



The Changing Poles: how Antarctic and Arctic science helps to inform and prepare the EU for changes in sea level rise and the global climate

Policy Brief
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Pictures provided by OCEAN:ICE and Arctic PASSION projects.



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Introduction: The Importance of Polar Science to Europe

Climate change is recognised as one of the biggest threats facing modern society, with the UN's Intergovernmental Panel on Climate Change (IPCC) stating with very high confidence that "Climate change is a threat to human well-being and planetary health." Whilst climate change may pose some of the greatest challenges and opportunities humanity has faced, it is the polar regions that are most susceptible to global warming. The poles are also where climate-induced changes could have the largest impact on life in other regions of the world: ice sheet loss leading to sea level rise, acceleration of surface warming as the polar oceans stratify, and thawing permafrost leading to additional unaccounted-for greenhouse gas release.

In addition to acting as a bellwether for the global climate, the socio-economic repercussions of environmental shifts extend well beyond the poles, influencing extreme weather patterns, biodiversity, and sea level rise. These shifts impact infrastructure planning, food security, global trade, energy security, natural disaster preparation, migration, and a host of other critical socio-economic and policy areas in the European Union and beyond. Scientific analysis from the ad hoc network of observations conducted in the polar regions have a direct impact on the ability of policymakers to make informed and urgent decisions on climate change mitigation and adaptation. However, this network is far from complete and lacks integration.

To deliver this knowledge, sustainable and fully-integrated observing systems are needed at both poles. This can only be achieved through the combined efforts and capacity of multiple countries to better coordinate and integrate their research projects, infrastructure and long-term monitoring. Research networks like the EU Polar Cluster¹, which includes the projects OCEAN:ICE² and Arctic PASSION³, help bring

together partners from across nations, disciplines, and sectors. By working together we are finding answers to the most relevant questions and improving coordination within the polar research community, along with the flow of knowledge to decision makers.

The European Union, through several programmes and initiatives such as Horizon, Copernicus, and the European Space Agency, remains a leader in funding large, interdisciplinary polar research projects. The results of these groundbreaking programmes help to inform policy priorities both for today and for a more resilient, inclusive, low-carbon society and economy in the future. Two of these funded projects - OCEAN:ICE and Arctic PASSION - are delivering new knowledge and data for adaptation and mitigation: OCEAN:ICE fills data gaps related to the interaction between the Southern Ocean and the Antarctic Ice Sheet, with direct consequences for predicting future of sea level rise, tipping points, and the wider global climate. One major obstacle to these observations is the lack of an integrated observing network - something which Arctic PASSION aims to ameliorate in the Arctic - which limits our ability to mitigate the effects and long-term implications of change in the polar regions.

This brief aims to convey the findings and goals of these projects, the challenges still present, and the importance of sustained and committed EU research funding for polar science into the future. The associated policy briefing provides an open forum for influential Europeans to enter into a dialogue with key European polar scientists. The session will demonstrate the dramatic climate-driven changes that are occurring in polar regions, along with their global impact. It will also provide evidence of how an inclusive, sustained observing system can inform ambitious mitigation and adaptation efforts.

This policy briefing is organised by the European Polar Board (EPB) with assistance from the European Parliament Intergroup European Bureau for Conservation and Development (EBCD) on behalf of the EU-funded projects OCEAN:ICE and Arctic PASSION.

¹ <https://polarcluster.eu/>

² <https://ocean-ice.eu/>

³ <https://arcticpassion.eu/>

Global mean sea level change relative to 1900

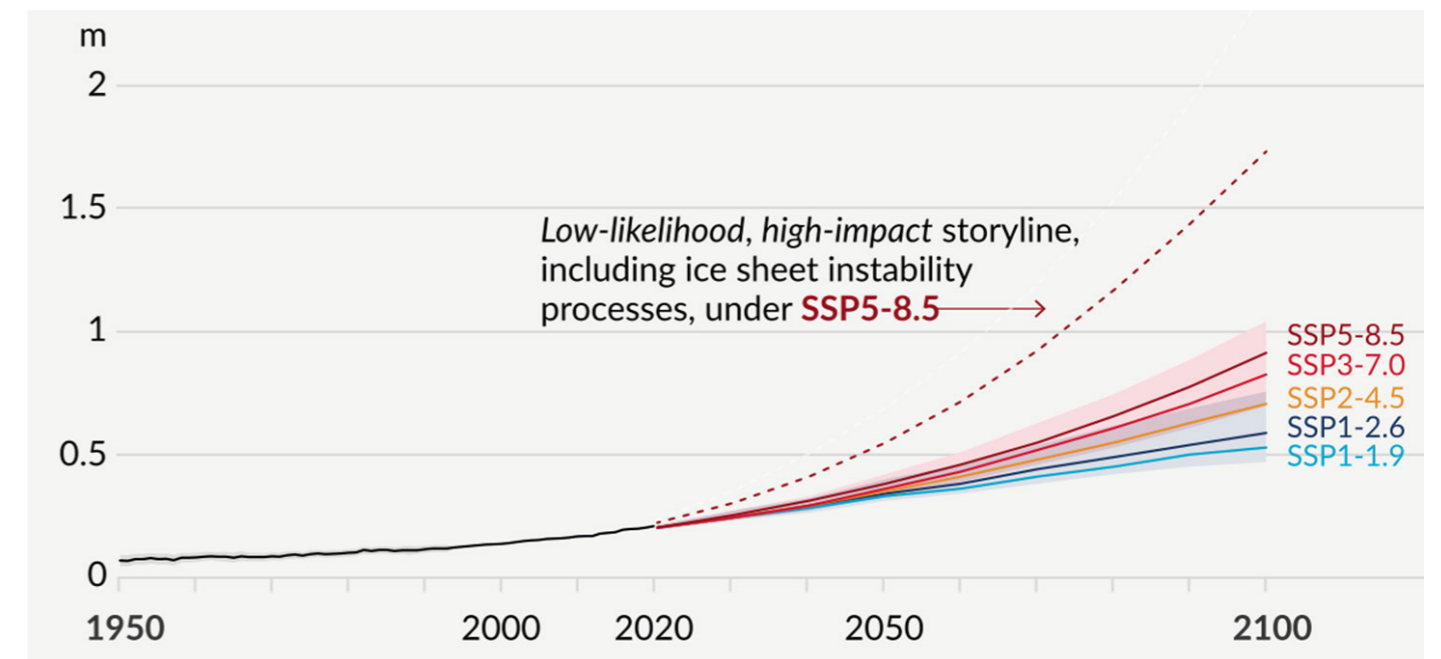


Figure 1. IPCC AR6 projections of future sea level rise under different emissions pathways. The blue line represents the Paris Agreement targets. The dashed line shows estimated sea level rise due to potential rapid collapse of the West Antarctic Ice Sheet via processes that are poorly understood.

The above graphic shows projected sea level rise to the end of 2100 as predicted in the IPCC Assessment Report 6 (2021). Critically however, these model projections do not incorporate all known processes that are important for predicting Antarctic or Greenland Ice Sheets. More importantly, due to scientific and technical limitations in existing state-of-the-art global climate models, recent work has shown they may be significantly underestimating the pace of ice sheet response to a warming climate. The dashed line shows potential sea level rise that expert surveys suggest is possible under potential ice sheet instability scenarios. Such scenarios are 'low likelihood' but potentially devastating to coastal infrastructure, and highlight the importance of improving our observations of the change and dynamics of the polar ice sheets if we are to accurately forecast such changes in the coming decades. Sea levels will continue to rise for centuries, even after emissions are stabilised.

Credit: Figure 9.27 in IPCC, 2021: Chapter 9. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Fox-Kemper et al, DOI: 10.1017/9781009157896.011.]

Effects of 2 metre sea-level rise in Europe

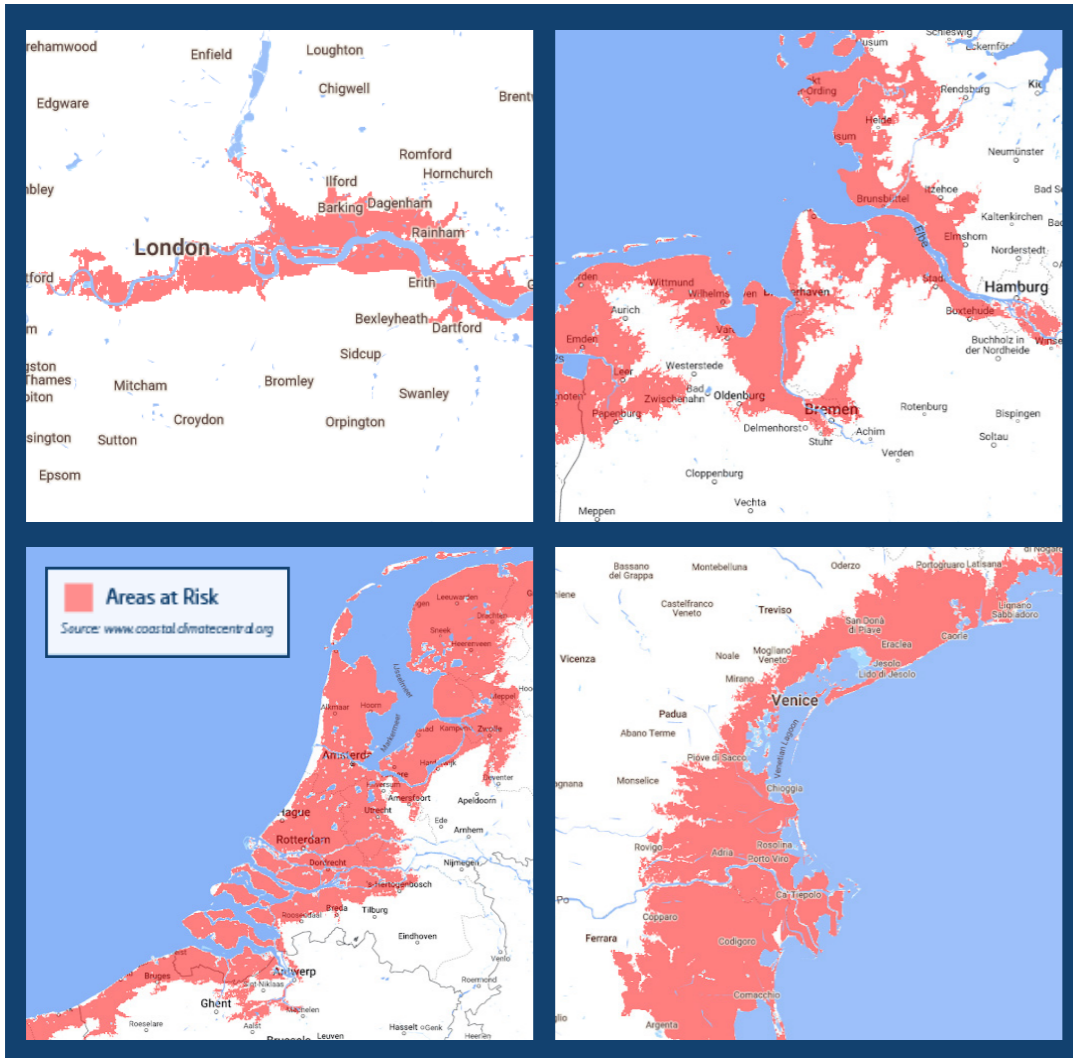


Figure 2. Maps showing areas particularly vulnerable to 2m of sea level rise in Europe. The latest research shows that 2m of global mean sea level rise is now almost inevitable, but the timing is still uncertain and dependent on emissions.

Schematic detailing OCEAN:ICE's primary Antarctic field and modelling research

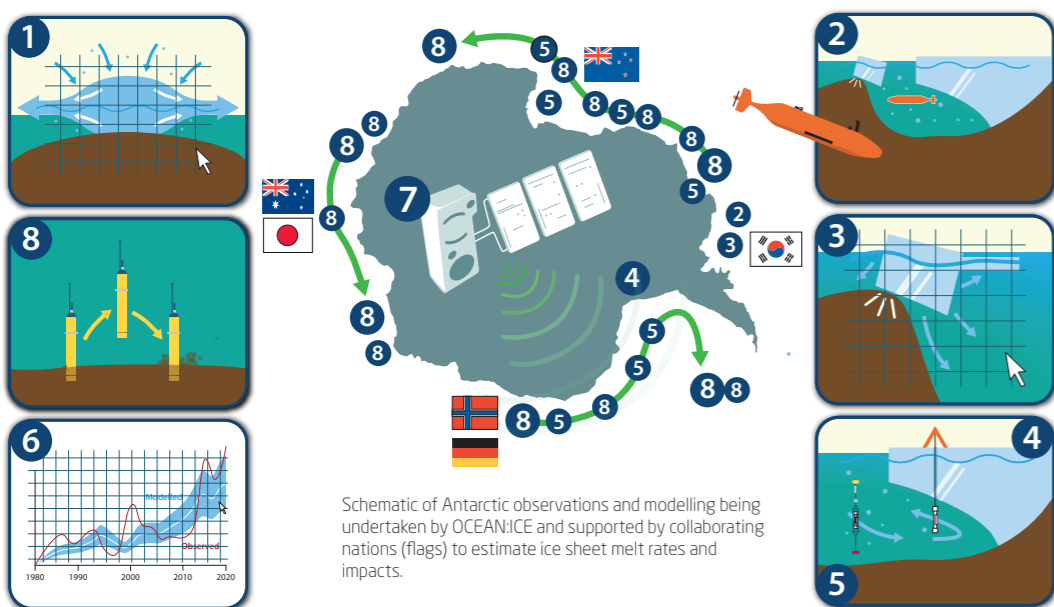


Figure 3. Modelling of net ice sheet balance 1) between snowfall and ocean melt, enabling 6), back projections of historical ice sheet melt rates. Observations underneath ice shelves and grounded icebergs using autonomous submarines 2) and through ice shelf drilling 4), allowing understanding of basal melt rates and dynamics, to be fed into models of iceberg drift 3). Deployment of free floating drifters 5) to assess the transport of heat and freshwater to and from key regions of ice sheet melt and around the continent. Satellite Earth Observations 7) used to constrain models as well as integrate disparate regional observational datasets.

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The **OCEAN:ICE** project focuses on understanding how the Antarctic Ice Sheet and the surrounding Southern Ocean influence our global climate. The data and models of the project will ultimately be able to reduce the level of uncertainty around how much the Antarctic Ice Sheet will melt in the near and far future, and provide information about tipping points, changes to sea level rise, and the potential impacts of ice sheet melt on global climate. In turn, it will assess how glacial melt modifies global ocean circulations and the climate system. The project was born from the need for more robust data to underpin and improve models of the interactions between the Southern Ocean and the Antarctic Ice Sheet and the implications of this on sea level rise. Climate change is affecting the polar regions more quickly than any other part of the globe and presently we do not understand the mechanisms and dynamics of ice sheet collapse in response to ocean warming to adequately model it. Melting of only 5% of the Antarctic Ice Sheet would trigger sea level rise of nearly 3 metres - a catastrophe for Europe's coastal areas.

- Support existing European and international ocean observation networks, such as the South Atlantic Meridional Overturning Circulation Basin-wide Array, Global Ocean Observing System, Copernicus Programme, the European Space Agency, and other EU-funded projects.

OCEAN:ICE brings together a diverse variety of actors in polar science, including: world-leading European ice sheet and ocean modellers, in situ and remote sensing scientists specialising in polar and global ocean circulation and ice-ocean-atmosphere interactions, as well as specialist policy experts and communicators. The project is coordinated by the Danish Meteorological Institute with major contributions from the British Antarctic Survey and is funded through the EU's Horizon Europe funding programme, with contributions from UK Research and Innovation. The project includes 17 partners from across the European continent and focuses primarily on litoral observation in the Southern Ocean, as well as Greenland.

OCEAN:ICE aims to accomplish the following goals in the next three years:

- Reduce uncertainty in predicting Antarctic Ice Sheet melt-rates and causes through new data and improved ocean-ice sheet-climate modelling.
- Develop and deploy new tools, such as Autonomous Underwater Vehicles and float profilers to support the next generation of data gathering and research. New data tools and dissemination methods will accompany these.
- Support EU ocean policy, and identify major climate impacts or tipping points resulting from the diminishment or collapse of the Antarctic and Greenland Ice Sheets, such as sea level rise, changes to the AMOC, and Arctic sea ice reduction.

In the next three years, OCEAN:ICE teams will also directly contribute to major international assessments and initiatives, such as the Intergovernmental Panel on Climate Change, the United Nations Decade of Ocean Science for Sustainable Development UN Ocean Decade, and the Southern Ocean Observing System.

⁴ Meredith, M. P., et al. "Chapter 3: Polar Regions. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate." Intergovernmental Panel on Climate Change: Special Report on the Ocean and Cryosphere in a Changing Climate (2019).



ARCTIC PASSION

Arctic PASSION is an EU H2020 funded project encompassing 35 partners and 6 Indigenous Communities from 18 countries from Europe, North America and Asia, reaching across sectors, disciplines and cultures to jointly improve the existing network of observing activities on a pan-Arctic scale. Arctic PASSION collaboratively works on a more coherent Arctic observing system. One that better monitors the ongoing changes, supports sustainable socio-economic activity, supports the livelihoods of Indigenous Peoples and local communities, and helps to improve forecasting and climate predictions. A coherent Arctic observing system can provide information that is useful for society, and is an essential contribution to the prevention and mitigation of climate change driven disasters.

Arctic PASSION's main actions include to extend and better coordinate pan-arctic observations, to close gaps and overcome

fragmentation, strengthen inclusion of science, Indigenous and local knowledge, streamline access to and interoperability of Arctic data, and develop services tailored to Arctic stakeholders and right holders needs.

Arctic PASSION, as a four year project, can initiate and contribute to necessary improvements. However, it is the sustained attention and support of the European Union, the European Parliament and the European Commission that is needed to forward these developments to create the urgently needed coherent and useful Arctic observing system - for the Arctic region as much as for Europe and the globe. This is a long term process and cannot be solved by one country or one programme, a sustained international effort is needed. We need Europe to continue to proactively push this process forward and provide the necessary political and financial support to better coordinate and fill data and knowledge gaps in the Arctic.

Pan-Arctic Observing System of Systems: Implementing Observations for Societal Needs



Figure 4: Arctic PASSION aims to improve the existing network of observing activities on a pan-Arctic scale by extending and better coordinating pan-Arctic observations, by strengthening inclusion of science, Indigenous and local knowledge, by increasing access to and interoperability of Arctic data, and by developing services tailored to Arctic stakeholders and right holders needs.

Major challenges identified, calls for future actions

To build observing systems and perform effective research in the polar regions that is useful for society's needs, Arctic PASSION and OCEAN:ICE have identified the following challenges and actions for urgent addressment by EU policymakers.

Long-term funding to support knowledge-based decision-making

Challenge: A lack of long-term financial and political support for polar observations and information services which serve the needs of local inhabitants, science and policymakers globally.

Calls for: Sustained support for long-term observations and information services based on the needs and requirements of inhabitants, stakeholders, and scientists by supporting actions initiated by the European Parliament and the European Commission.

Long-term monitoring of key climate variables is deemed essential by the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC). Such datasets provide the empirical evidence to understand and predict the evolution of climate, to guide mitigation and adaptation measures, to assess risks and enable attribution of climate events to underlying causes, as well as to underpin climate services. Despite their global importance, the polar regions are some of the most sparsely observed regions of our planet. This needs to change, and be guided by science as much as by the needs of the other data users and stakeholders.

Integrated Southern Ocean and Antarctic observing system

Challenge: The present observational network in the Antarctic and Southern Ocean is ad hoc, has significant spatial and technical gaps and struggles to maintain 'baseline' coverage.

Calls for: Sustained funding and political support for long term observations, the development and deployment of enabling technologies, and support for the implementation of the Southern Ocean Observing System future observing network.

While the Southern Ocean Observing System exists, and is supported by numerous nations, its recommendations are left to be implemented in an ad hoc fashion by individual research groups and projects, it rarely has operational level support as provided by e.g. National weather services, and it does not fully encompass Earth Observations or research on the Antarctic continent itself. This inevitably results in very limited coverage in space and time, meaning that it is difficult to develop the baseline of observations needed to understand regional climate change and its global impacts. Coordinated funding of such fundamental long time observations is needed, with stronger integration between ocean, ice and space based observations and long term data management. Additionally, targeted technological development and deployment is required to achieve the necessary ocean observations beneath ice covered regions; these are critical to understanding future sea level rise and other ice sheet impacts on the global climate.

Integrated Arctic observing system

Challenge: The present Arctic observing system is too fragmented and there is no clear governance structure.

Calls for: Sustained funding and political support by the European Union for better coordination of pan-Arctic Ocean observations and the dissemination of relevant data.

A coherent, integrated and inclusive 'Arctic observing system' does not presently exist. Instead, there are a multitude of organisations and observing system components from local to international scale, that are not coherent in their actions. We need to coordinate better the integration of the numerous separately

funded observations that are performed across the Arctic each year. An observing system that serves science and society will need a transparent and trusted governance structure, sustained funding, and pathways for data providers and data users to enable interaction with 'the observing system'

Inclusion of Indigenous Peoples and local communities

Challenge: Limited inclusion of Arctic Indigenous Peoples and local communities.

Calls for: Changes in the funding and decision-making structure for a more equitable and inclusive Arctic observing system

The EU Arctic Policy (JOIN/2021/27 final) states its responsibility 'for the livelihood of inhabitants, including Indigenous Peoples', and announces to "invest in Arctic research under Horizon Europe, including cooperation with indigenous knowledge holders, and involve women and young and Indigenous people more in relevant decision-making processes." Action is urgently needed to deliver meaningful participation of Arctic Indigenous Peoples and local inhabitants in the Arctic observing network in research and monitoring, as well as within decision-making processes. This will only be realised through changes to the current funding instruments that allow equitable participation by traditionally excluded groups.

Implications of geo-politics on Arctic science

Challenge: The current geopolitical situation prevents access and collaboration on a pan-Arctic scale.

Calls for: To become more resilient to changes in the collaboration of states.

We do not have an adequate solution and we ask the European Parliament and the European Commission to support the scientific community in finding ways to develop a resilient governance structure for Arctic observing and monitoring. The data and

knowledge gaps resulting from the hampered scientific cooperation with Russia after the start of the war calls for support from the European Parliament for intensified scientific collaboration with other states as well as the amplified and cooperative use of satellite technology.

Accessibility and standardisation of data

Challenge: The lack of easy access to data, as well as the inability to integrate datasets (data interoperability) to develop meaningful information services.

Calls for: An agreed framework for harmonised data and the enhancement of data-interoperability and accessibility.

Integration of data and products in relevant decision support systems and other information services is a strong need, not only to promote future research but also in development of the digital twin of the earth. However, this is only possible if data are interoperable and accessible. Having a standardised approach to observational data in Europe is a long-term effort, but is yet to be fully realised. Europe's framework of mandatory FAIR data policy needs to be fully supported and extended to cover all relevant data and the needs for interoperability, including accessibility to data from Copernicus and other services as well as research projects outside direct EU funding efforts.

Looking ahead

Human induced global warming has led to substantial environmental changes in the polar regions. We are in the midst of a climate emergency, and understanding the polar regions is critical in order to make coherent projections of future climate and sea levels, both globally and at the European regional scale. As the polar regions move towards unknown environmental conditions, our capacity to understand and predict how the environment and climate will react is substantially diminished. To overcome these knowledge gaps, society requires access to the most recent environmental information at different spatial and temporal scales. Only an integrated, coherent and inclusive network of polar observations can provide a fundamental part of this global knowledge base. To be of maximum benefit, observations and research must be girded by sustained, coordinated funding and active international collaboration, both to adhere to European Union policy priorities, to promote European interests, and to enable future decisions to be guided by reliable, robust data and knowledge.

The European Union is a major player in both polar regions. The output from the European Union's funding of multidisciplinary, multisectoral research in the polar regions has provided a much-improved understanding of the effects and long-term implications of change in the polar regions. Results have clearly demonstrated the scale of the challenges facing our planet. However, more needs to be done. It is only through the funding of research that unites different sectors, cultures and knowledge systems that we can provide a more systemic understanding of some of the most pressing challenges affecting the polar regions and their impacts in Europe.

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ARCTIC Passion
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The European Polar Board is an independent organisation focused on major strategic priorities in the Arctic and Antarctic. EPB Members include research institutes, logistics operators, funding agencies, scientific academies and government ministries from across Europe. The EPB serves as a strong and unified voice and single contact point for European polar research.

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