ISSN 2599-8293

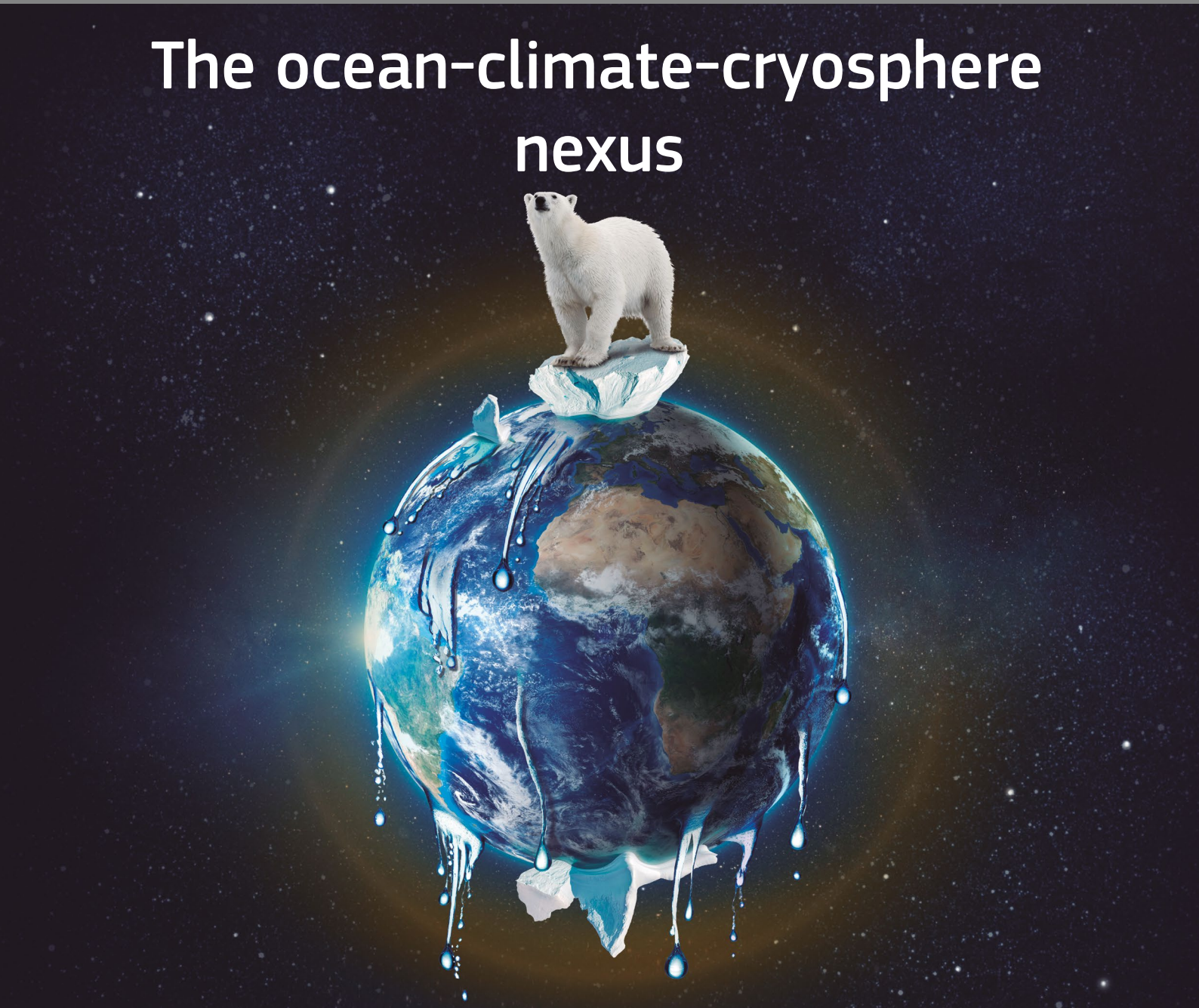
European Commission

CORDIS Results Pack on polar regions

A thematic collection of innovative EU-funded research results

May 2024

The ocean-climate-cryosphere nexus



Research and Innovation

Contents

Editorial

The ocean-climate-cryosphere nexus

The impact of climate change is most acute at Earth's polar regions. The Arctic and Antarctica are warming rapidly, with dramatic consequences for not only the local environment, but the wider world. This CORDIS Results Pack showcases the scientific advancements made by 13 EU-funded projects, studying polar regions, climate change and the ocean-climate-cryosphere nexus, closing important gaps linked to understanding, modelling and predicting the vulnerable components of Earth's climate system and the biosphere.

Few of us will set foot inside the Arctic or Antarctic circles in our lifetime, but what happens there will certainly have an impact on our own lives. The climate at Earth's poles is warming faster than the rest of the globe, leading to retreating sea ice and glaciers, thinning ice sheets, thawing permafrost and extreme weather events, driving habitat loss and economic and social degradation for the Arctic's inhabitants.

Disruptions to climatic and geochemical cycles may lead to the crossing of tipping points with cascading adverse effects on humans, marine organisms and the Earth system, and with high environmental, societal and economic impacts.

At the same time, an ice-free Arctic is fuelling a race to secure emerging resources, including untapped mineral and petrochemical reserves, increased tourism and new sea routes of significant commercial and geopolitical value.

Understanding these changes is essential if we are to mitigate the most deleterious impacts of climate change and make use of its resources in an equitable and sustainable manner.

A multifaceted and multidisciplinary approach

This Pack presents a diverse portfolio of projects supported by the Horizon research programme, which examine the key role of the ocean and the polar regions in climate regulation, and the wider interconnection between ocean, cryosphere, biodiversity and climate. Investigation of key processes in the polar regions is crucial for the development of more accurate and precise climate models, the identification of climate and ecological tipping points, and a deeper understanding of the coupling between drivers and responses in the ocean-climate-cryosphere system.

The projects highlighted here bring together researchers from Earth system science, oceanography, fisheries science, ecology, social sciences and economics, as well as ethics professionals, technology providers, local communities and regulators.

Their findings contribute to policy, legal and regulatory pathway recommendations for the implementation of the European Green Deal and its climate and biodiversity objectives, the integrated EU Arctic policy and make significant contributions to international assessments such as the Intergovernmental Panel on Climate Change and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Climate change and its consequences – the degradation of polar and ocean health and the loss of biodiversity – can only be dealt with by taking a holistic systems approach. The knowledge generated by the multidisciplinary approach shown here allows policymakers and stakeholders to intervene more effectively with mitigating measures, and incentivises the transition toward a just and sustainable development for the planet and people.

Stemming future conflicts in a thawing Arctic

Researchers with the EU-funded ArcticHubs project are planning ahead with co-creative solutions to ensure sustainability across competing interests.

© Jonathan Karkut

New economic sectors are opening up in the Arctic, which alongside the industrialisation of many traditional livelihoods, is creating divisions over land use and impacting the lives of local populations.

"These pressures, tensions and sometimes conflicts occur in locations where industries, livelihoods and interests converge or overlap," says Pasi Rautio, senior scientist at the Natural Resources Institute Finland (Luke) and ArcticHubs project coordinator. "The current threats to sustainability are often posed

by a lack of understanding, collaboration or recognition of the challenges each of those livelihoods or sectors faces," he adds.

The current threats to sustainability are often posed by a lack of understanding.

To ensure the long-term sustainability of Arctic society, the ArcticHubs project is listening to local communities. The project has developed a series of solution-oriented tools to reconcile competing goals, focusing on areas where various interests converge.

"We consider hubs as nodes hosting either a combination of economic activities, or one main industry or means of livelihood, where the challenges and impacts facing the Arctic region are tangible and acute," explains Rautio.

Researching solutions around Arctic hubs

Through the multi-year project, research teams on the ground have built up collaborative activities around the 15 hub locations. The hubs represent combinations of local and global flows of people, goods, capital, information, organisational activities and power relations.

The researchers identified five prominent land uses in the Arctic: fish farming, forestry, tourism, mining and indigenous hubs. These are typically concentrated in historically important locations, and generate relatively densely populated areas surrounded by vast tracts of sparsely populated hinterland.

"In each hub, ArcticHubs researchers have engaged with the local communities to more closely hear and understand their experiences, priorities, concerns and future livelihood aspirations," says Rautio.

Exchange of perspectives

The most important project results relate to the creation of opportunities for dialogue within hub areas, and the exchange of viewpoints across industries or sectors where occasions for such exchanges are rare.

This has in part been facilitated through developments in the public participation geographic information system (PPGIS), a collaborative approach to spatial planning using map-based surveys. The end result is 'Maptionnaire', an interactive online map platform that allows community engagement in policy and planning.

"By leveraging Maptionnaire's capabilities, ArcticHubs is helping to create a more collaborative environment where diverse voices are heard, enabling the co-creation of solutions for land and sea resource management in the Arctic," explains Rautio.

The project results support sustainable regional development through the co-designed adaptation of the Social Licence to Operate concept beyond mining and extractive industries; and the collaborative exploration of future scenarios, in particular by young people. "Taking the perspective and priorities of the Arctic youth is vital for long-term solutions to be found," adds Rautio.

Strengthening Arctic communities

ArcticHubs is already looking beyond this project cycle to build upon the knowledge generated and maintain the collaborative momentum.

"Further funding opportunities are never guaranteed," notes Rautio, "but the feedback we receive from local stakeholders is that continuity is vital, as opposed to the stop-start staccato rhythm tied to short project cycles. Only then will we be able to build long-term trust and collectively generate sustainable solutions."

PROJECT
ArcticHubs – Global drivers, local consequences: Tools for global change adaptation and sustainable development of industrial and cultural Arctic "hubs"

COORDINATED BY
Natural Resources Institute Finland (Luke) in Finland

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/869580

PROJECT WEBSITE
projects.luke.fi/arctichubs

Creating a coherent observing system for the Arctic

The EU-funded Arctic PASSION project aims to provide unrestricted, high-quality, science-based Earth Observation data to those living and working in the polar region.

© Owr/stock.adobe.com

In the Arctic, the effect of human-induced global warming is being felt faster than anywhere else on the planet. These changes have an environmental, societal and economic impact both locally and, due to the Arctic's role in the global climate system, far beyond the region.

This highlights the need for a sustained and accessible pan-Arctic observing system of systems, tuned to the diverse needs of users – from local inhabitants to academia, industry and decision-makers inside and outside the Arctic region.

Although there have been several advances in integrating Arctic observations, the various components of current observation systems are fragmented. The Arctic PASSION project aims to improve the situation by co-creating and implementing a coherent, integrated Arctic observing system of systems. It builds on the work which was developed in the context of the INTAROS project.

Developed via international collaboration, including with Indigenous and local communities, the project's pan-Arctic Observing System of Systems (pan-AOSS) aims to provide continuous unrestricted, high-quality, science-based Earth Observation information tuned to address the urgent needs of people living and working in the Arctic. The project is also contributing to EuroGEO activities and the Arctic Window of Copernicus.

Forecasting the growing threat of Arctic air pollution

The pan-AOSS is comprised of numerous services. One of those services, the Local Atmospheric Pollutant Forecast Service, was recently presented to representatives, policymakers and other Arctic stakeholders during the Arctic Frontiers Conference in Tromsø, Norway.

The Local Atmospheric Pollutant Forecast Service was developed at the European Commission's Joint Research Centre in Ispra, Italy, in collaboration with the Italian National Research Council. Using artificial intelligence, the service provides PM_{10} particulate pollution forecasts for the upcoming 24 hours for Finland, Iceland, Norway and Sweden.

These forecasts are made available via a dedicated website designed for a non-scientific audience. It features an interactive map where users can easily visualise and download PM_{10} pollution data at the selected geographical location.

Measuring permafrost and lake ice

The pan-AOSS also includes a Permafrost Service. The portal provides interactive maps of recent information on land surface changes, hot spots of disturbance, and potential areas of active permafrost thaw and erosion.

The service was recently tested in Alaska.

Another key component of the pan-AOSS is the Lake Ice Service, a web-based map for Arctic climate and safety.

Designed for everyone who needs information about lake ice conditions, the service collects and combines data from different sources for lake ice networks and water temperature data, as well as citizen-based observations, and visualises it in a way that is easy to access and understand.

More information on the project and all its various services can be found here.

PROJECT
Arctic PASSION – Pan-Arctic observing System of Systems: Implementing Observations for societal Needs

COORDINATED BY
Alfred Wegener Institute – Helmholtz Centre for Polar and Marine Research in Germany

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/101003472

PROJECT WEBSITE
arcticpassion.eu

Antarctic ice core data can help inform climate action

Examining million-year-old Antarctica ice could help scientists solve a major climate riddle, and provide valuable data for climate adaptation strategies.

Careful study of the past can provide valuable clues about the future. The Antarctic ice sheet – which is more than 3 km thick in places – contains within it a unique record of climate history. Air bubbles embedded in the ice can give scientists insights into the evolution of Earth's atmosphere over time.

The aim of the ongoing EU-funded Beyond EPICA project, which is coordinated by the Italian National Research Council, is to examine these Antarctic ice cores for data on past atmospheric compositions, and to better understand the processes governing our climate system.

What really sets this project apart, however, is the mind-boggling timespan the project intends to cover – up to 1.5 million years.

Research at the extremes

Beyond EPICA, which was launched in 2019, builds on the previous EU-funded projects EPICA and BE-OI. The latter sought to locate Antarctic regions where ice more than 800 000 years old might be found.

A promising site was identified about 40 km away from the Italian-French research station Concordia. Little Dome C is a 10 square kilometre patch of ice 3 233 metres above sea level. It is one of the most extreme climates on Earth, with an average air temperature of a bone-chilling -54.5 °C.

Beyond EPICA established a camp here, and since its launch, the international team has progressively drilled deeper and deeper ice cores. From mid November 2023 to mid January 2024, scientists succeeded in reaching a depth of over 1 836 metres, extracting a record of the climate and the atmosphere going back 195 000 years.

Some preliminary ice core analyses have been carried out at Concordia Station, while other ice core samples will reach colleagues in Europe via the Laura Bassi icebreaker. The project's final goal is to reach a depth of about 2 700 metres, which represents the thickness of the ice sheet underneath Little Dome C, and extract ice cores over 1 million years old.

Climate change mitigation and adaptation strategies

The project, which will run until May 2026, will give scientists an unparalleled view into our climatic past. No other climate record can provide such accurate atmospheric data, going so far back in history.

This will help researchers solve a major climate riddle: why, around 1 million years ago, glacial cycles shifted from 40 000 years to 100 000 years. More generally, project findings will help climate scientists to better understand the linkages between the carbon cycle, ice sheets, atmosphere and ocean behaviour. This information could prove critical in designing more effective mitigation and adaptation strategies for climate change.

PROJECT
Beyond EPICA – Beyond EPICA Oldest Ice Core: 1,5 Myr of greenhouse gas – climate feedbacks

COORDINATED BY
National Research Council in Italy

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/815384

PROJECT WEBSITE
beyondepica.eu/en

Building community guidelines for the Arctic

Researchers for the EU-funded CAPARDUS project developed a framework of standards, guidelines and best practices for those living and working in the Arctic.

The Arctic region is warming four times faster than the rest of the globe, bringing dramatic changes to the climate and landscape, as shown by the reducing sea ice, retreating glaciers, thinning ice sheets, thawing permafrost, increasing precipitation and other unusual weather events.

"Happening in parallel with this change in climate is a change in how the Arctic is being used," says Stein Sandven, senior researcher at the Nansen Environmental and Remote Sensing Center (NERSC) in Norway.

According to Sandven, as the Arctic warms, it is seeing an increase in activity, from scientific research to shipping, trade and even tourism – all of which will have a transformative impact on this already fragile region. "What we need is a new framework of standards, guidelines and best practices to ensure that all these activities happen in a sustainable way," he explains.

Helping to develop such a framework is the EU-funded CAPARDUS project.

A diversity of interests and ideas

Coordinated by the NERSC, the project brings together stakeholders from across relevant sectors and Arctic countries to discuss the future of the region. "Involving such a diverse array of players can make communication challenging, as different stakeholders tend to use different languages and have different, often competing goals," notes Sandven.

He says the broad representation of interests involved was essential to the project's overall success. "This diversity ensured that we could identify best practices, guidelines and standards that were aligned with the needs of everything from fisheries to tourist companies and shipping operators," adds Sandven.

Different stakeholders tend to use different languages and have different, often competing goals.

Empowering local communities

One key outcome of the project was a set of guidelines for using citizen science and community-based monitoring as a means of empowering local Arctic communities.

"By giving local communities a voice and a stake in the monitoring process, they are better able to identify and address their own needs and priorities, leading to more sustainable and equitable development outcomes," remarks Sandven.

For example, in Svalbard, the local tourist agency is exploring giving both tourists and community members various tools they can use to capture important environmental data, such as bird counts, as part of their daily activities.

"Through workshops and dialogue meetings, CAPARDUS has strengthened the communication between scientists and local community members in Svalbard, which is a prerequisite for sustainable development in the region," adds Sandven.

Safety standards for the Arctic

With the increase in commercial operations happening in the Arctic, the CAPARDUS project also focused on developing safety standards. "The increase in human activities requires that knowledge about safety is built up and disseminated to the people who travel, work and live in the region," explains Sandven.

These safety standards cover everything from what clothing to wear on tourist excursions, to protecting polar bears and managing environmental hazards.

These standards, along with all the project's work, have contributed to a preliminary framework for creating comprehensive standards for the Arctic. The project is now working with policymakers to implement this framework. It is also developing a digital hub for information and best practices that can be used by those living and working in the Arctic.

PROJECT
CAPARDUS – Capacity-building in Arctic standardisation development

COORDINATED BY
Nansen Environmental and Remote Sensing Center in Norway

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/869673

PROJECT WEBSITE
capardus.nersc.no

Understanding the drivers of Arctic biodiversity

To help local communities adapt to climate impacts, researchers in the EU-funded CHARTER project are creating an advanced model of the 21st century Arctic.

Global warming is fundamentally altering biodiversity and the climate in the Arctic. These changes will impact local human populations, see major socio-economic feedback and have long-term implications.

In the CHARTER project, researchers are advancing the state-of-the-art knowledge of changes to Arctic biodiversity and socio-ecological systems, to bolster the capacity of local communities to adapt to these changes.

The project is working to improve knowledge on several fronts: transitions in vegetation cover; energy balance and climatic change over time; how shifts in biodiversity are likely to affect Indigenous and local communities; as well as integrating detailed carbon exchange and albedo effects into Arctic modelling efforts and developing new policies to support Arctic communities.

"Incorporation of social-ecological and economic drivers into Arctic regional modelling is a difficult task, but we think we are

making progress," says Bruce Forbes, research professor from the Arctic Centre at the University of Lapland, and CHARTER project coordinator.

Combining fieldwork with citizen science

Running until 2025, the CHARTER project involves 21 research institutions across nine countries, and many different kinds of fieldwork across different seasons, led by professional researchers, local and Indigenous partners and citizen scientists. Unfortunately, fieldwork and cooperation in Russian field sites was suspended following the Russian invasion of Ukraine.

Local communities helped with snow sampling research, mapping of reindeer pasture at different scales, and participatory workshops in which those working in the region, such as herders and fishers, discussed what they saw as the main issues in the coming decades.

The modelling examines potential changes through to 2050, and potential climate feedback loops emanating from changes in surface albedo – the reflection of sunlight back into the atmosphere from land surfaces such as snow or vegetation. The project also includes remote sensing work exploring changes in vegetation on reindeer pastures from Fennoscandia to West Siberia.

Multidisciplinary and multicultural research

The work of the multidisciplinary research consortium has already led to several high-level peer-reviewed publications that generated broad interest.

The other achievement is the ethical co-development of the project with local and Indigenous partners and the inclusion of Indigenous scholars within the research team, notably Sami and Nenets.

The team also held an Arctic Biodiversity Policy event in Brussels, Belgium in 2022, which was so successful that another is planned in conjunction with the European Polar Science Week in Copenhagen, Denmark during the first week of September 2024.

The consortium is making a major push to disseminate results publicly through a combination of science and art exhibition models such as StoryMaps, as well as to policymakers.

Harnessing Indigenous knowledge

One area of focus is the long-term biodiversity of the Arctic and northern boreal ecosystems where Indigenous peoples (Sami and Nenets) and others such as Finns who herd reindeer, hunt and fish, have their livelihoods based.

One of the big issues for Nenets' social-ecological systems has been catastrophically high mortality of herded reindeer due to the increasing intensity and frequency of rain-on-snow events, for example.

"Because we focus on the interactions between Arctic livelihoods, biodiversity and climate, the best experts are the local and Indigenous peoples who have practised these livelihoods for centuries, if not millennia," explains Forbes. "Understanding future resilience and adaptive capacity requires co-developing the research plans and questions with locals," he adds.

Because we focus on the interactions between Arctic livelihoods, biodiversity and climate, the best experts are the local and Indigenous peoples who have practised these livelihoods for centuries, if not millennia.

PROJECT
CHARTER – Drivers and Feedbacks of Changes in Arctic Terrestrial Biodiversity

COORDINATED BY
University of Lapland in Finland

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/869471

PROJECT WEBSITE
charter-arctic.org

Research project urges immediate action to save oceans

EU-funded research investigated the critical thresholds that, when surpassed, can lead to irreversible damages in the marine ecosystems.

© Christoph Heinze

Ocean warming, deoxygenation and acidification are consequences of human activities, primarily from the release of greenhouse gases into the atmosphere. This triple threat leads to changes in the ocean that are happening fast and abruptly. According to the EU-funded project COMFORT, the time to act is now.

The project gathered experts from Earth system science, oceanography, fisheries science and ecology to study these threats' "tipping points", which are critical thresholds that, when exceeded, can lead to significant and often irreversible changes in the marine ecosystems.

COMFORT took an integrative approach to analyse factors contributing to the thresholds in parallel. "We looked at a suite of different targets, including limits to warming, ocean acidification, biological organic carbon production and oxygen content," describes Christoph Heinze, COMFORT project coordinator. "Common to all metrics is that reducing greenhouse gas emissions

and limiting reactive nitrogen input to the ocean upfront is better, more economical, and induces less environmental stress than fixing issues through geoengineering at a later stage."

Alarming findings

Coordinated by the University of Bergen, the project had alarming findings. Some thresholds have already been crossed and others are likely to be passed soon.

Reducing greenhouse gas emissions and limiting reactive nitrogen input to the ocean upfront is better, more economical, and induces less environmental stress than fixing issues through geoengineering at a later stage.

Some regions of the North Atlantic have already crossed tipping points resulting in regime shifts, namely sudden ecosystem changes. They are a consequence of factors such as overfishing, climate change and pollution.

"Climate change in combination with overfishing can trigger sudden changes in fish stocks. Some marine provinces that are characterised by certain environmental conditions and ecosystems are on the verge of vanishing," says Heinze.

The ocean absorbs about 25 % of the annual emissions of anthropogenic CO_2, reducing the impacts of climate change on the planet. However, it becomes more acidic the more it absorbs CO_2, bringing harmful consequences to many marine organisms. The ocean has also absorbed more than 90 % of the extra heat from global warming since 1970. Increased temperatures and nutrient pollution also reduce the ocean's oxygen.

The triple threat is already becoming reality in all European seas. In the Arctic Ocean, the acidification progresses 10 times faster and the warming advances two times faster than the rest of the globe.

"The sum of increasing regional non-linear changes, that is, the results of crossing certain thresholds, and regime shifts in the ocean are likely to happen with high probability and aggregate to a problem of global dimension," warns Heinze.

Mitigation strategies

Through statistical methods, COMFORT produced several model outputs for historical and future scenarios. The team also gathered in situ observations, resulting in valuable ocean hydrography, biogeochemistry and biological data. The project suggested a series of mitigation strategies for policymakers and was an important contributor to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

"We recommend urgent implementation of a drastic reduction of greenhouse gas emissions, which are the primary cause of global warming and ocean acidification, to avoid further stability loss of major Earth system tipping elements and long-lasting changes in ocean properties," states Heinze.

He also highlights the need for appropriate global resource management to achieve greenhouse gas emission reductions in line with the Paris Agreement. Furthermore, societies must engage in green energy production, as well as sustainable food production on land and in the ocean.

PROJECT
COMFORT – Our common future ocean in the Earth system – quantifying coupled cycles of carbon, oxygen, and nutrients for determining and achieving safe operating spaces with respect to tipping points

COORDINATED BY
University of Bergen in Norway

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/820989

PROJECT WEBSITE
comfort.w.uib.no

Exploring tipping points in the Arctic Ocean

Researchers in the EU-funded ECOTIP project examined the seas around Greenland to understand the cascading effects of climate change on Arctic biodiversity, and the consequences for ecosystem services in the region.

Sea-ice loss, rising temperatures, invasive species: the Arctic marine world is undergoing a lot of change. Predicting the future of marine biodiversity is key, both for the ecosystems themselves and for the local societies that rely on them for their livelihoods.

This is challenging due to huge gaps in our knowledge, the largest of which is a lack of understanding of the biological processes that link biodiversity to ecosystem services, and how they react to pressures from human activity.

"If we don't know how the pelagic (open ocean) food webs in the Arctic function or respond to changes, we cannot predict how the fisheries productivity will change, or how much CO_2 might be taken up and sequestered in the future ocean through biological processes," explains Marja Koski, a professor at the Technical University of Denmark's National Institute of Aquatic Resources and ECOTIP project coordinator.

In the ECOTIP project, researchers are shedding light on Arctic marine ecosystems. This includes exploring the drivers and thresholds of ecosystem tipping cascades, where a fundamental shift in the environment moves an ecosystem into a different state, as well as their consequences for Arctic marine biodiversity.

Past and present

The researchers gathered data during expeditions around the coasts of Greenland, combining this with existing time-series data to support advanced modelling.

If we don't know how the pelagic food webs in the Arctic function or respond to changes, we cannot predict how the fisheries productivity will change, or how much CO_2 might be taken up and sequestered in the future ocean through biological processes.

They combined these with historical records, as well as prehistorical sediment data, and developed models to identify the mechanisms and consequences of environmental change – for instance, how subtle changes in the environment can result in ecosystem tipping points.

While the project is still ongoing, the team has mapped a lot of past and present biodiversity and its response to external pressures, and developed a new understanding of pelagic food webs and links between the seabed and water column of Arctic ecosystems.

"Our modelling results have identified a mechanism for potential ecosystem tipping points, which needs to be verified and refined by the observations which we are currently working on," says Koski.

The researchers have also explored the distribution changes of fish and marine mammals and how this affects the local communities. For instance, an examination of fishing logbook records showed that new fish and whale species spread to East Greenland from the south, whereas the ice-associated mammals (such as walrus and narwhal) withdrew to the north.

The results have also improved our understanding of the biological carbon pump – a combination of biological processes that help to draw carbon out of the atmosphere – revealing that particularly large zooplankton and fish are globally important agents of carbon export and sequestration.

Integrating local knowledge

Engagement with Greenlandic society was an important part of the project, and the local ecological knowledge contributed greatly to the outcome.

The team are now finalising the data and creating policy recommendations to assist with future management and monitoring. The work will also continue in the EU-funded SEA-Quester project, exploring the carbon sequestration potential of novel polar ecosystems. "We hope that we can build on the insights and data, and continue the collaborations that have been built during ECOTIP," concludes Koski.

PROJECT
ECOTIP – Arctic biodiversity change and its consequences: Assessing, monitoring and predicting the effects of ecosystem tipping cascades on marine ecosystem services and dependent human systems

COORDINATED BY
Technical University of Denmark in Denmark

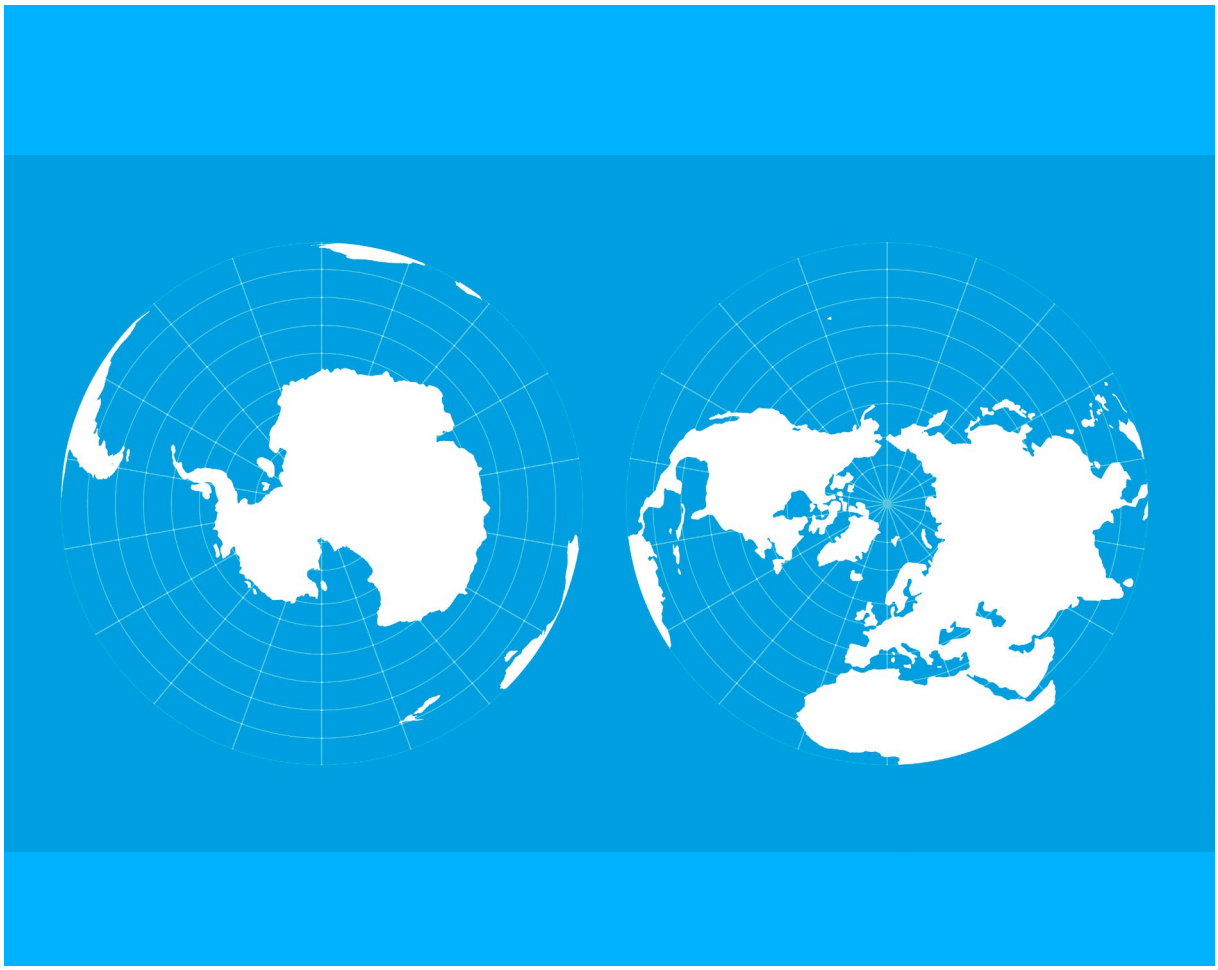
FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/869383

PROJECT WEBSITE
ecotip-arctic.eu

Shaping the future of polar research

Bringing together key stakeholders, the EU-funded EU-PolarNet 2 project is cultivating a comprehensive European polar research ecosystem, sharing knowledge and maximising resources for more evidence-based policymaking.



Climate change and human activities are dramatically altering the polar regions. Yet there's much we still don't know, according to Anneli Strobel, project manager of EU-PolarNet 2: "Despite indications that we may have already reached a tipping point, our knowledge about polar environmental systems remains too incomplete to forecast the scale and pace of change."

Building on predecessor project EU-PolarNet, EU-PolarNet 2 is focused on research coordination, prioritisation and optimisation, complemented by stakeholder involvement, leading to policy advice and the establishment of a European Polar Coordination Office (EPCO).

The project involved all the EU Member States and Associated Countries with polar research programmes, and is mandated to coordinate the EU Polar Cluster, a network of EU-funded Arctic and Antarctic research projects.

Capturing the particularity of the poles

According to Strobel, there is now less sea ice in the Antarctic than at any time since satellite observation began. The ice sheet is losing mass, causing sea level rise, alongside atmospheric and oceanic changes.

These have economic and geopolitical impacts, such as new Arctic shipping lanes and increased resource extraction, affecting local communities and Indigenous peoples.

To help identify and co-design critical research priorities, aided by a Polar Expert Group, the project engaged with a range of stakeholders, including through transdisciplinary workshops with stakeholders and rightsholders such as local fishers, reindeer herders and hunters.

One result was a call for increased scientific knowledge on the consequences of changing polar species distributions – impacting food supplies and habitats, alongside animal and human health – to inform risk assessments and policymaking.

"To develop adaptation strategies we have to ensure that the voices of industries and local communities are heard in international discussions and negotiations about conservation and sustainable management," adds Strobel.

The outcomes of these consultations will also contribute to the multi-year planning process for the Fourth International Conference on Arctic Research Planning.

One-stop shop for polar research

A prominent collaboration tool developed by the project is the registration-based Catalyst Platform which collates information about European polar community resources, news, events, research groups and jobs. Key features are the discussion forum and a moderated best practice forum.

The coordination platform will be complemented by a variety of additional tools under development, such as webinars, newsletters and a stakeholder tool.

A catalogue of large-scale and national polar programmes has been published, alongside a directory of European polar research funding opportunities.

A white paper also contains specific recommendations for accelerating the development of a sustainable, fully integrated polar observing system.

"All these activities will help policymakers join the dots about polar region changes. Greater appreciation of the science, and social consequences, of polar changes will help evidence-based decision-making. Our overview of the funding landscape and diversity of programmes available, will target resources more effectively," notes Strobel.

Meeting global commitments and ensuring sustainability

While the project team participates in, and represents, polar research in the All-Atlantic Ocean Research and Innovation Alliance, its work has already fed into the Arctic and Antarctic action plans of the United Nations Decade of Ocean Science for Sustainable Development. Meanwhile it continues supporting other international EU commitments.

Perhaps EU-PolarNet 2's most impactful legacy will be a permanent EPCO. "Now that the European Polar Board has agreed to host, and funding options are under discussion, we aim to open in early 2025," says Strobel.

Core activities will include: EU Polar Cluster coordination; polar observation coordination; cooperation with national funding agencies and research programmes, alongside continued Catalyst Platform management.

All these activities will help policymakers join the dots about polar region changes.

PROJECT
EU-PolarNet 2 – Co-ordinating and Co-designing the European Polar Research Area

COORDINATED BY
Alfred Wegener Institute – Helmholtz Centre for Polar and Marine Research in Germany

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/101003766

Tackling transformations in Arctic regions

The Arctic is on a precipice, experiencing rapid environmental and social change with global implications. The EU-funded FACE-IT project aims to understand the intricate dynamics at play in the European Arctic, specifically in the context of climate change and human activities.

© Geir Wing Gabrielsen

FACE-IT emerged from the recognition that the biodiversity of Arctic coastal zones is intricately linked to the rates of cryosphere changes. As the polar glaciers recede at an alarming pace, these changes reverberate across the entire Arctic ecosystem, impacting local species, trophic systems and local communities.

By focusing on selected Arctic fjord systems in Greenland, as well as Svalbard and Finnmark in northern Norway, the project aims to understand and address the challenges posed by rapid cryosphere changes.

Project coordinator Kai Bischof explains why the project was so necessary: "It's in the Arctic where we really see the manifestation of global climate change. And where the temperature is increasing four times faster than the global average. The rate of change is incredibly rapid, and there's no turning back from these transformations if we don't act."

Bischof adds: "FACE-IT aimed to understand and address the multifaceted challenges posed by rapid cryosphere and biodiversity changes in the region."

Inhabitants and visitors

It's been proven that local species in the region face significant challenges due to climate change, forcing them to migrate further north or risk losing their habitats entirely. But the Arctic's influence extends beyond environmental impacts, affecting socio-economic factors such as fishing and tourism, and the communities reliant on these resources.

The rate of change is incredibly rapid, and there's no turning back from these transformations if we don't act.

The main goal of the FACE-IT project was to develop approaches to navigating changes in Arctic fjord environments. The project brought together a wide range of experts from environmental and social science fields, aiming to comprehensively understand what drives these changes and how they affect local wildlife, ecosystems and the well-being of local populations, including aspects such as tourism.

"Tourism in Svalbard has surged," notes Bischof. "As retreating ice opens up previously inaccessible areas, tourist boats are able to visit pristine areas. This brings disturbances and pollution and also strains local infrastructure and rescue services."

Multifaceted approach

FACE-IT tackled these complex challenges in several ways, from examining the factors driving changes to developing shared knowledge for effective adaptive management approaches. Researchers engaged in experimental field and lab work simulating scenarios, exposing organisms to predicted changes in temperature, light intensity and other factors. Additionally, they utilised modelling approaches to compile all available data to make projections.

"The project emphasised interdisciplinary collaboration and international cooperation that generated a lot of brand-new knowledge about fjord functioning," adds Bischof.

Meanwhile, Indigenous communities in Greenland and their traditional knowledge systems face significant challenges due to the transformations in Arctic fjord systems and increased economic growth. This prompted the need for community engagement to address changes in food sources and, potentially, livelihoods.

The FACE-IT project generated valuable insights into long-term trends in Arctic fjord systems, and tailored recommendations for specific regions. The work also offers proposals on conserving the Arctic's unique biodiversity, identifying refuges for the protection of species and implementing restrictions on tourism access.

FACE-IT's findings directly address the EU's Arctic policy, inform reports by the Intergovernmental Panel on Climate Change and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services and support the UN's Sustainable Development Goals, aligning with broader international frameworks to promote a more sustainable and resilient future for the region.

PROJECT
FACE-IT – The future of Arctic coastal ecosystems – Identifying transitions in fjord systems and adjacent coastal areas

COORDINATED BY
University of Bremen in Germany

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/869154

PROJECT WEBSITE
face-it-project.eu

Ensuring Arctic development is fair, as well as sustainable

If development in the Arctic is not just and ethical, it will sow the seeds of its own resistance. Working with local communities, the EU-funded JUSTNORTH project offers a range of insights for policymaking.

The Arctic region has long been viewed as a frontier for the pursuit of valuable resources, from whaling expeditions to oil and natural gas exploration.

Alongside fisheries and tourism, it is now of increasing interest for climate transition efforts, alongside emerging industries such as data centres. Yet, already facing challenges such as depopulation, these interests introduce unique threats.

Land use is often disputed, with competition between traditional livelihoods, ecotourism, carbon capture, mining, renewable energy and railroads.

The JUSTNORTH project sought to ensure that the Arctic economies, environments and societies develop justly, ethically and sustainably.

"Most viability assessments prioritise profitability, technical feasibility and regulatory stability – sidelining environmental and social aspects," says Corine Wood-Donnelly, the project's scientific coordinator. "Even renewable energy production is premised on prior exploitation of finite resources."

JUSTNORTH focused on protecting the rights of Indigenous and Arctic communities while ensuring that they are meaningfully engaged in decisions about their homeland's future.

Listening to and learning

Undertaking interviews and workshops, JUSTNORTH conducted 17 case studies investigating the barriers, risks and costs of economic development, alongside the opportunities, benefits and pathways for sustainable development.

The team worked with political, economic and community-based stakeholders and rightsholders, using participatory techniques to explore values and justice issues viewed from the perspective of both: transitions, scale and distribution, and participation and governance.

Some case studies focused on one type of economic activity in several Arctic locations, while others examined the overlaps between activities in a single location, yielding insights across a range of themes.

"We gathered first-hand confirmation of climate change's increasing visibility and harm, with a clear appetite for long-term political and local community action," explains Wood-Donnelly.

Colonialism was found to have left a legacy of displacement and discrimination perceived to continue, as human rights are compromised for the green transition, exacerbating distrust in the political process.

Allied with this was the perception that globalisation benefits big corporations, with local communities dependent on one major industry while facing the consequences of industrial expansion.

"Many stated that while the Arctic is viewed as a solution to energy production and raw materials, profits go elsewhere, reinforcing a sense of exploitation," adds Gustav Sigeman, JUSTNORTH project manager.

Along with this were thoughts about the pressure to meet energy, food and tourism demands, often leaving communities with inadequate resources for themselves.

"The Arctic is often wrongly considered an empty arena, but it is actually a contested space for land rights, land and resource use," says Wood-Donnelly.

The Arctic is often wrongly considered an empty arena, but it is actually a contested space for land rights, land and resource use.

Ensuring fairness for current and future generations

JUSTNORTH's research offers fresh insights into social injustices, both identifying challenges and suggesting solutions, useful to the European Green Deal and the EU's Arctic policy.

"Supporting the green transition depends on whose lives are affected and to what degree. There will be losers and winners when wind farms cover land currently used for other purposes," notes Sigeman. For this reason, policymakers were engaged in participatory activities, such as policy labs, where key recommendations were discussed.

To support these efforts, JUSTNORTH is developing a digital negotiation tool, JUSTscore, to help communities map how their values and interests could be affected by small- and large-scale investment plans. "It will help redress the current power imbalance between those making decisions and those living with the consequences," remarks Wood-Donnelly.

The tool is complemented by two databases, one of bibliographic justice-related materials, the other on Arctic regulatory and policy documents.

Additionally, a documentary will share snapshots about hopes for the future from local communities and industries in northern Canada, Finland and Iceland.

PROJECT
JUSTNORTH – Toward Just, Ethical and Sustainable Arctic Economies, Environments and Societies

COORDINATED BY
Uppsala University in Sweden

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/869327

PROJECT WEBSITE
justnorth.eu

New ice melt model shows we need to act fast

New models that closely link sea level rises with melting polar ice have underlined the need for immediate and effective climate action. The EU-funded PROTECT project takes a closer look at the interactions between atmosphere, ocean and ice sheets.

Melting ice sheets and mountain glaciers are contributing to rising sea levels. If the Antarctic ice sheet – which contains 90 % of all ice on the planet – were to melt, it would wipe out all coastal cities in the world. Even modest sea level rise will likely have dire consequences for coastal regions.

While scientists agree that sea level rise is virtually certain to continue, the exact timing and rate of this transformation remain unclear. This is in part due to challenges in modelling ice loss in the polar regions, and partly because any rise is dependent on how effectively – or not – we cut emissions.

Cryosphere and coastal area expertise

PROTECT sought to improve projections of ice sheet melt in Greenland, Antarctica and glaciers around the world, as well as the evolution of global sea level rise. A key ambition of the project team was to expand the timescale of these projections, from what could happen over the next decade to the next few centuries.

"Sea level rise does not have the same impact everywhere," explains PROTECT project coordinator Gael Durand from the National Centre for Scientific Research (CNRS) in France. "So we also wanted to address sea level rise at both the global and the local scale."

To do this, the project brought together two key scientific communities – cryosphere experts such as Durand, specialising in ice sheet modelling – and researchers studying sea level impacts in coastal areas.

It also built upon a previous EU-funded project, ICE2SEA, which confirmed that melting ice sheets are a major source of current sea level rise.

Quantifying impact of climate change

Remote sensing observations were used to evaluate and improve models used for ice sheet and glacier projections, along with climate data extracted from the European Space Agency (ESA) Earth Observation Programme. This has given the team a better understanding of short-term variabilities, to make more accurate projections through to 2050.

This is the timescale that matters most for many coastal management decisions. The project was keen to involve a variety of coastal stakeholders, to better understand their information needs. "If you are a farmer, or running a nuclear power station, your approach to the risk of sea level rise will not be the same," says Durand.

The project team also attempted to project sea level rise as a result of ice sheet and glacier melt through to and beyond 2100, the timescale that the Intergovernmental Panel on Climate Change (IPCC) says is relevant for long-term infrastructure planning. Over 80 papers have been published so far, and the project team has uploaded onto its website an educational escape game about saving glaciers.

Climate action needed now

The project, which runs until the end of February 2025, will continue to develop new projections of possible sea level rise through to 2150 and beyond. In addition to emphasising the need for immediate greenhouse gas emission reductions, Durand notes that new climate services will be needed to encourage effective climate adaptation.

"Our findings so far have also reinforced the message that climate mitigation is not optional, and will give us more time and more options for adaptation," he adds.

"We simply cannot protect the whole coastline. We need to take action now, and following the Paris Agreement is the best option in front of us. What happens in Antarctica, in terms of ice melt, will not just stay in Antarctica."

If you are a farmer, or running a nuclear power station, your approach to the risk of sea level rise will not be the same.

PROJECT
PROTECT – PROjecTing sEa-level rise : from iCe sheets to local implicaTions

COORDINATED BY
National Centre for Scientific Research in France

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/869304

PROJECT WEBSITE
protect-slr.eu

Research reveals how heat and carbon uptake in the Southern Ocean affect our climate

The Southern Ocean significantly affects our global climate by regulating Research reveals how heat and carbon uptake in the Southern Ocean affect our climate critical heat and carbon exchanges between the atmosphere and ocean. EU-funded researchers provide new insight into how these intricate processes work over decades.

Over the past six decades, the simultaneous uptake of heat and CO_2 by the Southern Ocean has been instrumental in moderating the rate of global warming. The gap in knowledge regarding the underlying oceanic processes arises from a lack of observations in this extreme environment and inherent difficulties in capturing the intermittent processes across various scales in current Earth system models.

The EU-funded SO-CHIC project was established to further understand and quantify the variability of heat and carbon budgets in the Southern Ocean. "We investigated key physical processes that control exchanges between the atmosphere, ocean and sea ice by combining various observational and modelling approaches," notes project coordinator Jean-Baptiste Sallee.

Exploring the impact of tiny and short-lived processes

Fine-scale (1-10 km) and transient (days to weeks) processes challenge understanding of how the Southern Ocean moves heat, carbon and other important elements from its surface down to its depths. These processes occur in the mixed layer – a part of the ocean where different water properties combine together. The layer characteristics, such as depth and buoyancy, are key to understanding how these elements move up and down in the ocean.

"We showed that local and transient processes such as storm-induced turbulence, or mesoscale and sub-mesoscale processes developing in the open ocean or at the sea-ice edge might be instrumental in tracer transfer across the base of the mixed layer," explains Sallee. Efforts are ongoing to better comprehend the net effect of these small-scale processes on large-scale Southern Ocean circulation and their impact on climate.

Assessing what causes polynyas to open

Around Maud Rise – a submarine mountain located in the eastern Weddell Sea – anomalous water masses and cross-frontal fluxes can create favourable conditions for the formation of an open-ocean polynya. The latter provides a direct link between the surface and deep ocean. Such a cross-frontal flux is beneficial for Maud Rise because large-scale, horizontal water movement helps divide different water bodies around the edges of this plateau. The strength of this circulation evolves seasonally and is strongly controlled by winds and slightly by sea-ice coverage.

Sea ice, in turn, plays a crucial role in forming dense water on the Antarctic shelf, which is then transformed by interacting with ice shelves and warmer waters. The dense shelf waters are exported off the Weddell shelf mainly through canyons and are linked with the import of warmer deep water.

Investigating the processes controlling bottom waters

"Carbon and heat can enter the Southern Ocean through the formation, export and consumption of bottom waters. The bottom waters from the Weddell Sea are consumed by abyssal mixing processes, which control the overall water circulation in the deep ocean. New findings show that large ocean regions are not connected with this global water movement," explains Sallee.

We investigated key physical processes that control exchanges between the atmosphere, ocean and sea ice by combining various observational and modelling approaches.

Upper ocean processes, polynya events and bottom water formation and consumption combine to ventilate the Southern Ocean. This ventilation allows to propagate climate change signals at depth, which modify the Southern Ocean thermohaline structure. These changes are unequivocal when looking at multi-decadal repeated observations of the Southern Ocean.

SO-CHIC has not only generated and spread new knowledge but also helped ensure its practical application beyond the project itself. The project impact has featured in the Intergovernmental Panel on Climate Change sixth assessment cycle, through its reports and involvement in high-level policy events.

PROJECT
SO-CHIC – Southern Ocean Carbon and Heat Impact on Climate

COORDINATED BY
Sorbonne University in France

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/821001

PROJECT WEBSITE
sochic-h2020.eu

Identifying ice loss 'tipping points' in Antarctica

New climate models developed by the EU-funded TiPACCs project can help researchers to more accurately predict future ice loss in Antarctica, and assess the potential impact on sea level rise.

The Antarctic ice sheet is the largest mass of ice on the planet. It holds over 60 % of the world's fresh water and spreads over an area almost twice the size of Australia.

A key concern is that progressively warmer temperatures in the region have increased ice melt, causing glaciers to retreat and ice shelves to break apart, leading to global sea level rise.

The TiPACCs project was launched to shed new light on this situation, investigating the probability of abrupt, large changes in sea level contribution from the Antarctic ice sheet.

Point of no return

"A key focus was on the stability of the ice sheet itself, as well as on the possibility of it crossing 'tipping points' that could result in sudden changes in sea levels," explains TiPACCs project coordinator Petra Langebroek from the Norwegian Research Centre (NORCE) and the Bjerknes Centre for Climate Research (BCCR). Langebroek coordinated the TiPACCs project together with Svein Østerhus, also from NORCE and BCCR.

Langebroek notes that recent observations and modelling have confirmed a retreat in West Antarctica, especially in the region around Thwaites Glacier. This region is especially vulnerable because warm ocean waters can reach the ice there – other parts of Antarctica are protected by colder coastal waters.

"We wanted to study the entire Antarctica ice sheet, and to check if these coastal shelf seas could switch from a 'cold' state to a 'warm state'," says Langebroek. "We also wanted to know if the ice sheet has or could become unstable – cross a tipping point – due to higher melt rates caused by this." A key inspiration for this was a 2012 modelling study by TiPACCs colleague Hartmut Hellmer, which simulated the intrusion of warmer waters into these ice shelf regions.

Implications for global sea levels

To do this, the project team used numerical models to describe the ocean, and to simulate the ice sheet. Coupling these models helped the team to determine how a 'switching' of the seas surrounding the Antarctic from cold to warm states might occur, what impact this might have on ice sheet integrity, as well as any resulting implications for global sea levels.

"When we started this project, coupled models such as these hardly existed," adds Langebroek. "Through TiPACCs, and other European projects such as PROTECT, we have been able to significantly advance our modelling techniques, and now have several coupled ocean-ice sheet models."

The project's ice sheet models showed consistent results – that the present-day Antarctic ice sheet has likely not crossed a tipping point yet. "This means that the currently observed retreat is not due to a crossed tipping point," notes Langebroek. "If this pattern continues however, the ice sheet will become unstable, with irreversible retreat likely, especially in West Antarctica."

Advancing Antarctic ice sheet research

The project's findings will now feed into global assessment reports, such as those of the Intergovernmental Panel on Climate Change (IPCC). The team also created a policy brief, highlighting what it has learned, and what remaining knowledge gaps exist. For example, producing a holistic view of the Antarctic ice sheet and surrounding ocean, atmosphere and land is recommended.

"I see this project as a huge stepping stone for further Antarctic ice sheet research," concludes Langebroek. "The scientific knowledge gained through the project, especially the improved climate models, can help us to narrow down uncertainties in our projections of future ice loss."

We wanted to know if the ice sheet has or could become unstable – cross a tipping point – due to higher melt rates.

The project has also made their results accessible, with videos and teaching materials. The project has developed a freely available Virtual Antarctica tool, which enables anyone to learn about the frozen continent in an interactive manner.

PROJECT
TiPACCs – Tipping Points in Antarctic Climate Components

COORDINATED BY
Norwegian Research Centre in Norway

FUNDED UNDER
Horizon 2020-ENVIRONMENT

CORDIS FACTSHEET
cordis.europa.eu/project/id/820575

PROJECT WEBSITE
tipaccs.eu

CORDIS Results Pack

Available online in 6 language versions: cordis.europa.eu/article/id/450525

Published
on behalf of the European Commission by CORDIS at the
Publications Office of the European Union
L-2985 Luxembourg
LUXEMBOURG

cordis@publications.europa.eu

This Results Pack is a collaboration between CORDIS and the Directorate-General for Research and Innovation.

@HorizonEU @EUScienceInnov

Print	ISBN 978-92-78-44017-6	ISSN 2599-8285	doi:10.2830/147992	ZZ-AK-24-005-EN-C
HTML	ISBN 978-92-78-44019-0	ISSN 2599-8293	doi:10.2830/578798	ZZ-AK-24-005-EN-Q
PDF	ISBN 978-92-78-44022-0	ISSN 2599-8293	doi:10.2830/067516	ZZ-AK-24-005-EN-N

Luxembourg: Publications Office of the European Union, 2024

RESULTS PACK ON OCEAN OBSERVING

The ocean contains nearly 80 % of all life on Earth. As a source of oxygen, food, and employment, it supports billions of people, and also forms the planet's largest carbon sink. This Results Pack highlights 13 EU-funded research projects focusing on ocean observing and essential actions for its sustainable management.

Check out the Pack here:
cordis.europa.eu/article/id/448426

Publications Office
of the European Union

Follow us on social media too!
facebook.com/EUresearchResults
x.com/CORDIS_EU
youtube.com/CORDISdotEU
instagram.com/eu_science

EN