N-ICE2015) and MOSAiC sea ice drift expeditions.*

# ANDRÉS BARBOSA

Andrés Barbosa é atualmente investigador sénior do Conselho Espanhol de Pesquisa Científica no Museu de História Natural, Madrid, Espanha. Doutorado em Ciências Biológicas pela Universidad Complutense de Madrid, Espanha. Ele tem interesse na ecologia de pássaros em ambientes extremos e nos efeitos das mudanças globais. O seu trabalho em ambientes extremos tem se desenvolvido na Antártica, Ártico, Terra do Fogo (Patagónia - Argentina), altas montanhas durante o inverno e subdesertos. Os seus campos de pesquisa incluem ecofisiologia, especificamente imunologia e stress oxidativo, interação hospedeiro-parasita incluindo doenças, estratégias de forrageamento, comportamento reprodutivo, seleção sexual, contaminação e efeitos dos radicais livres. As espécies de aves estudadas incluem pinguins, pássaros marinhos e passeriformes. Ele é o autor de 133 artigos publicados em revistas especializadas. Ele foi o investigador principal de 10 projetos de investigação. Investigador participante em 23 projetos de investigação. Ele liderou 14 expedições à Antártica e 1 ao Ártico e 4 cruzeiros científicos ao longo da Península Antártica e foi orientador de 10 teses de doutorado. Foi vice-diretor da Estação Experimental de Zonas Áridas, CSIC (2003-2008), Chefe do Departamento de Ecologia Evolucionária do Museu de História Natural, CSIC (2010-2012), Vice-diretor do Museu de História Natural, CSIC (2012 -2015), Gerente Científico do Programa Polar Espanhol (2017-2021), Membro do Grupo de Peritos de Aves e Mamíferos Marinhos do Comité Científico de Pesquisa Antártica (SCAR) (2014-), Presidente do Grupo de Trabalho de Vigilância da Saúde da Vida Selvagem de EGBAMM-SCAR (2014- ), Delegado espanhol no Grupo de Trabalho de Gestão de ecossistemas e monitoramento da Convenção de Conservação dos Recursos Vivos Marinhos da Antártica (CCAMLR), Membro da liderança da Península Antártica Ocidental e Grupo de Trabalho do Arco da Escócia do SOOS (Sistema de Observação do Oceano Austral) (2021-), Representante da União Internacional de Biologia Ciências (IUBS) no Comité Científico de Pesquisa Antártica (SCAR) (2015-), Membro do Comité Científico da Sociedade Espanhola de Ornitologia (2004- 2006), Membro do Conselho de Administração da Sociedade Espanhola de Ornitologia (2015-2016), Vice-presidente da Sociedade Espanhola de Ornitologia (2016-) e Membro do Conselho de Administração da Sociedade Espanhola de Biologia Evolutiva (2016-).

*Andrés Barbosa is currently a senior researcher at the Spanish Council for Scientific Research in the Natural History Museum, Madrid, Spain. He holds a PhD in Biological Sciences by the Universidad Complutense of Madrid, Spain. He is interested in the ecology of birds in extreme environments and the effects of global change. His work on extreme environments has been developed in Antarctica, the Arctic, Tierra de Fuego (Patagonia – Argentina), high mountains during winter and subdeserts. The research fields include ecophysiology, specifically immunology and oxidative stress, host-parasite interaction including diseases, foraging strategies, breeding behaviour, sexual selection, contamination and free radicals effects. Studied bird species include penguins, shorebirds and passerines. He is the author of 133 papers published in peer-reviewed journals. He has been a principal investigator of 10 research projects. Researcher participant in 23 research projects. He has led 14 Antarctic and 1 Arctic expeditions and 4 scientific cruises along the Antarctic Peninsula and has supervised 10 PhD Thesis. He has been Deputy director of Experimental Station of Arid Zones, CSIC (2003-2008), Head of the Department of Evolutionary Ecology at the Natural History Museum, CSIC (2010-2012), Deputy director of the Natural History Museum, CSIC (2012-2015), Scientific Manager of the Spanish Polar Program (2017-2021), Member of the Expert Group of Birds and Marine Mammals of the Scientific Committee for Antarctic Research (SCAR) (2014-), Chair of the Working Group of Wildlife Health Monitoring of EGBAMM- SCAR (2014-), Spanish delegate in the Working Group of Ecosystem Management and Monitoring of the Convention of Conservation of Antarctic Marine Living Resources (CCAMLR), Leadership member of the West Antarctic Peninsula and Scotia Arc Working Group of SOOS (Southern Ocean Observing System) (2021-), Representative of the International Union of Biological Sciences (IUBS) in the Scientific Committee on Antarctic Research (SCAR) (2015-), Member of the Scientific Committee of the Spanish Ornithological Society (2004- 2006), Member of the Management Board of the Spanish Ornithological Society (2015-2016), Vice-president of the Spanish Ornithological Society (2016-) and Member of the Management Board of the Spanish Evolutionary Biology Society (2016-).*

# PROGRAMA | PROGRAMME

## 29 de novembro | 29th of November

XIII Conferência Portuguesa de Ciências Polares | XIII Portuguese Conference on Polar Sciences
*Antecipando um mundo em mudança | Anticipating a changing world*

**9:00** Registo dos participantes | Participant registration

**9:30** Sessão de abertura | Opening session
**Vitor Vasconcelos - CIIMAR/UP | Germana Santos - FCT | Gonçalo Vieira - IGOT/UL | Catarina Magalhães - CIIMAR/UP**

**9:45** O Programa Português Polar | The Portuguese Polar Program
**Maria Teresa Cabrita - PROPOLAR**

## Sessões Científicas| Scientific Sessions

Ciências do Ambiente | Environmental Sciences
*Chairs: Gonçalo Vieira - IGOT/UL e Joana Baptista - IGOT/UL*

**10:00** Cryosphere and Polar regions in the IPCC 6th Assessment Report and COP26: Key Issues and the Cost of Inaction
Oradora convidada **Dr. Irina Gorodetskaya - CESAM/UAveiro** | Keynote speaker **Dr. Irina Gorodetskaya - CESAM/UAveiro**

**10:20** Remote sensing analysis of recent coastal change and its controlling factors in Darnley Bay (Amundsen Gulf, Canada)
**Rodrigue Tanguy - UAlgarve**

**10:30** Variability of the atmospheric hydrological cycle in polar regions through water stable isotopes measurements in vapor, precipitation and firn cores
**Christophe Leroy-Dos Santos - UAveiro**

**10:45** Cloud supercooled liquid water measurements during the Antarctic Circumnavigation Expedition
**Negar Ekrami - UAveiro**

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**11:00** Pausa e sessão de posters | Coffee break and poster session

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**11:30** Daily ground surface temperature regimes and their spatial controls (Barton Peninsula, King George Island, Antarctic)
**Joana Baptista - IGOT/UL**

**11:40** The relevance of using Unoccupied Aerial Vehicles (UAV) in Antarctica
**Pedro Pina - IA/DCT/UC**

**11:50** Remote sensing and in situ observations of solid precipitation around the coast of Adélie Land, East Antarctica
**Claudio Durán-Alarcón - CESAM/UAveiro**

**12:05** The importance of considering the biotic interactions to model present and future Antarctic vegetation
**Paula Matos - IGOT/UL**

**12:15** Ocean Tides Around Cierva Cove
**Pedro G. Almeida - UBI**

**12:25** Ocean Planning in the Poles: A Comparative Analysis of Governance Challenges and Practices
**David Santos - MARE/UL**

**12:40** Introdução aos posters | Flash introduction to posters

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**13:00** Almoço e sessão de posters | Lunch and poster session

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# Sessões Científicas| Scientific Sessions

Ciências Biogeoquímicas Biológicas | Biological and biogeochemical Sciences
*Chairs: João Canário - CQE/IST-UL e Catarina Magalhães - CIIMAR/UP*

**14:00** Emerging physical and biological properties of the new Arctic Ocean
Orador convidado **Dr. Philip - NPI** | Keynote speaker  **Dr. Philip - NPI**

**14:20** Long Term Changes at Southern Ocean Squid Ecology
**José Abreu - MARE/UC**

**14:30** Diversity and distribution of Arctic protists using metabarcoding approach
**Maria Paola Tomasino - CIIMAR/UP**

**14:40** Antarctic Biodiversity "hotspots": relevance for conservation of marine ecosystems
**José Xavier - MARE/UC**

**14:55** Microplastics and other anthropogenic particles in Antarctica: Using penguins as biological samplers
**Joana Fragão - MARE/UC**

**15:05** Integrating biodiversity and genetic approaches into sub-Antarctic deep sea research
**Rui Vieira - CEFAS**

**15:20** Cephalopods in the diet of Snares penguins: relevance to conservation of an endemic penguin species
**Hugo R. Guímmaro - MARE/UC**

**15:30** Net Ecosystem Metabolism of Kongsfjorden (Svalbard)
**Pedro Manuel da Silva Duarte - NPI**

**15:45** Solidifying previous knowledge on the types of prokaryotic rarity in the Arctic ocean by using novel methodologies and analytical approaches
**Francisco Pascoal - CIIMAR/UP**

**15:55** Introdução aos posters | Flash introduction to posters

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**16:15** Pausa e sessão de posters | Coffee break and poster session

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# Sessões Científicas| Scientific Sessions

Ciências Biológicas e Sociais e Educação Polar | Biological and Social Sciences and Polar Education
*Chairs: José Xavier e Marta Espírito Santo*

**16:45** Potential cascade effects of global change in Antarctic penguins
Orador convidado **Dr. Andrés Barbosa - MNCN/CSIC** | Keynote speaker **Dr. Andres Barbosa - MNCN/CSIC**

**17:05** Untangling local and remote influences in two major petrel habitats in the oligotrophic Southern Ocean
**Filipe Rafael Ceia - MARE/UC**

**17:20** Mission Challenges and Collective Responses During a Two-men Moon Analogue Mission in the Artic
**Pedro Quinteiro - ISPA**

**17:30** Steps to boost Polar Education in Portugal: Action and Outreach
**Marta Espírito Santo - Agrupamento de Escolas Professor Ruy Luís Gomes**

**17:40** APECS Portugal as a tool to boost the next generation of polar researchers
**Hugo R. Guímmaro - MARE/UC**

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**18:00** Sessão final | Closing session
**Catarina Magalhães - CIIMAR/UP**

## 30 de novembro | 30th of November

XII Workshop da APECS Portugal | XII APECS Portugal Workshop
An Unexpected Journey - Polar Science in a Pandemic crisis

**9:00** Sessão de abertura (manhã) | Opening talk (morning)

**9:10** Irina Gorodetskaya

**9:50** Andrés Barbosa


**10:25** Pausa | Coffee break


**10:50** Pjotr Elshout

**11:25** Kahoot

**12:00** Almoço | Lunch


**14:00** Sessão de abertura (tarde) | Opening talk (afternoon)

**14:10** Maria Vargas

**14:45** Philipp Assmy

**15:20** Debate

**16:05** Pausa | Coffee break and networking

**17:40** Sessão de fecho | Closing session

# RESUMOS | ABSTRACTS

# ORADORES CONVIDADOS | KEYNOTE SPEAKERS

## Cryosphere and Polar regions in the IPCC 6th Assessment Report and COP26: Key Issues and the Cost of Inaction

Irina Gorodetskaya

*CESAM/Universidade de Aveiro*

In this presentation I will highlight key topics concerning the changes in the cryosphere and the polar regions that have been assessed in the Intergovernmental Panel on Climate Change (IPCC) Working Group 1 (WG1) contribution to the 6th Assessment Report (AR6) "Climate change 2021: The Physical Science basis" released in August 2021 and discussed during the Cryosphere Pavilion event organized by the International Cryosphere Climate Initiative at the Glasgow Climate Change Conference of the Parties (COP26). The key issues include mountain glacier and snow cover reduction and changing water supplies, permafrost thaw and associated emissions, Arctic heatwaves and fires, changing Arctic Ocean and sea ice loss, ice sheets including inherent instabilities and irreversibility of changes, sea level rise acceleration due to the ice sheet melt and "committed" SLR projections, the ice sheets tipping points and the important role of ice shelves in stabilizing ice sheets, acidification, warming and freshening of the polar oceans. I will touch in more detail on the changes over the Greenland and Antarctic ice sheets – observed climate variability and trends, projections and impacts, as well as the risk of massive and abrupt West Antarctic ice sheet mass loss leading to much higher (compared to the conventional pathways) and potentially irreversible global sea-level rise within the next couple of centuries for global warming levels above 2°C.

# Emerging physical and biological properties of the new Arctic Ocean

Philipp Assmy

*Norwegian Polar Institute, Norway*

Arctic warming is proceeding three times faster than the global average and one of the most prominent manifestations of climate change is the drastic decrease in Arctic summer sea-ice extent. These changes in the physical environment will have cascading effects on Arctic marine ecosystems and the services they provide (e.g. food security and carbon cycle). In my presentation I will focus primarily on the Atlantic sector of the Arctic Ocean and the most prominent emerging physical properties of the new Arctic Ocean that we have been witnessing in the recent decades. I will link changes in the physical environment to changes in Arctic primary production and how these changes at the base of the Arctic marine food web have ripple effects on higher trophic levels and biogeochemical cycles.

# Potential cascade effects of global change in Antarctic penguins

Andrés Barbosa

*Dept. Evolutionary Ecology, National Museum of Natural Sciences Spanish Research Council*

Global change is one of the main drivers of environmental change in the Antarctic Peninsula. Climate change, contamination and the introduction of invasive species can be found among its different components.  In the last decades temperature increase has produced deep changes in both the physical and the biological components of the ecosystem. Penguins are the 80% of the vertebrate biomass of Antarctic ecosystem and together with its position as top predators make them the role of sentinels of the marine ecosystem reflecting all the environmental changes affecting lower levels in the food chain. In the last 18 years we have been working to identify the potential effects of the global change in the Antarctic penguin populations through its physiology and behaviour.  The work has three levels, one at long term to determine such effects; another at short term to have basic descriptive information and to identify the mechanisms explaining the effects; and finally at geographical level to know the extent of changes but also to use the environmental differences already present as a predictor of changes in the future. In this talk we will show the potential cascade effects relating climate change, diet, foraging behaviour, parasites and pathogens, immunity, stress and contaminants with pygoscelid penguin populations.

## Ciências do Ambiente | Environmental Sciences
https://padlet.com/PROPOLAR/cgc8lqoxjgc2k80t

## 1. Evaluation of the impacts of vegetation shadows and scattering on remotely sensed detected optical properties of small thermokarst lakes

Pedro Freitas (a, b); Gonçalo Vieira (a, b); Carla Mora (a); João Canário (b, c); Diogo Folhas (b, c); Warwick F. Vincent (b, d)

*(a) Centro de Estudos Geográficos, IGOT, Universidade de Lisboa; (b) Centre d'Études Nordiques, Université Laval; (c) Centro de Química Estrutural, Instituto Superior Técnico, Universidade de Lisboa; (d) Département de biologie, Université Laval*

Permafrost soils are one of the largest surficial organic carbon reservoirs on Earth, estimated to contain twice the amount of carbon that is in the atmosphere. Abrupt permafrost thaw creates widespread thermokarst lakes, affecting greenhouse gas emissions to an extent that still needs to be fully integrated in Earth System and Global Climate Models. Scarce attention has been given to waterbodies smaller than 10,000 m2, yet these are biogeochemically more active than larger lakes. Additionally, the landscapes where they develop notice fast vegetation structure changes (e.g. shrubification and northwards treeline migration). Tall vegetation that is colonizing waterbody margins project shadows and induce radiation scattering, which in optical remote sensing fosters mixed signatures. These processes can affect the ability of optical sensors when studying the amount of surface-leaving radiation or perceived lightness of the water itself. We undertook UAV surveys using optical and multispectral sensors at long-term monitoring sites of the Centre d'Études Nordiques (ULaval) in the boreal forest-tundra transition zone in Northern Quebec. This ultra-high resolution data enabled the spectral characterization, landcover classification and 3D reconstruction of the study areas. Here we use the ultra-high resolution multispectral data and digital surface models to better understand the impacts of vegetation shadows and scattering when studying the interannual dynamics of the optical properties of very small thermokarst lakes (2 to 2,200 m2) and show that UAV data can be used to better assess the errors and accuracy of satellite data.

## 2. Partial Linear Regression (PLRS) and Machine Learning Models (ML) for mapping and monitoring ground properties and albedo in periglacial areas using ground samples, and NIR-Spectra resampled to Sentinel images bands (Byers Peninsula, Antarctica)

Susana Fernandez (a); Alfonso Pisabarro (b); Juan J. Peón (c); Javier F. Calleja (d); Rubén Muñiz (e); Jesús Ruiz (f); Celestino Ordoñez (g)

*(a) D. Geología. ICTEA, Univ. Oviedo. fernandezmsusana@uniovi.es; (b) D. Geografía y Geología, Univ. León. apisp@unileon.es; (c) D. Geología. ICTEA, Univ. Oviedo. juanjopeon@gmail.com; (d) D. Física, Univ. Oviedo. jfcalleja@uniovi.es; (e) D. Ciencias de la Computación, Univ. de Oviedo. rubenms@uniovi.es; (f) D. Geografía, Univ. Oviedo. ruizjesus@uniovi.es; (g) D. Explotación y Prospección de Minas, Univ. Oviedo.*

Byers Peninsula (62° 34'-62° 40'S - 60° 54´ 61° 13´W) has a surface of 60 km2 and is one of the largest ice-free areas in Antarctica. In periglacial areas, as Byers, ground thermal regime has undergoing rapid changes in response to atmospheric oscillations. Runoff and subsurface water flow are affected by this thermal effect promoting transport of fine grain particles and dissolved chemical substances towards depositional areas. Mapping and monitoring ground properties and albedo fluctuations is useful to understand physical and chemical changes. Also, ground NIR-spectra can be used to identify transfer functions between ground and albedo data. In addition, supervised classification of optical images using ML or PLRS models training with ground data could be useful to monitoring ground properties and albedo in temporal series of Sentinel images. According this background it has been analyzed some variables in several grounds of Byers Peninsula: pH, electrical conductivity, total organic carbon, grain-size, dissolved organic carbon, Fe and Mn, ground moisture and albedo. PLSR models of organic carbon grain-size, Fe and Mn, ground moisture variables have been performed and regionalized for entire Byers Peninsula using GIS, and albedo spatial distribution model was obtained through ML supervised classification. Also, NIR-spectra radiance emitted from the grounds was taken and resampled to Sentinel bands and compared with spectra indexes calculated in Sentinel images. As result it was found a significative correlation between ground properties and spectral indexes that allow to stablish several relationships between grounds, climate patterns and landforms using Digital Elevation Models.

## 3. Remote sensing analysis of recent coastal change and its controlling factors in Tuktoyaktuk Peninsula (Beaufort Sea Coast, Canada)

Bernardo Costa (a); Gonçalo Vieira (a); Dustin Whalen (b)

*(a) Centre of Geographical Studies, IGOT, University of Lisbon, Portugal; (b) Natural Resources Canada, Dartmouth, Nova Scotia, Canada*

The average rate of coastal erosion in the Arctic Ocean is 0.5 m/yr-1, despite significant local and regional variations, with large areas well above 3 m/yr-1 (Lantuit et al., 2012). Recent data suggest an acceleration of coastal retreat in specific areas due to an increasingly shorter sea ice season, higher storminess, warmer ocean waters and sea-level rise (O'Rourke, 2017). Moreover, climate warming is inducing the subaerial degradation of permafrost and increasing land to sea sediment transportation. This work consists of the characterization and analysis of the main controlling factors which influence recent coastline change in the Tuktoyaktuk Peninsula (Beaufort Sea, Northwest Territories, Canada). The specific objectives are: I. mapping Tuktoyaktuk Peninsula's coastline and its changes between 1985 and 2020 using remote sensing imagery, II. characterizing the coastal morphology, III. quantifying the recent coastal change rates, IV. identifying the main controlling factors of the coastal change rates. For this, we are working on historical aerial imagery and a very high-resolution Pleiades survey from 2020, as well as surveys using unmanned aerial vehicles which encompass detailed study areas. Preliminary results have shown an average coastline change rate of -1.08 m/yr-1 between 1985 and 2020. While this number is a considerable increase when comparing to the Arctic average rate, it neglects to show the sheer erosion prevalent in specific areas. Tundra Cliffs, usually with a sandy beach are the main coastal setting, occupying c. 56% of the Tuktoyaktuk Peninsula coast. In a more detailed classification, these are divided in Very Low (c. 23%), Low (15%) and medium (5%) tundra cliffs, with Inundated Tundra Flats and Polygons representing another 23% of the coastline.

## 4. Recent impacts of climate change on the landforms and dynamics of Pingo Canadian Landmark (Northwest Territories, Canada)

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Pingo Canadian Landmark (PCL) is a 16km2 protected coastal area managed by Parks Canada, in the SW region of Tuktoyaktuk Peninsula (NWT, CA), near the Mackenzie River delta, the region with the highest concentration of pingos in the world. PCL's rare permafrost landforms have great geomorphological significance, but the Park's Inuvialuit heritage also has great cultural value, and, as evidence points to a rise in frequency and magnitude of erosion and permafrost degradation, linked to increased marine storms and higher air and sea temperatures, their preservation is dire. This study will characterize PCL's landscape and analyze it in the framework of regional climate change, according to the following approach: i. An ultra-high-resolution optical orthomosaic and DSM (10cm; July 2019) will be used to create a geomorphological map, focusing on permafrost features and man-made changes to the Park (e.g., vehicle tracks); ii. A very-high-resolution WorldView-2 scene (2m, 8 bands multispectral and 0,5m panchromatic; July 2017) will be used to create a vegetation community map, using supervised classification; iii. Archived Landsat imagery and aerial photos will be compared with the present-day landscape to detect changes; iv. A LiDAR survey (1m; 2004) will be compared with the 2019 DSM, through the calculation of morphometric variables; v. Climate, ocean and permafrost data will be used to identify factors contributing to landscape changes. The field data used was collected in the summers of 2018 and 2019. This methodology, supported by remote sensing data of unprecedented quality, will allow a fine characterization of PCL's landscape (including geomorphology and man-induced impacts). Also, the analysis of the landscape evolution, the assessment of that evolution's potential controlling factors and the comparison with future climate scenarios, will help estimate PCL's geoheritage areas more susceptible to degradation, and help better manage the Park in upcoming decades.

# 5. Atmospheric rivers in the Arctic: historical climatology and impacts

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Atmospheric rivers (ARs) are defined as elongated, narrow and transient corridors of strong horizontal water vapor transport. ARs are responsible for the majority of the poleward moisture transport in and across the midlatitudes. When reaching the Arctic, they cause a significant increase both in air temperature and precipitation amount, and can bring both snowfall and rainfall. This study presents the climatology of the ARs influencing the Arctic (crossing 70°N) during a 40-year period from 1980 to 2020 using MERRA-2 reanalysis. ARs are identified using two different tracking algorithms: a global algorithm by Guan et al. (2018) and a regional polar algorithm by Gorodetskaya et al. (2014; 2020). In the latter, we focused now only on potential ARs (pARs) defined as integrated water vapour (IWV) above a threshold (based on saturated IWV), with no geometrical criteria applied. The analysis includes AR frequency on annual, seasonal and monthly scales, and a more comprehensive analysis at specific sites located north of the Arctic circle and within different preferential AR pathways. Additionally, the impacts of ARs are analysed, focusing on changes in temperature and precipitation amounts and phase (rain and snow). Preliminary results from Gorodetskaya algorithm show a relatively high number of pARs over the Atlantic pathway, mainly during autumn and winter. However, during the summer, the Siberian pathway has a higher frequency of pARs, while the Canadian Arctic has a relatively low frequency of pARs during all year. Comparing the results from both algorithms, depending on the location and season, the global algorithm was found less restrictive, identifying more ARs when compared to pARs based on the regional polar algorithm. Focusing on the impacts of ARs, we find that in the Atlantic pathway, ARs have the most prominent impact on precipitation, contrary to the Siberian pathway where ARs have larger impacts on surface air temperature.

## 6. Using hydrodynamic and bathtub water-level models to assess the current and future storm surge flooding in Tuktoyaktuk

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Arctic warming is leading to an increased reduction in sea ice, with models for 2100 indicating a reduction in the Arctic sea ice area from 43 to 94% in September and from 8 to 34% in February (IPCC, 2021). The increase of the sea-ice free season duration will result in more exposure of the coasts to wave action, with changing climate also modifying the contribution of terrestrial erosion processes. Coastal erosion in permafrost regions can also be enhanced by warmer seawaters and sea-level rise, with more frequent storms and associated surge events. During the short open water season (June to October) there has been an increase in coastal storms in the Beaufort Sea (wind speed > 36 km/h and surge level > 1.5m), this has led to an increment in coastal erosion and flooding (Fritz et al., 2015, Ramage et al., 2018). This work focused on the Hamlet of Tuktoyaktuk (Northwest Territories, Canada), where ultra-high-resolution surveys with unmanned aerial vehicles (UAVs) have been conducted, allowing to generate orthophoto mosaics and digital surface models (DSM) that were used as inputs for a probabilistic bathtub-like flood model and MOHID Water hydrodynamic model. The results of the probabilistic model show that using the UAV data, that has a spatial resolution of 0.1 m, translates in precise overlaps with the modelled and real water surface, reducing the overall over-estimation of flooded areas obtained by using the 2004 LiDAR digital elevation model (DEM) with a 1 m spatial resolution. From the IPCC scenarios RCP4.5 and RCP8.5, respectively, it is expected that 29.2 to 32.2% of the study area is permanently submerged by 2100, only accounting for the sea level rise. These percentages can go up to 76.5 to 80% during a storm surge event with a 100-year return period.

## 7. Upscale classification of Antarctic vegetation: from drone Ground truth to Very high resolution and high resolution satellite images

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By understanding how vegetation classification can be accurately upscaled through the increasing pixel sizes of the different sensors, one can infer changes in vegetation cover through a broader set of available images and through a larger historic period of satellite coverage. In our study area, Barton Peninsula (king Jorge Island), the imagery ranges from the UAV images, with a spatial resolution of 2 cm/pixel and the multispectral satellite imagery with varying spatial scales: WorldView2, QuickBird, Sentinel2 and LANDSAT with 2, 2.4, 10 and 30 m/pixel, respectively. The upscale classification is expected to have a negative effect on the accuracy of the classification, so it is essential to understand variation throughout the scale jumps. This will allow for comparison of vegetation cover across multiple dates were the imagery available is from different sensors. Moreover, the adequate classification technique used to achieve the thematic maps can differ with the scale, given the usual size of the vegetation patches being smaller than the pixel size of some of the sensors. Summing up, the present work aims to achieve comparable thematic vegetation maps using different scale images and estimate the changes associated with this upscale. For this, the classification method is being refined among several techniques such as Support Vector Machines and Spectral unmixing. Once this stage is complete, it will be possible to compare the vegetation cover for a given area through the different datasets and estimate said cover in more remote areas where the acquisition of higher resolution images is difficult or even impossible.

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## 8. Determining the habitats and trophic ecology of Cephalopods in the Southern Ocean using Antarctic toothfish (Dissostichus mawsoni) as biological samplers

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The Southern Ocean is home to 75 species of Cephalopods. They play a major role in the Southern Ocean food webs but studies analysing their habitat and trophic ecology are scarce. Using the Antarctic toothfish Dissostichus mawsoni as a biological sampler, we studied the bathyal cephalopod fauna from the Ross, Amundsen, and D'Urville Seas. Ten cephalopod taxa were identified, with Pareledone turqueti and Moroteuthopsis longimana being the only species present in all the three seas. DNA analysis conducted on squid flesh samples allowed identification of eight Mesonychoteuthis hamiltoni and two M. longimana specimens, proving this technique as a useful tool to study the cephalopods diversity and biogeography in the Southern Ocean. Stable isotopes were used to compare the habitat ($\delta13C$) and trophic ecology ($\delta15N$) between two life-stages

of the two most abundant squid species (M. longimana and Psychroteuthis glacialis) from the Amundsen and D'Urville Seas. Higher $\delta$13C values in M. longimana suggest that this species inhabits waters near the Antarctic Polar Front, with incursions into sub-Antarctic waters, whilst P. glacialis spends its entire life in Antarctic waters. Higher $\delta$15N in adults of both species suggests an increase in trophic level during squid growth. These results provided the first insights into the bathyal distribution and the ontogenetic changes of two of the most important squid species consumed by the top predators, in the Amundsen and D'Urville Seas.

## 9. Weekly Fluctuations of Prokaryotic Planktonic Communities in a Changing Arctic Fjord

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The Svalbard Archipelago, in the Arctic Ocean, is among the most sensible regions to climate change on Earth. Microbial communities play an important role in this oligotrophic fjord ecosystem, by being at the base of the food web and crucially contributing to the biogeochemical cycles. However, the seasonal patterns in Arctic microbial community composition and abundance are still poorly understood. The objective of this study is to provide a baseline of successional patterns in microbial community composition in the period of time between April and September at weekly base, improving the temporal resolution of our current understanding, and complementing a long-term microbial monitoring program that has been implemented in the region since 2016. Water samples were collected at the surface (15m) and close to the seafloor (300m) at a mid-fjord station, every week during the Spring/Summer transition in 2019. Samples were filtered onto 0.2 μm sterivex filters for DNA extraction. The 16S rRNA genes from extracted DNA were further sequenced by a MiSeq Illumina platform and the sequences obtained were processed using DADA2 package in the R environment to characterize the structure and diversity of the prokaryotic communities over the sampling period. Our results showed that Proteobacteria dominated the Kongsfjorden pelagic microbial community. The alpha diversity analysis revealed an overall higher richness and diversity within samples at 300 m with respect to 15 m associated with a larger evenness in the former samples. The beta diversity analysis revealed a larger variability between samples at 15 m than at 300 m. Changes in salinity and temperature over time influenced the distribution of 15 m prokaryotic communities that revealed a loose community correlation network. These preliminary findings, together with future multi-year analysis, will be useful to predict the most probable targets of climate change on the planktonic prokaryotic communities in Svalbard fjords.

# 10. CONNECT2OCEANS - Connecting Atlantic and Arctic Oceans to Decipher Climate Change Impact on Plankton Microbiome Functions

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CONNECT2OCEAN project aim to understand how the progressive increase in Atlantic Water heat inflow to the Arctic, the so called 'Atlantification', will promote shifts in Arctic plankton microbiome diversity and functions. We hypothesize that the warming of North Atlantic water masses will increase the microbiological connectivity between the North Atlantic and the Arctic, by reducing temperature gradients between the two water masses, promoting new metabolic microbial functional regimes with ecosystem implications. Our hypothesis will be tested by integrating ongoing monitoring complementary projects, which are generating unique long¬term genomic microbiome data sets in the Arctic Ocean and North Atlantic by combining cutting¬edge methodologies and by crossing different types of data (genomic / metagenomic / biogeochemical / metadata). During the lifetime of this project, the long term monitoring data sets will be also complemented with controlled experiments to test the mixed effect of Atlantic Waters and Arctic Waters on microplankton diversity and functional shifts. Innovative microbiome monitoring technologies (autonomous eDNA sampler) will be developed and tested to extend microbiome data sets in the remote Arctic and Atlantic North environments, particularly urgent to cover Winter periods. This project will use environmental observations, experiments, and global data analysis in an interdisciplinary effort to produce reliable scientific data to better understand the interactions between climate change perturbations on the North Atlantic and Arctic microbial communities and their functions. Because microbiomes sustain crucial environmental functions that dictate for example oxygen, carbon dioxide and primary productivity balance in the Ocean, our scientific findings will help to understand processes of global significance and identify emerging risks as well as problems definition and prioritization.

## 11. Exploring the link between ecological functions and biosynthetic pathways in Arctic Ocean metagenomes

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The Arctic Ocean microbiome represents a rich source of metabolic functions which can include key biogeochemical transformations (e.g. N cycle) as well as pathways involved in the production of secondary metabolites (SM), associated with survival strategies. This highlights the relevance of these microbiomes in maintaining ecological functions and also in governing metabolisms with potential biotechnological applications, such as in bioremediation, or in the discovery of new natural products. However, there is still an absence of studies that investigate the metabolic and taxonomic connection between the microorganisms (MO) that are implicated in key ecological functions, like the nitrogen (N) transformations, and the microbial biosynthetic pathways. This study aims to fill this knowledge gap by studying the distribution of biosynthetic gene clusters (BGCs) and N cycle genes in metagenomes collected in the Arctic Ocean near the Svalbard Archipelago, in the scope of the N-ICE2015 Project. Our analysis were able to retrieve a total of 99 metagenome-assembled genomes (MAGs) were retrieved and assessed at taxonomic and functional levels. Several BGCs were identified with Terpene being the most abundant class. Results showed that the recovered BGCs were distributed by ten diverse bacterial and archaeal phyla, but some stood out as the most prolific ones, with BGCs associated with the production of novel compounds. In a more in-depth analysis of the 7 more complete MAGs, it was found the presence of BGCs associated with N transformation in some MAGs. These results suggest that MO involved in the denitrification process also have the ability to produce SM with potential biotechnological applications. Although the possible connection between these two metabolic pathways is still unknown and is currently part of our ongoing investigation, the richness of Arctic Ocean microbiome diversity and functionality is emphasized.

## 12. ARTICOMICS: Metagenomics-guided discovery of chemical diversity in the Arctic

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Cyanobacteria are recognized as one of the richest bacterial phyla regarding the production of natural products (NPs). Recent (meta)genomic studies have shown that cyanobacteria genomes englobe a large diversity of biosynthetic gene clusters (BGCs). Many of such BGCs are not associated with known NPs, highlighting the small fraction of currently known cyanobacterial metabolites. This knowledge gap occurs in part due to the difficulty to grow the cyanobacteria in laboratory or the difficulty to collect large amounts of biomass directly from the environment in non-tropical regions, which would be necessary to obtain biomass for the isolation of sufficient amounts of NPs for structural characterization. In particular, the polar regions remain a vastly untapped reservoir of bacterial biodiversity and of its associated chemical and biosynthetic diversity. NPs derived from polar organisms represent only 3% of all the described NPs, due to the difficulty to cultivate polar bacteria in laboratory. An alternative and promising route to NP isolation, involves capture and expression of BGCs in a heterologous host. In the ARTICOMICS project we will use a metagenomics approach to recover cyanobacterial metagenome-assembled genomes (MAGs) from underexplored cyanobacterial rich environmental samples collected in Svalbard Archipelago (Arctic). The proposed sampling locations in the Longyearbyen region, include the Sassendalen Valley, Foxfonna Glacier as well as Bjørndalen and Adventdalen regions. Biosynthetic gene clusters will be recovered from the MAGs, their diversity explored, and prioritized for heterologous expression, providing the foundation for secondary metabolite and enzyme discovery. This will be a valuable resource to discover new secondary metabolites and new biosynthetic enzymes, which expand our knowledge on the chemistry of life and have the potential to become future drugs or biocatalysts.

## 13. Response of extremophile microbial communities to diverse environmental disturbances

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Understanding the mechanisms that determine how the abundance and composition of microbial communities respond to environmental change are major challenges in microbial ecology. In this study we disturbed the soil microbial communities of two very different (e.g. edaphic factors, elevation) Antarctica Dry Valleys. The availability of water, nitrogen, carbon, copper ions and sodium chloride salts was increased in a laboratory-controlled disturbance experiment and the microbial communities structure was assessed for about two months. Our hypothesis was that in the absence of a clear biogeographic pattern soil microbial communities from Beacon and Miers Valleys would become more similar, over time, in response to the same environmental disturbance. The community turnover in the geochemically divergent soils of the two valleys, subjected to the same disturbance, did not converge with time. This was seen for both the 16S rRNA genes and the corresponding 16S rRNA transcripts data sets. Moreover, the response of the communities from each valley to these disturbances followed diverging hierarchical clustering. This suggested that even though both communities had been subjected to the same selective pressure their long isolation history had managed to create and maintain genetic heterogeneity amongst microbial communities. Our findings strongly support the occurrence of endemic microbial communities that show a structural resilience to environmental disturbances spanning a wide range of physicochemical conditions. In the highly arid and nutrient-limited environments of Antarctica Dry Valleys these results provide direct evidence that the microbial communities can exhibit biogeographic patterns across these cold deserts.

## 14. The spatial distribution and biogeochemical drivers of the Nitrogen Cycle genes in Antarctica Cold Deserts

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The Antarctica Cold Deserts (ACD) are an unique site to study microbial ecology and biogeochemical cycles at a fundamental level, because they represent an extreme environment. In fact, the year-round low temperatures, oligotrophic nature, limited water availability, high pH and salinity provide the conditions for very simple biological communities. Despite the simplicity of these communities, previous studies have found evidence for the presence of key biogeochemical pathways. For example, the identification of at least one gene implicated in each major Nitrogen (N) biogeochemical metabolic transformations. In this study our objective was to provide a deeper understanding on the spatial distribution of the genetic diversity of key N biogeochemical genes across the environmental gradients of ACD. Previous studies had several limitations, because they either focused on amplicon sequencing of single marker genes, or because they used metagenomic sequencing, but didn't provide details on each N pathway reaction. In this project we used metagenomes from 36 ACD sites and were able to provide the first full description of the major genes implicated in the N biogeochemical cycle (available at Kyoto Encyclopedia of Genes -- KEGG). Furthermore, by correlating the abundance and presence of the genes with each other, as well as with biochemical variables and geographic coordinates, we were able to integrate the N cycle mechanisms with its environmental context.

## 15. Microbiome diversity under bacterial and thermal challenges in Notothenioid fish

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Climate change is bound to modify the environmental conditions and biological interactions in the Antarctic Ocean. Notothenioid fish radiated over the past 10 million years and are known to have developed unique phenotypic features adapted to the stable and extreme cold environment. It is well established that many physiological functions are modulated by the relationship between the host and its microbiome. How such relationships or how microbiome composition will change in such novel scenarios is unknown. The microbiome of immune barrier tissues such as skin and gut, protect the host against foreign potential pathogens, however its composition remains to be explored among Notothenioids. The current study focused on the establishment of microbial community of these two tissues in Notothenia coriiceps and N. rossii and on the impacts of bacterial (LPS) and thermal (up to 6°C) challenges on microbial richness using 16S rRNA gene sequencing. The Proteobacteria, Cyanobacteria, Firmicutes, Fusobacteria and Bacteroidetes phyla were identified as the most dominant in all treatment groups while genera Allivibrio, Mycoplasma, Photobacterium and Cetobacerium were modified under LPS and increased temperature treatments. The number of common operational taxonomic units (OTUs) varied from 1 to 1935 in newly caught fish and from 1 to 145 in captive fish, while unique OTUs varied from 23 to 998 and 31 to 130, respectively. Our findings indicate that bacterial LPS and increased temperature, but also captivity, impact the bacterial community in the two tissues of the species studied. Thus, environment and physiology are important for microbiota diversity in Notothenioid fish but remains to be seen what are the impacts of a modified microbiome on the fish physiology and its adjustment to the current and future environments.

## 16. PERMAMERC - A new project to track mercury biogeochemistry in Arctic permafrost thaw ecosystems

João Canário (a);  Gonçalo Vieira (b); Catarina Magalhães (c); all the PERMAMERC team

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The recent increase in the global surface air temperature is having its greatest impact in the Arctic, and among other direct consequences, permafrost thaw is of urgent concern. Many contaminant studies in the Arctic have been focused on other environmental compartments rather than permafrost. In fact, only recently has special attention been directed to the study of heavy metals and POP's in permafrost environments. This issue is of special concern for mercury (Hg). It has been estimated that the Northern Hemisphere permafrost regions contain 1656 Gg of Hg, twice the amount present in ocean, atmosphere and soils combined. The relatively few Hg published permafrost studies have shown that Hg methylation in permafrost soils increases with increasing temperatures, and that permafrost thaw lakes provide the perfect environmental conditions for biotic Hg methylation. Notably, a study showed MMHg concentrations in the water column of thermokarst lakes were considerably higher than in other freshwater aquatic systems. However, in spite of these findings many questions remain open, such as: what are the rates of Hg methylation and MMHg demethylation in permafrost thaw environments, and what is the impact of permafrost thaw not only in the regional and global Hg cycle, but also on the arctic wildlife and northern human communities. PERMAMERC Project intends to contribute to the much-needed information for understanding the Hg cycle in permafrost thaw systems: from Hg methylation processes to gas exchange in permafrost thaw surface waters, and the key photochemical and microbiological processes involved. PERMAMERC will also contribute towards understanding the importance permafrost thaw in the global Hg cycle and will provide scientific based knowledge related to impacts on Arctic ecology, ecosystem services and human health.

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### 17. This is APECS: Shaping the Future of Polar Research

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From the International Polar Year resulted an important legacy known as the Association of Polar Early Career Scientists (APECS), a home for all undergraduate and graduate students, postdoctoral researchers, early faculty members, educators and others with interest in the Polar and Alpine regions and the wider Cryosphere. Our goals are to create a network of polar researcher across disciplines and national boundaries to meet, share ideas and experiences, and develop new research directions and collaborations. Moreover, we provide the opportunity for career development as well as education and outreach activities as an integral component of polar research to stimulate future generations of polar researchers. Nowadays, after 14 years, APECS already had more than 7500 early career scientists (ECRs) joining the network during the early stages of their careers and the current membership number is about 3800 from 76 different countries. Here, we highlight opportunities for training, leadership and skills development, such as the APECS International Online Conferences, the International Polar Weeks or even the Antarctica Day celebrations. These have been great opportunities for ECRs to develop valuable soft skills such as networking, communication and interdisciplinary knowledge, working near to several partners worldwide establishing strong links with them (e.g., SCAR, IASC, PEI or European Polar Board) and gaining leadership skills, such as team management. These examples demonstrate how APECS is training the next generation of polar leaders.

# COMUNICAÇÕES ORAIS | ORAL COMMUNICATIONS

## Ciências do Ambiente | Environmental Sciences

### 1. Remote sensing analysis of recent coastal change and its controlling factors in Darnley Bay (Amundsen Gulf, Canada)

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As the Arctic warms, permafrost coasts are experiencing high rates of erosion, threatening coastal communities and infrastructure, and altering sediment and nutrient budgets. However, some areas are still neglected by research. Darnley Bay is situated of the mouth of the Amundsen Gulf and is home to the Anguniaqvia Niqiqyuam Marine Protected Area. This area is home to Arctic char, cod, beluga whales, ringed and bearded seals, polar bears and sea birds. It is also an important area for the Inuvialuit ensuring the survival of their culture and food source. Settled in Paulatuk, the Inuvialuits are witnessing the warming of their territory and the degradation of the permafrost. This study aims to quantify coastal changes over 55 years at regional and locale scale coupled with a geomorphological characterization of the coasts, using a new very high resolution survey based on CNES Pleiades imagery from August 2020, as well as historical aerial photos from 1965. Key areas, such as Paulatuk, were surveyed using unmanned aerial vehicles in 2019. The results of the coastline change analysis indicate a small average erosion (-0.1 m/year) of the surveyed coastline, with very stable sections, which is due to its predominantly rocky composition. The coasts composed of unconsolidated materials show erosion rates of up to -3 m/year. These values are relatively low compared to other sites on the Beaufort coast, more susceptible to erosion due to soil composition, elevation and exposure to swells. The very high resolution geomorphological mapping and analysis of the Paulatuk has allowed the identification of landforms showing the degradation of the permafrost. A preliminary assessment suggest that the presence of infrastructure such as the airfield and associated building

and roads might influences the retention of thaw water, potentially leading to permafrost degradation at the surface. This study contributes to the general knowledge on Arctic erosion rates and associated landforms.

## 2. Variability of the atmospheric hydrological cycle in polar regions through water stable isotopes measurements in vapor, precipitation and firn cores

Christophe Leroy-Dos Santos (a,b); Amaelle Landais (b); Elise Fourre (b)

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It is key to estimate the evolution of the atmospheric hydrological cycle in the polar regions, which directly influences the surface mass balance of the Arctic and Antarctic ice caps. Records are available from satellite data for the last 50 years and a few rare weather data since the 50's in Antarctica. One of the best ways to access longer records is to use climate proxies in snow cores. The water isotopic composition in these cores is widely used to reconstruct past temperature variations. However, the link between temperature and isotopic composition is not very well constrained because many other parameters influence the isotopic composition of snow at the time of its formation or after snow deposition on the surface. We need to better understand the atmospheric hydrological cycle and its influence on the isotopic composition of vapour and precipitation in polar regions with the idea of improving the interpretation of snow core records in these regions. We first analyzed the longest series of vapor and precipitation isotopic composition measurements ever performed in a polar region: 4.5 years continuously at 78°N in Svalbard. The water isotopic composition at this measurement site was unsignificantly influenced by local processes. Thanks to this, we was able to attribute the observed winter variability to synoptic events and thus assign a different isotopic signature to the air masses according to their origin (Leroy-Dos Santos et al., 2020). Then, thanks to new technical solution presented here (Leroy-Dos Santos et al., 2021), we were able to measure the vapor isotopic composition all year round in Antarctica, at Dumont D'Urville station. I present the first two years of this new record. This unique series would make possible to document the isotopic signature of the atmospheric hydrological cycle in Terre Adélie all year round. These preliminary results open perspectives for the interpretation of recently drilled cores from the ASUMA program.

**3.**

## 3. Cloud supercooled liquid water measurements during the Antarctic Circumnavigation Expedition

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Mixed-phase clouds are important in Antarctica because of their role in precipitation and a strong radiative forcing. They are crucial to understanding the changes of the surface energy and mass balance. Cloud supercooled liquid water content (SLWC) impacts the ice growth processes via Bergeron-Findeisen process of ice growth at the expense of liquid droplets as well as SLW droplets riming on ice hydrometeors, which enhance surface precipitation. However, cloud thermodynamic phase simulation, in particular SLW, is one of the largest sources of bias in climate models. Therefore, advanced measurements of cloud microphysical properties are crucial to improve the knowledge about their impact on the Antarctic climate system. The Antarctic Circumnavigation Expedition (ACE), conducted between December 2016 - March 2017, provides 90 radiosonde profiles, from which 10 were equipped with cloud SLWC sensors manufactured by Anasphere. Vibrating wire-based instruments for measuring SLWC have been developed since 1980s and initially used in aviation to detect the potential icing hazards. Application of this sensor for research has been very recent, with SLWC measurements in midlatitudes (Serke et al 2014) and in the Arctic (Dexheimer et al 2019). This study is a pioneering step in using these sensors to understand cloud microphysics in Antarctica. The ACE data analysis shows the occurrence of single and multiple liquid layers below 5 km above sea level with SLWC up to 0.36 g/m3. Two specific cases are considered in detail: 1) on 2 February with snowfall; 2) on 15 February with a warm and moist intrusion but without precipitation. Building on the ACE results, measurements with SLWC sensors will be conducted during the PROPOLAR 2021-2022 campaign at the Antarctic Peninsula with the goal to understand cloud properties during warm air intrusions and impact on precipitation and/or melt. These projects are a contribution to the Year of Polar Prediction international initiative.

## 4. Daily ground surface temperature regimes and their spatial controls (Barton Peninsula, King George Island, Antarctic)

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The ground surface temperature (GST) is a function of topo and microclimatic factors that influence the energy balance between the atmosphere and ground surface and is an important variable controlling biophysical processes in the soil, as well as for evaluating permafrost. In order to assess the relevance of the controlling factors on GST in Barton Peninsula, King George Island (Antarctic Peninsula), 20 miniloggers were installed according to altitude, exposure, curvature and distance to late-lying snow patches, at 2cm depth. The temperatures, recorded at 3-h intervals, from March 2019 to February 2020, allowed the analysis of the GST and the identification of the patterns of daily ground temperature regimes. Multiple Factorial Analysis (MFA) allowed to identify the most relevant controlling variables, and Discriminant Analysis allowed to model the probability of spatial distribution of GST regimes. The mean annual ground surface temperatures ranged from -2 to 0.6 °C. The freezing season started in April 2019 and lasted until October 2019, with 438 to 1041 FDDs, depending on site-specific conditions. Daily GST regimes were classified into three frozen types, two unfrozen types, and 2 regimes with freeze-thaw. The temporal analysis of the occurrence of these regimes allowed to identify different patterns, depending on the topo and microclimatic setting. The MFA showed that GST and daily ground thermal regimes were strongly controlled by elevation, potential summer solar radiation, aspect, and by snow cover. This emphasises on the need to properly account for snow dynamics for an accurate modelling of ground temperatures, but also to understand the processes that are impacted by the different temperature regimes.

## 5. The relevance of using Unoccupied Aerial Vehicles (UAV) in Antarctica

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The recent global emergence of Unoccupied Aerial Vehicles (UAVs or drones) has also allowed researchers obtaining data with unprecedented detail in Antarctica, more frequently and in safer and cheaper ways. To understand the relevance of such development we present a picture capturing the whole scene, yet unavailable, through a comprehensive review about the use of UAVs in the scientific activities developed in Antarctica. It is based on the analysis of 174 scientific publications (full papers) published in peer-reviewed journals and proceedings of conferences. The first paper on the topic was published in 2006, showing since then a consistent growing trend (near 40 papers published in 2021), which we organize into six main application topics: Terrestrial or ice-free areas (28%), Ice and Snow (24%), Fauna (19%), Technology (15%), Atmosphere (12%) and Others (2%). The majority of the field surveys are developed in the South Shetlands and Antarctic Peninsula and also in Terra Nova Bay, mostly where stations are located. On average each paper is written by 5 researchers and although the collaborations show they come from up to 4 different countries, more than 75% of the papers are published from authors of the same country. Although most of them originate from the largest countries, there are also many relevant publications from several smaller countries. Also, the gender of the first author of each paper shows an expected disparity (78% are male), but a recent trend seems to show a desired decrease in the gender gap and a bridging effect. The critical analysis encompasses a detailed overview of the activities developed in each topic of research, namely the scientific purposes, the description of the datasets acquired and the results obtained, and also the type of platforms and sensors used. We identify advantages and difficulties, and also evaluate future possibilities and challenges for the use of UAVs in Antarctica.

## 6. Remote sensing and *in situ* observations of solid precipitation around the coast of Adélie Land, East Antarctica

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The Antarctic Ice Sheet (AIS) is the largest ice mass in the world and has great potential to contribute to sea level rise in the future, driven by climate change. Precipitation is the main input term in the surface mass balance of the AIS, yet it remains poorly understood in current climate models, mainly because of the lack of observations in this extreme environment. Ground-based remote sensing have become a robust tool for monitoring precipitation in the Antarctic region in high temporal and vertical resolutions, complemented with in-situ observations. Since November 2015, the French project APRES3 (Antarctic Precipitation, Remote Sensing from Surface and Space), has contributed with a unique dataset to study clouds and precipitation on the coast of Adélie Land, at the Dumont d'Urville station (DDU), East Antarctica. Observations include a 24 GHz vertically pointing micro rain radar (MRR-2) that measures Doppler moment profiles to characterize snowfall; lidar profiles with depolarization capability used to detect supercooled liquid water in mixed-phase clouds; a snow gauge to quantify the in-situ snowfall rate; disdrometers to obtain ice particle size distributions; a high resolution multi-angle snowflake camera to capture the ice particle microphysical properties (e.g. shape, size, riming level), among other weather observations. There are also other experiences in the Antarctic region, using MRR and insitu measurements of precipitation such as Princess Elisabeth and Mario Zuccelli stations, and more recently on board the vessel Akademik Tryoshnikov, as part of the Antarctic Circumnavigation Expedition (ACE, austral summer 2016-17). This study presents an overview of the current challenges in the observation of precipitation in the Antarctic continent and the advantages and limitations of using remote sensing. This work also analyzes in detail the precipitation event occurred on Feb. 2, 2017, measured simultaneously at the DDU station and by the ACE mission.

## 7. The importance of considering the biotic interactions to model present and future Antarctic vegetation

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Antarctica is a highly vulnerable region to climate change. The harsh environmental conditions forged a simplified terrestrial ecosystem, where bryophytes, lichens and vascular plants constitute the bulk components of the vegetation. Predicting Antarctic vegetation change due to climate change implies considering both the direct effects of climate and the biotic interactions between vegetation types. However, these abiotic and biotic effects have not yet been simultaneously quantified. We tested the importance of considering both climate and vegetation interactions using a non-destructive sampling methodology in 150 sites along a spatial climate gradient in two islands of the Antarctic Peninsula region. We identified the main climatic drivers and linked them with the measured abundances using a structural equation modelling. Including links among the main vegetation types resulted in the best-fitting model, which was used to quantify the interactions between the three vegetation types, predict their present spatial distribution and expected changes under future climate change scenarios.

# 8. Ocean Tides Around Cierva Cove

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Ocean Tides around Antarctica are less well known than in other parts of the world. This is caused by the lack of in-situ tide gauges and the fact that most satellite altimetry missions do not cover the polar regions. Floating ice shelves, which occupy about three quarters of the perimeter of Antarctica, rise and fall in synchrony with the ocean tide which also influence the push and pull forces on these ice shelved. Therefore, ocean tides provide insight into the ice sheet mass balance and dynamics. In this research we focus only on the ocean tides around Cierva Cove. In the scope of the LATA2015, a GNSS receiver was installed at station Prima Vera on the Antarctic Peninsula. Data was collected during LATA2017 and LATA2019. During the last campaign the ocean tide in front of the station was observed using a pressure sensor and tidal gravity for several days. However, by observing the effect of the GNSS reflected signal from the sea level on the total received signal, one can estimate the sea level height. We present here the results of analysing all available GNSS data at the station. The pressure sensor data were used to validate the values. Although the GNSS derived sea level estimates are noisy (RMS of around 10 cm), having long time series produces estimates of the main tidal harmonics with cm level accuracy.

## 9. Ocean Planning in the Poles: A Comparative Analysis of Governance Challenges and Practices

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The Arctic and Antarctic are two of the Earth's most special places, both have significant environmental, scientific, historic, and intrinsic values, all of which are worth protecting. With the acceleration of global environmental change and the increase of human activities and related pressures in these regions, developing sustainable ocean planning and governance is crucial. Marine spatial planning (MSP) is a process and approach that allows for the balancing of multiple social, economic and political objectives while ensuring a healthy ocean. The advantages and limitations of developing MSP in polar regions have been discussed by some authors over the past few years. Still, a comparative analysis of MSP-related governance challenges and practices in the Arctic and the Antarctic has not been developed so far. The present study addresses this gap by investigating the existing MSP initiatives and governance mechanisms for the Arctic and Antarctica; identifying the main challenges, issues, and constraints related to such initiatives; and pinpointing a set of recommendations to overcome identified challenges and support the sustainability in the use of the ocean. The study builds on a number of dedicated interviews carried close to renowned scientists and experts on polar regions, as well as on the results from a global online survey on the topic, which collected c. 205 responses from over 31 countries.

## 10. Long Term Changes at Southern Ocean Squid Ecology

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Long-term studies of pelagic nekton in the Southern Ocean and their responses to ongoing environmental change are rare. We used stable isotope ratios measured in squid beaks recovered from diet samples of wandering albatrosses Diomedea exulans, and assessed decadal variation (from 1976 to 2016) in the habitat ($\delta$13C) and trophic level ($\delta$15N) of five important Southern Ocean squid species in relation to indices of environmental conditions—Southern Oscillation Index (SOI) and Southern Annular Mode (SAM). Based on $\delta$13C values, corrected for the Suess effect, habitat had changed over the last 50 years for Taonius notalia, Gonatus antarcticus, Galiteuthis glacialis and Histioteuthis atlantica but not Moroteuthopsis longimana. By comparison, mean $\delta$15N values were similar across decades for all five species, suggesting minimal changes in trophic levels. Both SAM and SOI have increased in strength and frequency over the study period but, of the five species, only in Taonius notalia did these indices correlate with, $\delta$13C and $\delta$15N values, indicating direct relationships between environmental conditions, habitat and trophic level. The five cephalopod species therefore changed their habitats with changing environmental conditions over the last 50 years but maintained similar trophic levels. Hence, cephalopods are likely to remain important prey for top predators in Southern Ocean food webs, despite ongoing climate change.

## 11. Diversity and distribution of Arctic protists using metabarcoding approach

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Climate change is affecting the Arctic Ocean through the decrease of sea ice extent and thickness and, consequently, the dynamics of phytoplankton has been changing, radically redefining the biogeography of marine Arctic ecosystem and, consequently, phytoplankton diversity and bloom dynamics. In this study we present a comprehensive analysis of diversity patterns of the Arctic protists (including phytoplankton) along two oceanographic transects in the Svalbard region connecting Atlantic-influenced Kongsfjorden with Fram Strait and Arctic Rijpfjorden with the Nansen Basin. Whereas relatively warm Kongsfjorden has lost most of its winter sea ice cover over the last two decades, Rijpfjorden is a cold fjord, with frequently abundant sea ice cover even in summer. This space for time approach is a proxy to evaluate the warming trends affecting the Arctic marine environment. Fieldwork was performed during the Environmental Monitoring of Svalbard and Jan Mayen (MOSJ) cruise in summer 2016. Water samples were collected from 11 stations at three depths [surface, deep chlorophyll maximum (DCM) and above the seafloor] and filtered through sterivex 0.22 μm pore size filters. Metabarcoding analysis was performed using the rRNA 18S-V4 gene region. Results showed that these Arctic environments comprise complex and diverse protist communities, with links between protist communities and environmental gradients. We found clearer distinction among surface, bottom and DCM samples at Kongsfjorden than Rijpfjorden. Surface and DCM communities were quite different between the two transects, whereas deeper samples were more homogeneous. We hypothesize that light availability and the relative predominance of different water masses explain the observed patterns, impacting the structure of protist communities. This study could help to fill critical gaps concerning the evaluation of the response of the changing protist microbiome in response to climate change impacts.

## 12. Antarctic Biodiversity "hotspots": relevance for conservation of marine ecosystems

José C. Xavier (a, b); José Abreu (a, b); Patrícia Fialho (c); Filipa Bessa (a); Filipe R. Ceia (a); Joana Fragão (a); Hugo Guímaro (a); Vítor H. Paiva (a); José Queirós (a, b);  Marta E. Santo (d)

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Southern Ocean ecosystems are under pressure from resource exploitation and climate change (Xavier & Convey 2020, Caccavo et al. 2021). As mitigation requires the identification and protection of Antarctic biodiversity marine hotspots, in this presentation, we review the most recent research papers from our group on this issue. Areas of ecological significance were found in the Southern Ocean, based on > 4000 tracks of 17 bird and mammal species, around sub-Antarctic islands and over the Antarctic continental shelf (Hindell et al. 2020), with 37.9% of these areas being fished today (i.e. with a moderate to high fishing effort). Oligotrophic areas of the Southern Ocean are more productive that previously thought (Jones et al. 2021). These hotspots have regional importance but also in the wider Earth system due to the global connectivity of the Southern Ocean (Murphy et al. 2021). Similarly, threats to these biodiversity hotspots include pollution. Microplastics in penguins scats showed that they already entered the Antarctic marine food chain in various penguin species (Fragão et al. 2021). Future efforts to model Southern Ocean marine foodwebs must be able to compare ecosystems structure, function and response to change (Hill et al. 2021), based on basic biological and ecological information (Xavier et al. 2020, Xavier & Cherel 2021) addressing gaps of knowledge (Gutt et al. 2021). Finally, the presentation will also review the relevance of the education and outreach initiatives carried out to engage all relevant stakeholders.

# 13. Microplastics and other anthropogenic particles in Antarctica: Using penguins as biological samplers

Joana Fragão (a); Filipa Bessa (a); Vanessa Otero (b,c); Andrés Barbosa (d); Paula Sobral (e); Claire M. Waluda (f); Hugo R. Guímaro (a); José C. Xavier (a, f)

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Microplastics (< 5 mm in size) are known to be widespread in the marine environment but are still poorly studied in Polar Regions, particularly in the Antarctic. As penguins have a wide distribution around Antarctica, three congeneric species: Adélie (Pygoscelis adeliae), chinstrap (Pygoscelis antarcticus) and gentoo penguins (Pygoscelis papua) were selected to evaluate the occurrence of microplastics across the Antarctic Peninsula and Scotia Sea. Scat samples, were collected from breeding colonies over seven seasons between 2006 and 2016. Antarctic krill (Euphausia superba), present in scat samples, contributed 85%, 66% and 54% of the diet in terms of frequency of occurrence to the diet of Adélie, gentoo and chinstrap penguins, respectively. Microplastics were found in 15%, 28% and 29% scats of Adélie, chinstrap and gentoo penguin respectively. A total of 92 particles were extracted from the scats (n = 317) and 32% (n = 29) were chemically identified via micro-Fourier Transform Infrared Spectroscopy. From all the particles extracted, 35% were identified as microplastics, particularly polyethylene (80%) and polyester (10%). It was not possible to ascertain the identification of the remaining 10% of samples. Other anthropogenic particles were identified in 55% of samples, identified as cellulose fibres. The results show a similar frequency of occurrence of particles across all colonies, suggesting there is no particular point source for microplastic pollution in the Scotia Sea. Additionally, no clear temporal variation in the number of microplastics in penguins was observed. Overall, this study reveals the presence of microplastics across Antarctica, in three penguin species and offers evidence of other anthropogenic particles in high numbers. Further research is needed to better understand the spatio-temporal dynamics, fate and effect of microplastics on these ecosystems, and improve plastic pollution policies in Antarctica (Fragão et al. 2021).

## 14. Integrating biodiversity and genetic approaches into sub-Antarctic deep sea research

Rui Vieira (a); Kerry-Lee Etsebeth (b);  Michelle Taylor (b)

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The South Georgia and the South Sandwich Islands are a chain of sub-Antarctic volcanic islands located in the Atlantic sector of the Southern Ocean. Both the South Sandwich and South Georgia islands are internationally important sites for higher predators, hosting some of the largest populations of seabirds and marine mammals. Furthermore, South Georgia is recognised as an internationally important site due to its abundant, diverse and unique benthic marine fauna. Whilst considerable research has been undertaken at South Georgia, comparatively little is known from the South Sandwich Islands. In this context, two multidisciplinary expeditions around South Georgia and the South Sandwich Islands were conducted to investigate diversity and distribution of epibenthic macro- and megafauna. Using data from drop camera imagery, selected indicator morphotaxa were mapped along the slopes, showing a substantial variation in taxon composition and frequency of occurrence, both along bathymetric and latitudinal gradients. This new information reveals aspects of ecological processes underpinning benthic biodiversity, and is crucial to understanding benthic productivity, speciation, and how adverse environmental conditions impact benthic communities (e.g. climate change). Deep-sea coral tissue samples were also collected for genetic analyses, and combined with historical samples, to investigate population structure and drivers of connectivity across this rapidly-changing region. Combining environmental and genomic data to examine gene flow allows an understanding of the processes that underpin ecological stability, dispersal pathways and genetic linkages between different populations across the South Atlantic Antarctic region. This information is required to make sound management decisions to protect the most ecological valuable (e.g. ecosystem services), diverse and/or well-connected areas, thereby maintaining large enough effective population sizes and sustainability.

## 15. Cephalopods in the diet of Snares penguins: relevance to conservation of an endemic penguin species

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Cephalopods play an important role as prey to top predators in the food webs of the Southern Ocean, but relatively little information is available regarding their biology and distribution. Penguins are apex predators known to feed on cephalopods around their breeding colonies, and thus good biological samplers at a local scale. Here, was used the top predator endemic to Snares Islands (New Zealand), Snares penguin (Eudyptes robustus), to evaluate the cephalopod component of their diet and the habitat and trophic levels of the cephalopods (as well as ontogenic changes) through stable isotope analysis (SIA). Historical data on this penguin species is rare but our data collection were carried out during the breeding season 1986–87. The data reveal that only three juvenile cephalopod species – two squids (Nototodarus sloanii and Moroteuthopsis ingens) and one octopod (Octopus campbelli) – were prey to Snares penguin. Regarding SIA analysis, habitat information ($\delta$13C) suggested that all cephalopods occupy a similar habitat, whereas juvenile O. campbelli showed lower $\delta$13C values. Moreover, when looking for trophic level ($\delta$15N) information, the octopus species fed on higher trophic level prey relative to squid species. Furthermore, our results suggest that there was no overlap between the foraging of Snares penguin and cephalopod fisheries in Snares island waters, but lower diversity and larger sizes of cephalopods species were found when compared with recent studies. This study shows that Snares penguin can be a valuable bioindicator for understanding biogeographic patterns of cephalopod diversity at a local scale, as well as providing relevant historical information for the conservation of this endemic seabird (Guímaro et al. 2021).

## 16. Net Ecosystem Metabolism of Kongsfjorden (Svalbard)

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Net Ecosystem Metabolism (NEM) is a measure of ecosystem functioning, allowing to quantify the relative importance of autotrophy/heterotrophy and whether an ecosystem is a carbon sink or source. It thus provides a direct link to the magnitude of important ecosystem services. The concept may be used to follow ecosystem functioning over time and how it is affected by global warming. Kongsfjorden is a high latitude fjord located in West Spitsbergen. Over the last years it became almost sea-ice free in Winter. The main goal of this study is to get insight into Kongsfjorden NEM as a first step towards a better understanding about how warming will affect the carbon sink-source role of coastal Arctic ecosystems. The Land-ocean interactions in the coastal zone (LOICZ) approach is a method designed to calculate NEM. In this study the LOICZ method is combined with results from mathematical modeling and bibliography sources. From the obtained results a few general trends emerge: (i) nitrogen river inputs are in the order of tens of tons per year and compare with atmospheric nitrogen precipitation; (ii) nitrogen removal by birds is probably one order of magnitude lower than the previous inputs; (iii) exchanges with the sea are by far the largest ones with values in the order of $2 \times 10^4$ to $2 \times 10^5$ tons per year for inorganic nitrogen, 3000 - 4400 tons per year for zooplankton nitrogen and 200 – 4000 tons per year for phytoplankton nitrogen. Since the concentration gradients increase from the fjord to the sea it is likely that the net exchange of nitrogen is from the sea into the fjord and that its NEM is larger than zero corresponding to a predominantly autotrophic functioning and a nitrogen and carbon sink role. This study should be enlarged to other Arctic fjords, more or less affected by global warming, towards an in-depth understanding of predictable changes in NEM in Arctic coastal waters as warming trends progress.

## 17. Solidifying previous knowledge on the types of prokaryotic rarity in the Arctic ocean by using novel methodologies and analytical approaches

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The Arctic ocean environmental conditions are changing rapidly due to climate change. One important question regarding the response to these changes at the microbial level is on whether the rare biosphere plays an important role or not. Generally, the rare biosphere has been recognized as a seed bank that can respond to changing conditions, thus providing resistance and resilience to the ecosystem. Notwithstanding, most studies on the microbial rare biosphere of the Arctic ocean have found it to be essentially always rare, with only a minor fraction oscillating between rare and abundant with changing seasonal or geographical conditions. The objective of this work was to further explore the patterns of the types of rarity in the Arctic ocean, using the Norwegian Young Sea Ice Expedition (N-ICE) 2015 data, which includes molecular data (16S rRNA amplicons and total community DNA shotgun sequencing -- metagenomes) of a winter to spring transition. By using novel molecular methods and analytical pipelines we were able to compare how different methodological variations influence the interpretation of the rare biosphere ecology in the Arctic ocean. Specifically, we found that factors such as rarefaction of data, different definitions of rarity or the utilization of either 16S derived ASVs or OTUs did not change the interpretation of the rare biosphere ecology in this environment. We further found that the combination of traditional 16S rRNA amplicon sequencing with metagenomes can improve the description of the rare biosphere. Overall, despite using novel methods and different sampling points, we found the same pattern for the rare biosphere as was previously identified most rare taxa do not seem to be responding to changing conditions --, thus solidifying the knowledge of the types of rarity in the Arctic ocean.

## 18. Untangling local and remote influences in two major petrel habitats in the oligotrophic Southern Ocean

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Ocean circulation connects geographically distinct ecosystems across a wide range of spatial and temporal scales via exchanges of physical and biogeochemical properties. Remote oceanographic processes can be especially important for ecosystems in the Southern Ocean, through the Antarctic Circumpolar Current (ACC). Recent tracking studies have indicated the existence of two large-scale, open ocean habitats in the Southern Ocean used for extended periods by grey petrels (Procellaria cinerea) from two populations (Kerguelen and Antipodes islands) during their nonbreeding season in the austral summer (October to February). In this work, we used a novel combination of large-scale oceanographic observations, surface drifter data, satellite-derived primary productivity, numerical adjoint sensitivity experiments, and output from a biogeochemical state estimate to examine local and remote influences on these grey petrel habitats. Our aim was to understand the oceanographic features that control these isolated foraging areas and to evaluate their ecological value as oligotrophic open ocean habitats. We showed that less than 1% of the estimated local primary productivity was sufficient to support these populations. The region in the southeast Indian Ocean used by the birds from Kerguelen is connected by circulation to the productive Kerguelen shelf. In contrast, the region in the south-central Pacific Ocean used by the grey petrels from the Antipodes is relatively isolated, suggesting more influence by local factors or the cumulative effects of many seasonal cycles. This work exemplifies the potential use of predator distributions and oceanographic data to highlight areas of the

open ocean that may be more dynamic and productive than previously thought. Our results highlight the need re-evaluate the ecological relevance of oligotrophic Southern Ocean regions from a conservation perspective.

# COMUNICAÇÕES ORAIS | ORAL COMMUNICATIONS

Ciências Sociais | Social Sciences

## 19. Mission Challenges and Collective Responses During a Two-men Moon Analogue Mission in the Arctic

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Teamwork in isolated, confined, and extreme (ICE) environments is key to ensure mission success in the polar regions. Whereas the mission challenges of working in ICE environments have been identified before (i.e., stressors related to the mission, the environment, or the crew), there have been few empirical efforts to find how they happen during missions and their relationship with team processes (i.e., collective behaviors that are goal-driven) and outcomes (i.e., cohesion; performance). To tackle this limitation in the current literature, this research has combined qualitative and quantitative methodologies to describe the occurrence of factors affecting human adaptation in ICE environments, and how team processes and team outcomes co-evolve with those. Data was collected during a 3-month moon analog mission in the artic circle. Participants in this research were two male volunteers. Data was collected from 6 weekly surveys, plus 90 daily satellite-phone messages sent by the crew during the mission. Our findings suggest that over 90 days, participants reported the occurrence of 51 events that fall onto one of 5 mission challenges: Habitability (N= 7), physical and mental health (N= 4), mission attributes (N= 14), and physical conditions (N= 27). The highest frequency of events was during the 2nd and 11th weeks of the mission. Interestingly, our findings also highlight the fact that participants reported a decreased in the need to change their processes as an adaptation strategy from the 6th week onwards. This finding also speaks to the fact that participants reported an increase in team cohesion and team performance. Although descriptive, our results suggest that the temporal trajectories of mission challenges, team processes, and team outcomes not always co-evolve in a way that aligns with what theory would suggest.

# COMUNICAÇÕES ORAIS | ORAL COMMUNICATIONS

## Educação Polar | Polar Education

### 20. Steps to boost Polar Education in Portugal: Action and Outreach

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In Portugal, there is evidence that in the past few years has been successfully created the space, resources and momentum to better connect scientists and educators through its educational activities and collaborations. Working with other countries, as well as with the contribution of Polar Educators International (PEI) and the Association of Polar Early Career Scientists (APECS), our country, since the International Polar Year (IPY) 2007-2008, is highly involved in education and outreach (Kaiser et al. 2010; Xavier et al. 2019). In this presentation, we review the most recent and relevant educational activities developed in collaboration with APECS and PEI, in connection with other organizations (e.g. Portuguese Polar Program - PROPOLAR, Antarctic Treaty System, Scientific Committee on Antarctic Research). These activities engaging scientists and educators contribute to define a common and effectively strategy to communicate polar knowledge (Xavier et al. 2019). However, continue to be perceived as extra-curricular in both educator and researcher communities, where professional recognition, perceived value and investment of resources are still lacking. In Portugal, in the last years, we are taking steps to bring the Polar Science to the Portuguese Curriculum, developing didactic activities with the second cycle students, and keep highly in long-term events, such as POLAR WEEKS and PEI national/International Workshops. This presentation will show the most important results. This way, we are working to change this culture and conduct activities that help to boost science-educational links need to be a continued area of focus for broader science and education polar communities (Roop et al. 2019).

## 21. APECS Portugal as a tool to boost the next generation of polar researchers

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The Polar Regions and the Cryosphere are known to influence the world, mainly through their role in key processes such as climate change, sea level rise and oceans circulation. Moreover, raise awareness of our changing world is crucial for us to protect our planet. The portuguese Association of Polar Early Career Scientists is a branch of the international association (APECS) in Portugal with the same values and goals. That is, we facilitate networking between senior polar researchers and Portuguese early career scientists (ECRs) across disciplines to enhance the development of new research directions and collaborations; and we provide career development opportunities, as well as education and outreach activities, as an integral component of polar research to stimulate future generations of polar researchers. Here, we highlight opportunities for training, leadership and skill development offered by APECS Portugal. We are committed to polar science communication, working on diverse education and outreach activities with APECS International, Scientific Committee on Antarctic Research (SCAR), Antarctic Polar Treaty, Polar Educators International (PEI), and

endorsed by the Portuguese Polar Program (PROPOLAR). In the past 12 years, we provided to ECRs many opportunities to develop valuable soft skills such as networking, communication and interdisciplinary knowledge, through activities such as the International Polar Weeks, workshops, lectures and webinars with polar scientists, and our blog "Open Science". These activities have involved more than 100 000 students, 300 schools, 2 000 educators and 150 polar scientists from more than 20 countries over the years. These examples demonstrate how APECS Portugal is training, as well as helping shape the next generation of polar scientists.

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