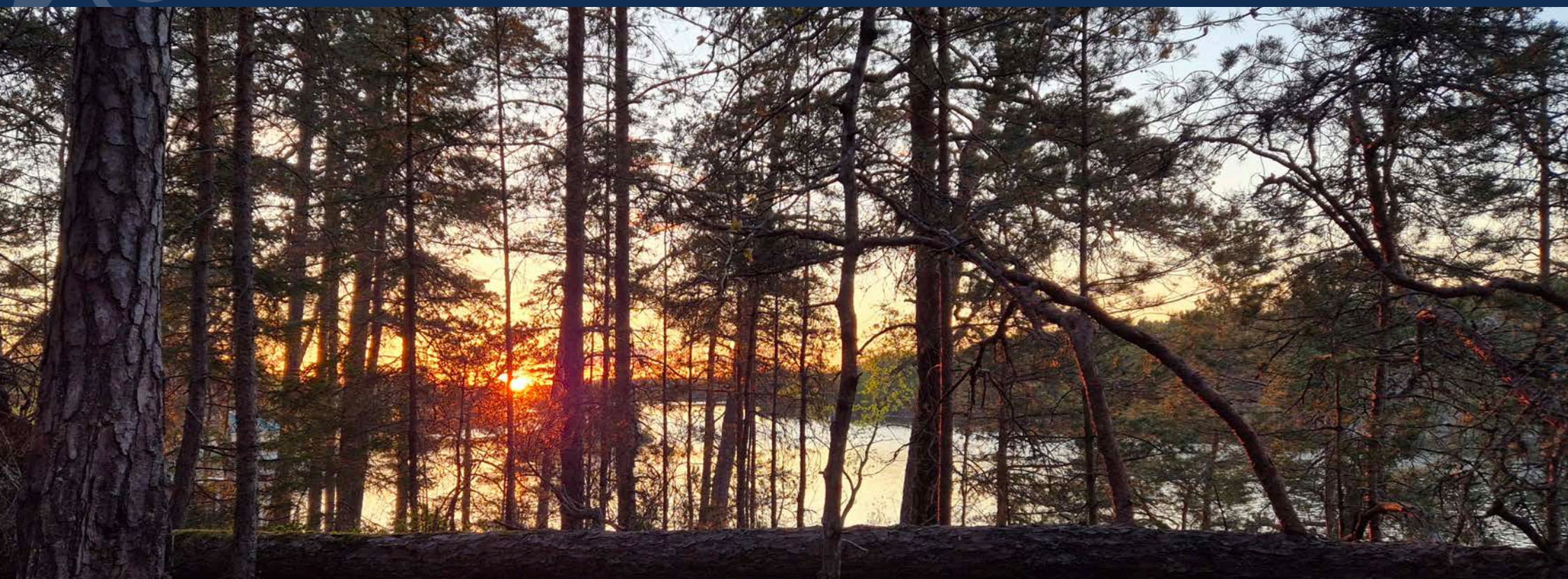




Bolin Centre for Climate Research

Annual Report 2025–2026



Including research highlight articles:

Ocean heat pulses help regulate a key
climate circulation in the North Atlantic

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Climate change threatens the world's tropical
mountain biodiversity hotspots

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Did plants learn to survive the
cold by first surviving drought?

Page 28



Bolin Centre Mission

The mission of the Bolin Centre is to create and communicate fundamental knowledge about the coupled climate system and its interactions with life on Earth in the past, present, and future, and to connect this knowledge to effective societal actions.

Bolin Centre Vision

Our vision is for the Bolin Centre to be a thriving research environment at the international forefront, uniting experts across disciplines, training future generations of climate scientists, and delivering climate knowledge that supports societal action to mitigate and adapt to climate change.

*Cover photo: Inês Jakobsson
Production: Bolin Centre for Climate Research, 2025–2026. Research highlights produced by Laila Islamovic in collaborations with the author(s) of the study in question. The text has been proofread by CBG Konsult & Information AB. Graphic layout by Inês Jakobsson. Printed by Ljungbergs Tryckeri AB, 2026.*

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Photo: Sara Cousins

The Bolin Centre for Climate Research

The Bolin Centre is a multi-disciplinary consortium of more than 400 scientists in Sweden who conduct research, graduate education, and outreach related to the Earth's climate. It was formed in 2006 by Stockholm University (SU), and in 2010 the Royal Institute of Technology (KTH) and the Swedish Meteorological and Hydrological Institute (SMHI) joined the centre. The Bolin Centre is named in honour of Professor Bert Bolin of Stockholm University, a world leader in climate and carbon cycle research.

The Bolin Centre focuses on extending and disseminating fundamental knowledge about the coupled climate system and its interactions with life on Earth; climate-impacting processes; climate modelling; human impact on the climate; and climate impacts on ecosystems, biodiversity, and humanity; as well as the ways in which society can minimise the negative impacts of climate change. It contributes to the knowledge base on climate mitigation and adaptation policies nationally and internationally.

The Bolin Centre is named after Professor Bert Bolin of Stockholm University, one of the founders of the Intergovernmental Panel on Climate Change (IPCC). The work of the IPCC and others led to recognition of the need for cross-disciplinary collaboration on climate science at Stockholm University. This resulted in a Climate Research School being established in 2005, and shortly thereafter, in 2006, the SUCLIM (Stockholm University Climate Research Centre) research programme was awarded a 10-year Linnaeus Grant by the Swedish government.

In 2008, SUCLIM was renamed the Bert Bolin Centre for Climate Research, a name which was afterwards shortened to the 'Bolin Centre for Climate Research' in 2013. In 2010, the Swedish Hydrological and Meteorological Institute and the Royal Institute of Technology joined the Bolin Centre in a collaboration aimed at strengthening climate modelling within the centre. This initiative was funded as a strategic research area by the Swedish government.

In June 2016, the Bolin Centre merged with another strategic research area at Stockholm University: EkoKlim, a multiscale, cross-disciplinary approach to the study of climate change on natural resources, ecosystem services, and biodiversity. This merger widened the scope of the Bolin Centre to include the impacts of climate change on landscape processes and biodiversity. As a result of the merger, the Bolin Centre's strategic funding now surpasses 20MSEK per year.

In early 2023, the Bolin Centre completed a process of redefining its strategic plan and strategic goals for 2023–2027. This collaborative initiative aimed to redefine priorities and unite leadership, Research Theme leaders, and active members in discussions of the centre's essentials and its future development path.

*Bolin Centre for Climate Research
A collaboration between Stockholm University, the Royal Institute of Technology, and the Swedish Meteorological and Hydrological Institute.*



Stockholm
University



SMHI

Organisation

The Bolin Centre aims to bring climate scientists together. The centre follows four Research Themes (RTs), where scientists from different disciplines come together to tackle key questions about climate. The Bolin Centre organises seminars, workshops, conferences, outreach projects and research education.

The Bolin Centre aims to foster collaboration and interdisciplinary research among climate scientists. To this end, the centre has established four Research Themes that bring together experts from diverse fields to address key questions related to climate. In addition, the Bolin Centre organises a range of activities, such as seminars, workshops, conferences, and outreach projects, and also provides research education opportunities.

The Bolin Centre is built around its four multi-disciplinary Research Themes, each of which is led by two (or three) scientists:

Research Theme 1 | The physical-chemical climate system

Research Theme 2 | Water, biogeochemistry and climate

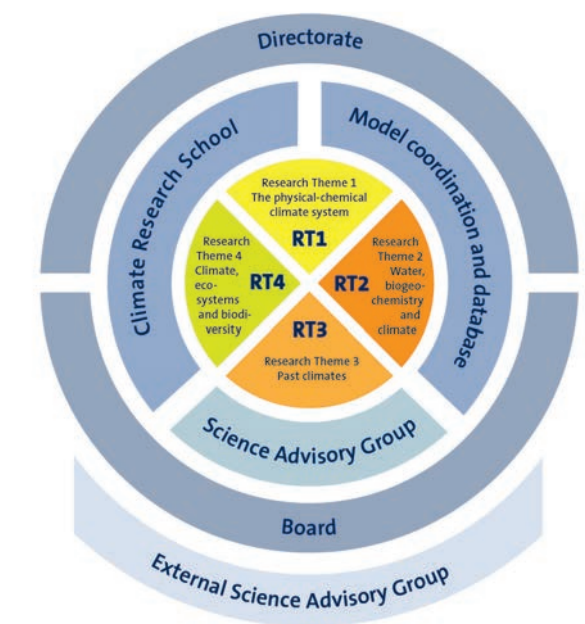
Research Theme 3 | Past climates

Research Theme 4 | Climate, ecosystems and biodiversity.

The centre hosts a research school and an open-access database and also provides communication support and support for climate modelling activities.

The directorate consist of a director, a co-director and a coordinator, who share the centre's daily tasks. All Research Themes' co-leaders and the directorate meet regularly in the Science Advisory Group, working to support climate-related science conducted by the Bolin Centre members.

The Bolin Centre is led by its board, which includes heads of participating departments at Stockholm University, representatives from KTH Royal Institute of Technology and the Swedish Hydrological and Meteorological Institute, and external members. The Bolin Centre receives guidance from its External Science Advisory Group. These internationally recognised leaders in climate science aim to visit the Bolin Centre annually at its internal conference: the Bolin Days.



The operational philosophy of the Bolin Centre is one of mutual respect and trust – a philosophy which is reflected in the form of paired leadership, which is applied throughout the organisation.

Directors’ corner

The mission of the Bolin Centre is to create and communicate fundamental knowledge about the coupled climate system and its interactions with life on Earth in the **past, present, and future**. While our eyes must be on the horizon, only the present moment is real, and to understand it we need to understand the past. This holds equally true for our pursuit in understanding the evolution of the climate system, as well as fulfilling its vision as a thriving research environment at the international forefront.

The academic year of 2025–2026 was marked by intense work toward the strategic goals of the Bolin Centre, as the present strategy period ends at the end of 2027. In practice, this has meant, for instance: 1) vibrant activities organised by the new Early Career Researcher (ECR) council; 2) opening the new *Tellus* journal for submissions and finding resources to make it free for both authors as well as readers (see p. 30); 3) collaborations within and outside the immediate Bolin Centre environments to form new strategic research environments building on the Bolin activities; 4) but also keeping up with the organisation of our flagship activities such as the Bolin days, the Bert Bolin Climate Lecture, and the Swedish Climate Symposium.

Besides activities advancing our strategic goals towards the immediate future, this academic year has also meant learning from the past. This has been supported by excellent input from our External Science Advisory Group (see p. 42), as well as the focus evaluation organised by the Science Faculty within Stockholm University. In the latter, three leading experts (Professor Markku Rummukainen, Professor Camilla Snowman Andresen and Professor Thomas Jung) provided a review of the Bolin Centre activities as well as guidance on how to enhance the scientific and societal added value of our environment even further. Both of these expert groups acknowledged the excellent quality of the research conducted at the centre, but also raised the need to think strategically and highlight our flagship activities, reflected in the use of the funds for research and communication. The added value of the modelling support and Bolin database has proven stronger than ever with expected changes in the resource allocation within the Swedish National Supercomputing landscape, and new initiatives for enhancing open research data (see p. 32 and 34).



Professor Emeritus Henning Rodhe, Bolin Centre Director Ilona Riipinen, Pulitzer Prize–winning journalist and author Elizabeth Kolbert, and Gustaf Arrhenius, great-grandson of Svante Arrhenius. During her visit to the Bolin Centre, Kolbert explored the origins of climate science for her forthcoming book *Under the Glacier*. She discussed Arrhenius’s pioneering 1896 calculations of the warming effect of CO₂ with Henning Rodhe and his scientific legacy with Gustaf Arrhenius. Photo: Deputy director Gustaf Hugelius



Deputy director Gustaf Hugelius at COP30. Photo: private

Looking at the research highlights from the past academic year, water in the climate system seems to be one of the common denominators in many highlights stemming from the RTs – as well as the perspective of learning from the past to better understand the future and guide actions in the present. Becoming even better in communicating our findings is one of the missions that the directorate is taking on during the coming academic year. We need to continuously find new ways to persuade the broader environment and our fellow humans about the necessary actions that need to be taken **now**.



Publications

The total number of publications where researchers have listed an affiliation to the Bolin Centre in 2025 is 303. The total number of publications by researchers listed as Bolin Centre members on our website in 2025 is 641.

The Bolin Centre Database

The Bolin Centre Database promotes research results and visualises data. As of December 2025, the Database hosts more than 500 datasets and several thematic data collections and interactive visualisations. Read more on page 32.

Social media handles

Visit www.bolin.su.se and follow @BolinCentre on LinkedIn, Bluesky and Facebook for the latest research news from us.

Bolin Centre's Strategic Goals for 2023–2027

Bolin Centre seeks to expand its influence across climate-related research disciplines and within Earth System science via the following strategic goals:

Resources

To secure the necessary resources to reach the strategic goals below, including: (i) long-term base funding to sustain the breadth of our research fields and enhance integration across them, particularly in relation to the biosphere component of the Earth system and support infrastructures; (ii) new investments into strategic partnerships; and (iii) external competitive grants raised by Bolin Centre Pls.

Local, regional and national partnerships

To be an integrated key part of the larger research environment for climate and sustainability in Sweden. Regionally, the research and outreach at the Bolin Centre will be aligned with the strategic goals of Stockholm University, the Royal Institute for Technology, the Swedish Meteorological and Hydrological Institute, and synergistic with other collaborating centres.

Integration

To further enhance internal communication and integration of the research within the Bolin Centre, providing an environment that promotes scientific inquiry and output of high-quality peer-reviewed publications, fostering collaboration among Bolin Centre members and RTs.

Infrastructure

To further develop the national landscape for technical support of climate research, including science infrastructures for modelling, observation, and data science as well as the open, fair and transparent publication of scientific data and knowledge in collaboration with other relevant Swedish and international research environments.

Career opportunities

To host a vibrant and diverse community of climate researchers and offer a research environment that sustains their further development. We build a foundation for future employment opportunities for early career researchers through networking and exposure to diverse career pathways. We support and strengthen the recruitment of staff to SU, KTH, and SMHI and offer attractive possibilities for international researchers to visit our research environment.

External communication.

To have a strategic approach to external communication that optimally addresses the growing demand for our expertise by various stakeholders, with a particular focus on future generations of experts, decision-makers, and society members.



Climate and health: advancing solutions through the Stockholm Trio collaboration

In 2024, the Bolin Centre for Climate Research continued to contribute actively to the Stockholm Trio's joint work on climate and health, building on the foundation laid in previous years. Through ongoing interdisciplinary collaboration and research-driven input, the Bolin Centre supported efforts to move from understanding risks to developing actionable solutions – particularly in areas such as sustainable food systems, urban resilience, and the health benefits of climate mitigation. These activities reflected the Bolin Centre's commitment to translating scientific knowledge into practical guidance for policy and planning.

From science to solutions: 2024 Climate and Health Symposium

On November 12, 2024, the Bolin Centre co-led the Second Symposium on Climate and Health, shifting the focus from identifying risks to implementing solutions. Co-organised with the Royal Swedish Academy of Sciences and Stockholm Trio partners, the event brought together researchers, policymakers, and industry leaders to explore how climate-smart food systems and healthier lifestyles can serve both people and the planet.

The Bolin Centre helped shape the agenda, with discussions targeting actionable strategies, cross-sector collaboration, and policy integration. The message was clear: science must not only inform – it must drive change.

Empowering the next generation: student competition

The Bolin Centre supported the “Climate and Health: A Vision for Stockholm 2029” student challenge, led by KTH Climate Action Centre. Promoting the event, joining the organising team, and providing a jury member, the Bolin

Centre helped inspire bold student ideas – from heat-resilient cities to climate-smart diets. The competition showcased the Trio's commitment to engaging young minds in shaping a sustainable future.

Looking ahead, the Bolin Centre's 2024 work within the Stockholm Trio has strengthened the foundation for integrating scientific evidence into climate and health policy. Building on interdisciplinary collaborations, the Bolin Centre is now advancing targeted research areas, including the use of machine learning to better predict climate-related health impacts and define effective points for intervention. Planning has also begun for the 2026 Swedish Climate Symposium, where the Stockholm Trio plans to present joint findings on how climate policy can generate measurable health co-benefits. These initiatives reflect a clear move toward data-driven, applied research that directly supports decision-making and cross-sector solutions.



Illustration: The 2R Artificiality, Adobe Stock

The Bolin Centre Research Themes

Until the end of 2021, the research was structured into eight multi-disciplinary research areas (you can read more about them on our website). Since the beginning of 2022, the Bolin Centre has been organised into the following four Research Themes:

Research Theme 1 | The physical-chemical climate system

Research Theme 1 addresses some of the major knowledge gaps in the physical-chemical climate system. Covering a range of scales, we study aerosols and clouds; the dynamics of the atmosphere, ocean and cryosphere; risk of reaching climate system tipping points and regional effects of global warming; and climate sensitivity and the carbon budget. We develop and use tools ranging from Large Eddy Simulation to Earth system models, ranging from in-situ observations to satellite and reanalysis products.

Co-leaders:

Geert Brethouwer, FLOW, Dept. of Engineering Mechanics, KTH
Léon Chafik, Dept. of Meteorology (MISU), SU
Ramón Fuentes Franco, Rossby Centre, SMHI
Liine Heikkinen, Dept. of Environmental Science (ACES), SU.

Research Theme 2 | Water, biogeochemistry, and climate

Research Theme 2 studies the coupled water and biogeochemical cycles and their interactions with climate and society over multiple spatial and temporal scales. Our ultimate goal is to define the adaptation necessary to address climate risks related to these cycles and to guide policy towards the mitigation of these risks. For this task, we rely on field- and space-based observations, modelling, monitoring, and experiments on land, in the ocean, and in the atmosphere.

Co-leaders:

Volker Brüchert, Dept. of Geological Sciences (IGV), SU
Fernando Jaramillo, Dept. of Physical Geography (NG), SU (until early 2026)
Julie Lattaud, Dept. of Environmental Science (ACES), SU (from early 2026)
Andrea Popp, Hydrology Department, SMHI
Anna Scaini, Dept. of Physical Geography (NG), SU (from early 2026).

Research Theme 3 | Past climates

Research on past climates encompasses climate variability on tectonic, orbital, millennial, centennial, and historical timescales. We use a wide range of geoscientific data to reconstruct the evolution of the climate system, including its landscapes and ecosystems, from local to global scales. Climate models are used to simulate extreme climate states in the past, and to study impacts, mechanisms, and feedback operating in the climate system under different climate forcings. Past climates provide a thorough test of models to project future changes in a confident way.

Co-leaders:

Frederik Schenk, Dept. of Geological Sciences (IGV), SU
Fredrik Charpentier Ljungqvist, Dept. of History, SU
Natasha Barbolini, Dept. of Ecology, Environment, and Plant Sciences (DEEP), SU
Margret Steinthorsdottir, Swedish Museum of Natural History, affiliated with Dept. of Geological Sciences (IGV), SU.

Research Theme 4 | Climate, ecosystems, and biodiversity

Research on climate, ecosystems, and biodiversity at the Bolin Centre aims to understand how the climate affects ecological, evolutionary, and biophysical processes, as well as to understand the possible feedback of these processes on climate and human use of land and water. The research relies on using field observations, experiments, and modelling to examine the effects of the climate on different aspects of ecosystems and biodiversity.

Co-leaders:

Stefano Manzoni, Dept. of Physical Geography (NG), SU
Rhonda Snook, Dept. of Zoology, SU.



Please note that the list of SAG RT co-leaders is accurate as of December 2025. Later changes to the SAG leadership may have occurred. The most up-to-date information can be found on our website: www.su.se/bolin-centre-for-climate-research/about-the-centre/organisation

RT1 | Black carbon: a small particle with a big impact on climate

Black carbon, commonly known as soot, is one of the most important yet uncertain contributors to climate change. Produced by the incomplete burning of fossil fuels, biomass, and other fuels, these tiny particles absorb sunlight, warm the atmosphere, influence clouds, and can accelerate the melting of snow and ice. Unlike carbon dioxide, which remains in the atmosphere for centuries, black carbon persists only for days to weeks. This means that reducing emissions can deliver climate and air-quality benefits relatively quickly. A major review co-authored by Research Theme 1 member Örjan Gustafsson provides the most up-to-date assessment of black carbon in the climate system, bringing together observations and modelling studies from around the world.

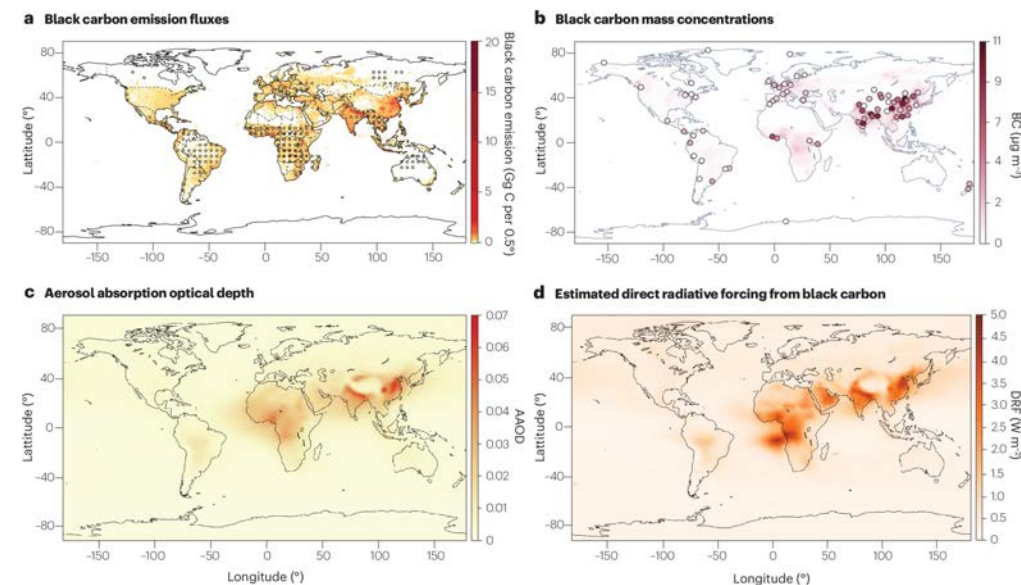
Tracking the sources of atmospheric soot

The study highlights how the sources of black carbon vary considerably between regions. Using isotopic “fingerprints”, researchers can identify whether black carbon originates primarily from biomass burning, such as wildfires and household cooking, or from fossil fuel combustion. The review shows that biomass burning dominates black carbon emissions in parts of Africa, while fossil fuels make up a larger contribution in many industrialised regions.

The authors also document how atmospheric black carbon concentrations have changed over recent decades. Levels have generally declined across Europe, North America, South America, and East Asia, reflecting the success of cleaner technologies and air-quality regulations. In contrast, concentrations have stabilised rather than decreased in parts of Africa and South Asia, where rapid societal development and population growth continue to drive emissions.

An underestimated climate influence

Although scientists have studied black carbon for decades, major uncertainties remain. The review finds that climate models often underestimate how strongly black carbon absorbs sunlight and how much warming it can produce in key emission regions. Observations suggest that atmospheric black



A global overview of black carbon in the atmosphere, showing regional differences in sources and concentrations. Understanding these patterns is essential for improving climate models and reducing uncertainty in future climate projections.

carbon frequently absorbs more solar energy than current models simulate, particularly after particles have aged and mixed with other substances during transport through the atmosphere.

These discrepancies matter because black carbon affects much more than just temperature. By altering atmospheric heating, it can influence humidity, clouds, precipitation patterns, and regional climate systems. Black carbon deposited on snow and ice can also reduce surface reflectivity, allowing more solar energy to be absorbed and increasing melt rates in vulnerable regions such as the Arctic and in high mountain environments.

Improving climate predictions and mitigation strategies

The review concludes that a closer integration of observations and modelling is needed to better quantify black carbon’s role in the climate system. Improved emission inventories, expanded monitoring networks, and more accurate representations of particle properties in climate models will help reduce uncertainty and strengthen future climate projections.

Because black carbon is both an air pollutant and a climate forcer, reducing emissions offers a unique opportunity to improve public health while simultaneously slowing near-term warming. By providing a comprehensive assessment of the current state of knowledge, this review helps guide future research and informs efforts to develop effective climate mitigation policies.

This research highlight is based on the scientific publication *Atmospheric black carbon in the climate system*, published in Nature Reviews Earth & Environment (2026), DOI: [10.1038/s43017-026-00773-3](https://doi.org/10.1038/s43017-026-00773-3).

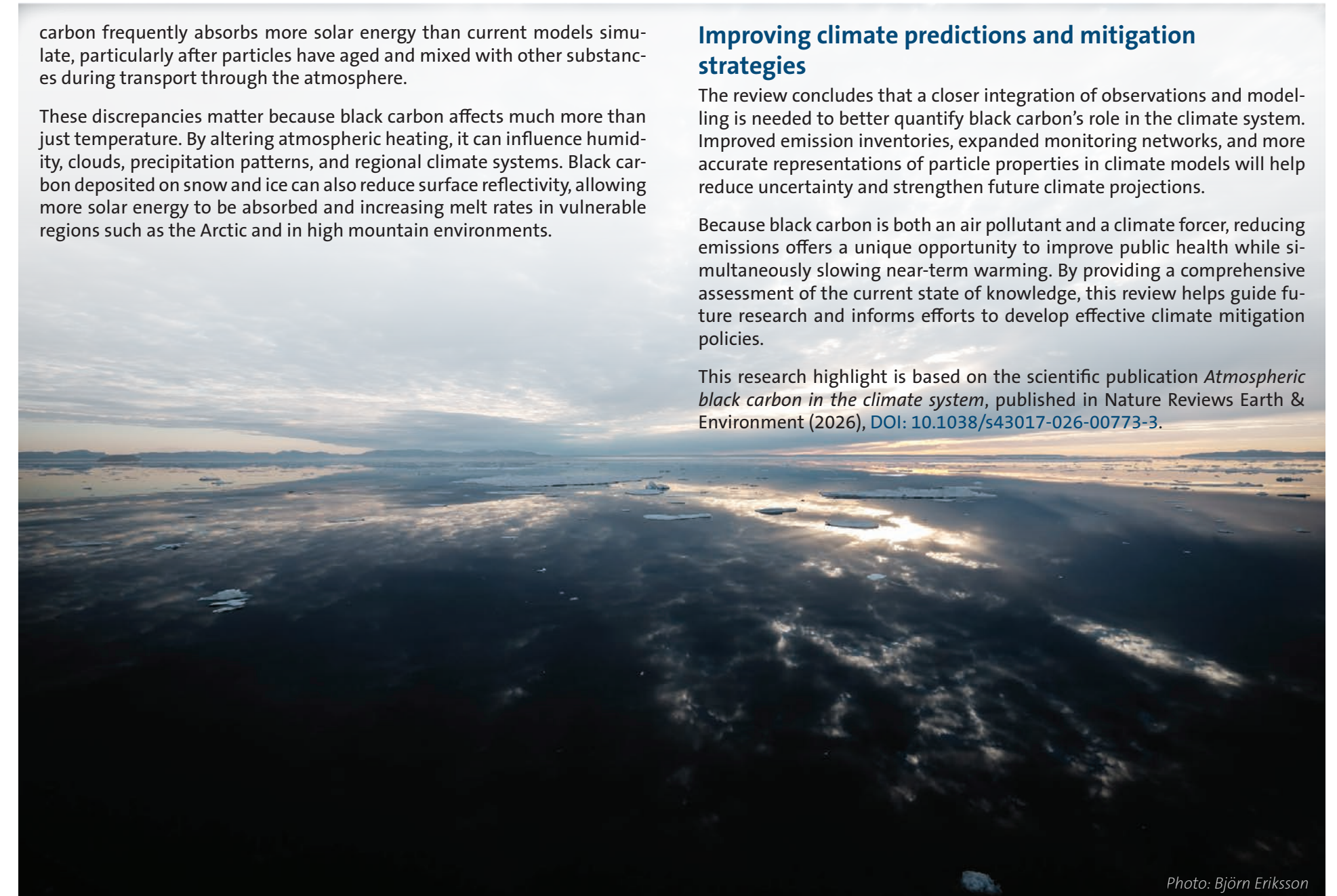


Photo: Björn Eriksson

RT1 | Ocean heat pulses help regulate a key climate circulation in the North Atlantic

Ocean currents transport heat across the North Atlantic and play an important role in regulating climate in northern Europe and the Arctic. A study led by Research Theme 1 co-leader Léon Chafik shows that slowly moving temperature and salinity anomalies travelling north through the Atlantic help control a key part of this circulation system. The findings improve our understanding of how ocean-driven climate variability develops over years to decades.

A climate signal travelling through the ocean

The researchers focused on the flow of warm Atlantic water entering the Nordic Seas, the region between Greenland, Iceland, and Scandinavia. By analysing ocean observations collected over several decades, they discovered that changes in this inflow are linked to large-scale temperature and salinity anomalies that slowly propagate northward through the Atlantic Ocean.

These anomalies, sometimes called “thermohaline anomalies”, can be thought of as large bodies of unusually warm and salty water, or unusually cold and fresh water, that move with the ocean currents. The study shows that these signals originate in the North Atlantic and gradually travel north along the North Atlantic Current, eventually reaching the Nordic Seas and the Arctic Ocean.

Remarkably, the journey can take many years. The researchers identified recurring cycles lasting approximately 10 to 14 years, providing a mechanism through which climate signals generated in one part of the Atlantic can influence conditions thousands of kilometres away.

More than passive ocean signals

Previous studies have shown that temperature and salinity anomalies move through the North Atlantic. However, this study demonstrates that these signals do more than simply travel with the currents. They actively influence the strength of the circulation itself.



Photo: Michael Tjernström

When warm and salty anomalies reach the eastern North Atlantic, they increase the northward transport of Atlantic water into the Nordic Seas. This stronger inflow is accompanied by enhanced formation of dense waters that flow back southward at depth. Conversely, cold and fresh anomalies weaken both the inflow and the return flow.

In other words, the study reveals a tightly connected system in which changes originating in the mid-latitude Atlantic can influence both the amount of heat transported northward and the sinking of dense water that helps maintain the overturning circulation.

Why this matters for climate prediction

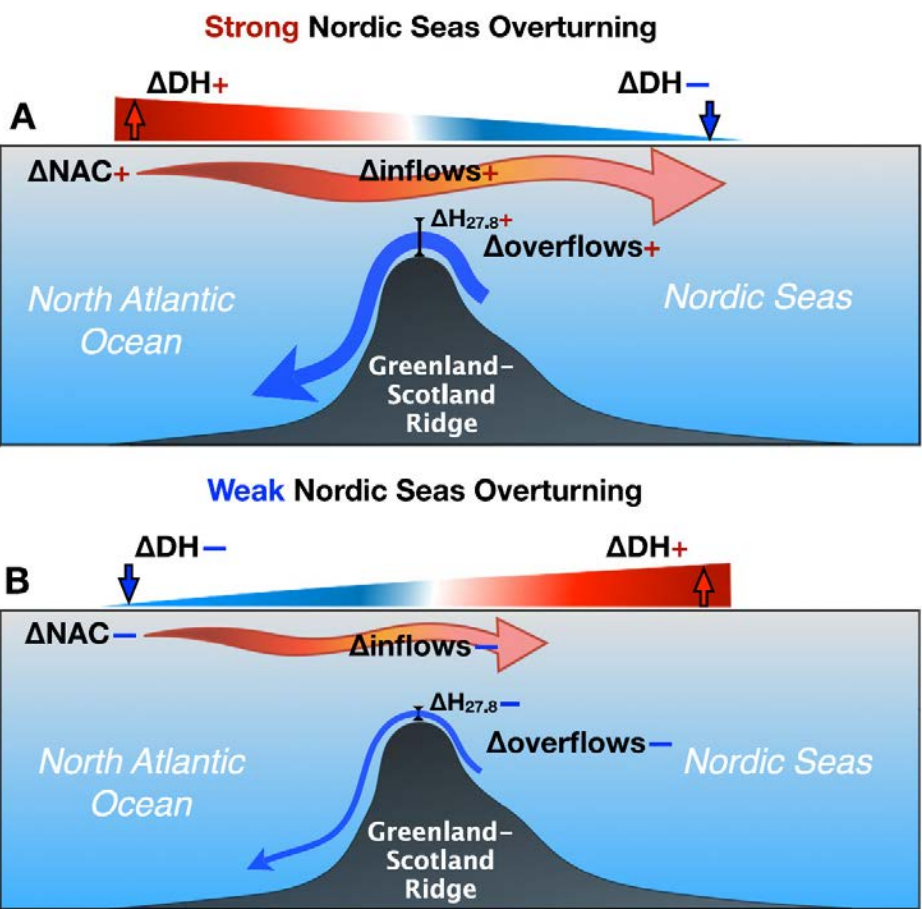
The Atlantic overturning circulation is one of the most important components of Earth’s climate system, influencing weather patterns, marine ecosystems, and regional climates, particularly across Europe and the North Atlantic region. Understanding the processes that regulate its variability is therefore essential.

The study shows that slowly propagating ocean anomalies provide a source of climate predictability on timescales of years to decades. Because these signals can be tracked as they move northward through the Atlantic, they may help scientists anticipate future changes in ocean circulation and regional climate.

Importantly, the researchers also found no evidence of a long-term slowdown in the Nordic Seas overturning circulation over the observational period. Instead, the system appears to undergo substantial natural variability driven by the arrival of these large-scale ocean anomalies.

By identifying the physical mechanism linking heat transport in the North Atlantic to circulation changes farther north, the study sheds new light on how different parts of the ocean are connected and why the Atlantic remains a key source of climate predictability.

This research highlight is based on the scientific publication *The Nordic Seas overturning is modulated by northward-propagating thermohaline anomalies*, published in *Communications Earth & Environment* (2025), DOI: [10.1038/s43247-025-02557-x](https://doi.org/10.1038/s43247-025-02557-x).



Warm and salty water anomalies travelling north through the Atlantic can strengthen the flow of Atlantic water into the Nordic Seas, while cold and fresh anomalies have the opposite effect. These oceanic signals help regulate a key component of the Atlantic overturning circulation and influence climate variability on timescales of years to decades.

RT2 | Climate change threatens the world's tropical mountain biodiversity hotspots

Humid high-elevation tropical ecosystems are among the world's most unique environments. Found in mountain regions of South America, Africa, and Australasia, they harbour exceptional biodiversity and provide vital ecosystem services, including water regulation for millions of people. A new study involving Research Theme 2 co-leader Fernando Jaramillo shows that climate change could push many of these ecosystems beyond the temperature and rainfall conditions under which they currently exist.

Unique ecosystems with limited room to move

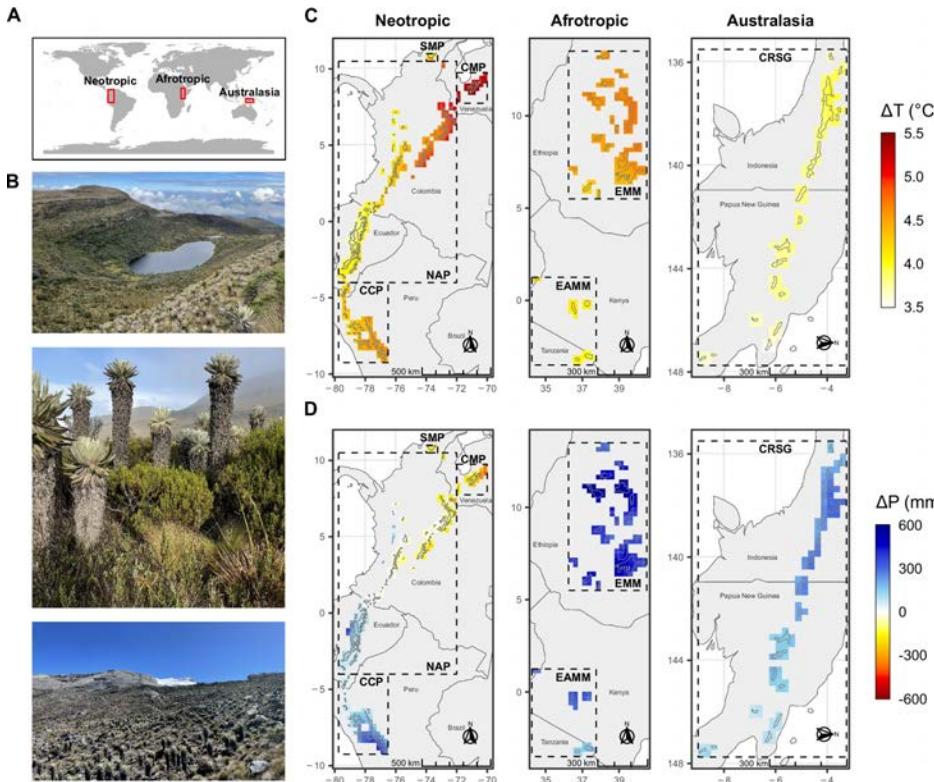
Humid high-elevation tropical ecosystems occur between the upper forest line and the permanent snow line in tropical mountain regions. Despite covering relatively small areas, they are biodiversity hotspots supporting remarkably high levels of species richness and endemism. For example, the Northern Andes alone host thousands of plant and animal species, many of which occur nowhere else on Earth.

These ecosystems are naturally fragmented across isolated mountain ranges. Over recent decades, land-use change has further increased this fragmentation, making it more difficult for species to move in response to changing environmental conditions. As temperatures continue to rise, many species may have limited opportunities to migrate to suitable habitats.

Future climates unlike anything seen today

The researchers used high-resolution climate projections from the latest generation of climate models to investigate how future temperature and precipitation patterns may alter the hydroclimatic conditions that currently define

Humid high-elevation tropical ecosystems occur in mountain regions across South America, Africa, and Australasia. Climate projections indicate substantial increases in temperature and, in some regions, declining precipitation, threatening the hydroclimatic conditions that currently support these biodiversity-rich ecosystems.



Sierra Nevada del Cocuy, Colombia. Photo: Juan Felipe Ramírez @pexels.com

these ecosystems. Rather than examining temperature or rainfall separately, the study focused on the broader “hydroclimatic space” in which these ecosystems have developed and persisted.

The results indicate that many humid tropical mountain ecosystems could experience climate conditions that fall outside their current hydroclimatic range by the end of the century under a high-emissions scenario. The strongest changes are projected for northern South America, where ecosystems are expected to face both substantial warming and declining precipitation. In some regions, the current hydroclimatic space could be breached entirely.

Humid high-elevation ecosystems in Africa and Australasia are also projected to experience significant changes, particularly in temperature extremes and seasonal climate patterns. Together, these results suggest that many of the environmental conditions that currently support these ecosystems may disappear within decades.

Implications for biodiversity and water resources

The findings highlight the vulnerability of tropical mountain ecosystems to ongoing climate change. Because these environments support unique species assemblages and provide essential ecosystem services, changes to their hydroclimatic conditions could have far-reaching consequences for both biodiversity and human societies.

By identifying regions where climate change is most likely to exceed current environmental limits, the study provides valuable information for conservation planning and climate adaptation strategies. Protecting connectivity between habitats, reducing other human pressures, and strengthening ecosystem resilience may become increasingly important as tropical mountain regions face unprecedented climatic conditions.

This research highlight is based on the scientific publication *Current hydroclimatic spaces will be breached in half of the world's humid high-elevation tropical ecosystems*, published in *Communications Earth & Environment* (2025), DOI: 10.1038/s43247-025-02087-6.

RT2 | How retreating ice sheets transformed groundwater beneath the seafloor

Groundwater flowing beneath the seafloor is one of the least understood links between land and ocean. Yet these hidden flows transport freshwater, nutrients, and dissolved substances that can influence marine ecosystems and coastal biogeochemical cycles. A study involving members of Research Theme 2 reveals how the retreat of the Fennoscandian Ice Sheet fundamentally transformed groundwater circulation beneath the Norwegian continental shelf thousands of years ago.

A hidden groundwater system beneath the ocean

Offshore northern Norway, submarine canyons cut into the seafloor near the edge of the continental shelf. Here, researchers have discovered unusual ecosystems characterised by white microbial mats, carbonate crusts, and tube-dwelling organisms. These features are sustained by groundwater and methane slowly seeping from sediments beneath the seabed.

What makes these systems particularly remarkable is their location: nearly 80 kilometres offshore and around 800 metres below the sea surface. The groundwater feeding these ecosystems has remained hidden beneath the seafloor since the last Ice Age.

The legacy of the last Ice Age

During the last glacial period, the vast Fennoscandian Ice Sheet covered northern Europe and extended across the continental shelf. Meltwater from the ice sheet infiltrated the subsurface, while the immense weight of the ice increased pressure within underground aquifers. This pressure helped drive freshwater deep into offshore sediments, creating a large groundwater reservoir beneath the seafloor.

To reconstruct the history of this system, the researchers combined radiocarbon dating, sediment and porewater chemistry, and numerical modelling. Their results reveal that major changes occurred following deglaciation as the ice sheet retreated and the pressure driving groundwater flow gradually disappeared.

When freshwater gave way to seawater

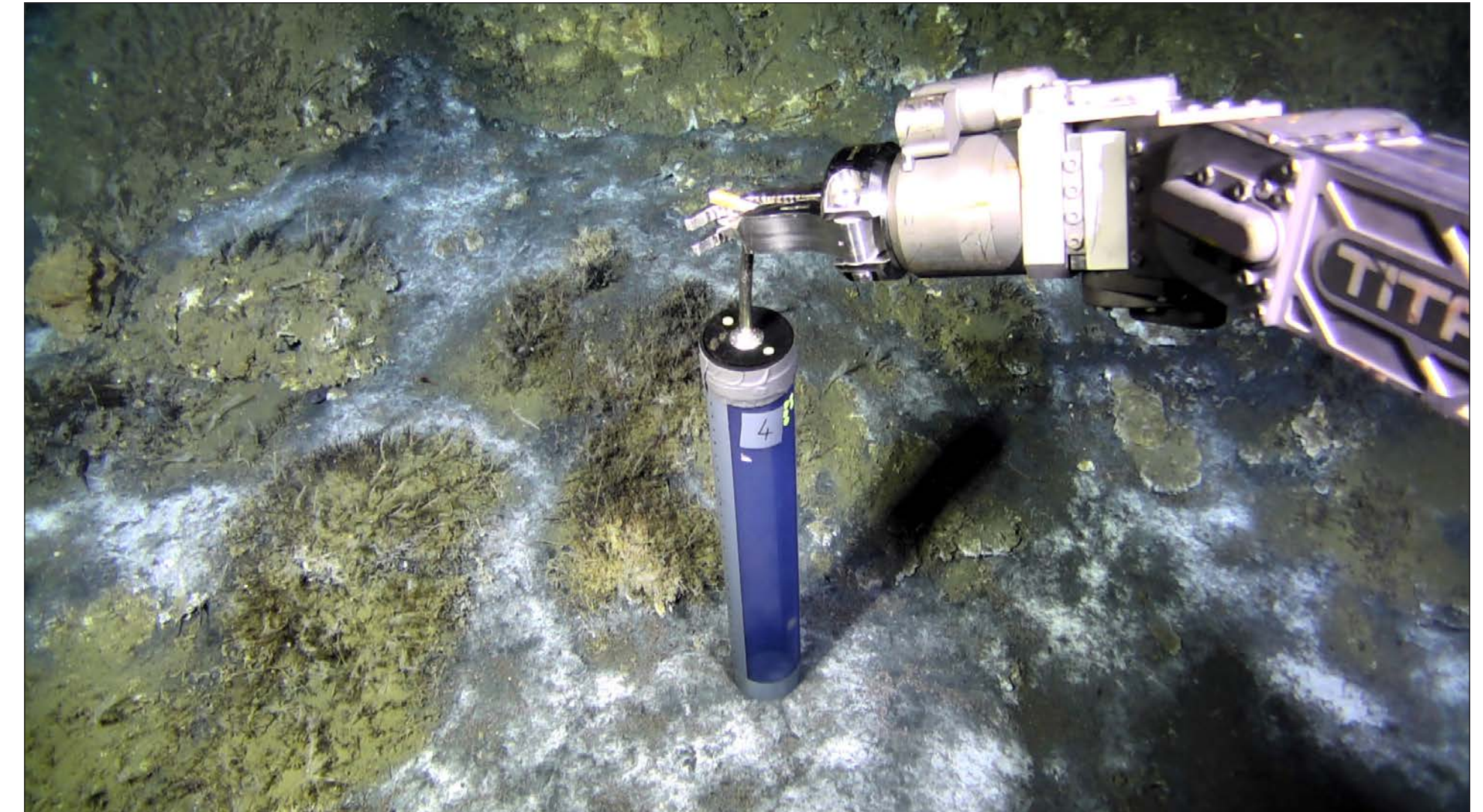
The study shows that seawater began infiltrating the continental margin between approximately 11,500 and 2,600 years ago. Over time, the seawater progressively replaced the freshwater that had accumulated beneath the ice sheet during the glacial period.

As the pressure exerted by the ice sheet disappeared, groundwater flow slowed substantially. The amount of groundwater discharging into the ocean declined, reducing the transport of dissolved substances from the subsurface to marine environments. Evidence for this transition remains preserved in minerals formed within the sediments, which act as geological archives of past groundwater conditions.

Lessons for a warming world

The findings reveal how large-scale climate changes can reshape groundwater systems far beneath the seafloor and over thousands of years. They also provide a rare observational record of how offshore groundwater systems respond to the advance and retreat of major ice sheets.

As glaciers and ice sheets continue to shrink in response to modern climate change, similar processes may already be underway in currently glaciated regions. By examining the long-lasting legacy of past ice sheets beneath the Norwegian continental shelf, researchers gain valuable insights into how hidden groundwater systems may evolve in the future and how these changes could influence coastal and marine environments.



Still frame from a video showing Microbial mats and carbonate crusts on the seafloor of the Lofoten-Vesterålen margin, northern Norway. These ecosystems are sustained by groundwater and methane slowly seeping from sediments beneath the seabed.

This research highlight is based on the scientific publication *Deglaciation drove seawater infiltration and slowed submarine groundwater discharge*, published in Nature Geoscience (2025), DOI: [10.1038/s41561-025-01750-z](https://doi.org/10.1038/s41561-025-01750-z).

RT3 | Clues from the Miocene: when the Atlantic overturning circulation first emerged

The Atlantic Meridional Overturning Circulation (AMOC) is one of the most important ocean circulation systems in the modern climate. By transporting heat northward through the Atlantic Ocean, it helps shape temperatures, precipitation patterns, and weather across Europe and beyond. Understanding how this circulation responds to a warmer climate is therefore crucial. A new study led by members of Research Theme 3 investigates ocean circulation during the Miocene, a period around 20 to 12 million years ago when atmospheric carbon dioxide levels were comparable to those expected in the coming century.

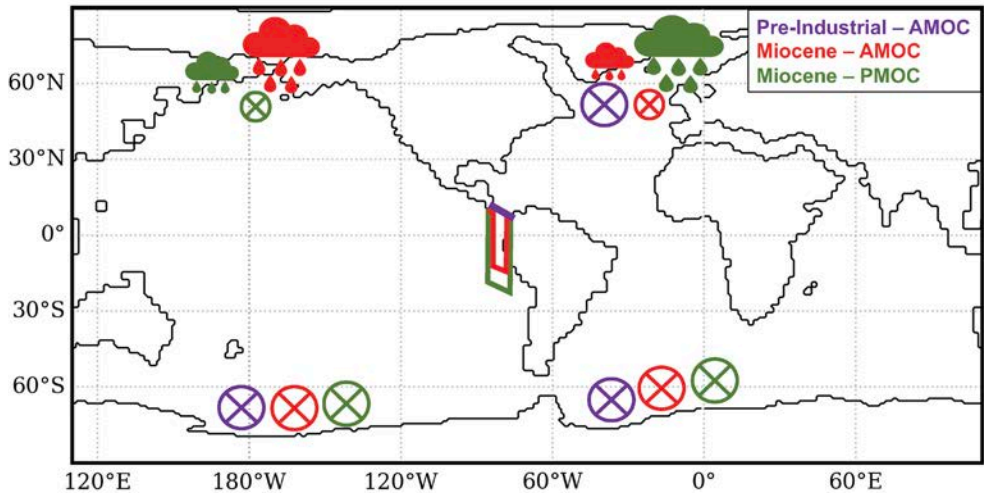
Looking to the past for answers about the future

Future climate projections rely heavily on numerical models, but evaluating how well these models represent long-term climate processes is challenging. Modern observations cover only a short period and do not capture the full range of climate conditions that Earth may experience in a warmer world. Past climate states therefore provide valuable opportunities to test our understanding of the climate system.

The Miocene represents a particularly interesting period in Earth's history. It falls between the very warm Eocene, when deep water formed mainly around Antarctica, and the cooler climate of today, where deep waters form both in the Southern Ocean and the North Atlantic. Understanding how ocean circulation operated during this transition can help scientists better understand the mechanisms controlling the AMOC.

A world between two circulation states

The researchers analysed an ensemble of climate model simulations from the Miocene Model Intercomparison Project (MioMIP1). Across all simulations, the Arctic Ocean remained substantially fresher than today, and deep-water formation continued to be dominated by the Southern Ocean. However, unlike simulations of the earlier Eocene, many Miocene simulations showed signs of an emerging Atlantic overturning circulation.



Conceptual summary of Miocene ocean circulation. During the Miocene, deep-water formation may have occurred in either the North Pacific or the North Atlantic, depending on factors such as ocean gateways, topography, and freshwater inputs. The period represents an intermediate stage between ancient circulation patterns and the modern Atlantic overturning circulation.

The study also found evidence that some simulations supported deep-water formation in the Pacific Ocean, known as the Pacific Meridional Overturning Circulation (PMOC). Whether deep waters formed primarily in the Pacific or the Atlantic depended on several factors, including the depth of the Panama Seaway, mountain elevations, and regional freshwater input to the ocean.

Water entering the ocean as precipitation, rivers, or meltwater reduces salinity and makes it harder for surface waters to sink. The simulations show that regions receiving more freshwater generally developed weaker overturning circulation, highlighting the strong influence of the global water cycle on ocean circulation patterns.

The birth of a modern ocean circulation

The results suggest that the Miocene occupied an intermediate state between ancient and modern ocean circulation regimes. Pacific overturning circulation may have been present during the early Miocene, while a weak AMOC became increasingly established during the middle Miocene.

As the first comprehensive multi-model assessment of Miocene deep-ocean circulation, the study provides important insight into how large-scale ocean currents develop under warmer climate conditions. By revealing how ocean gateways, freshwater inputs, and atmospheric conditions influence overturning circulation, the findings help scientists better understand how this critical component of Earth's climate system may respond to future warming.

This research highlight is based on the scientific publication *Ocean Meridional Overturning Circulation During the Early and Middle Miocene*, published in *Paleoceanography and Paleoclimatology* (2025), DOI: [10.1029/2024PA005055](https://doi.org/10.1029/2024PA005055).



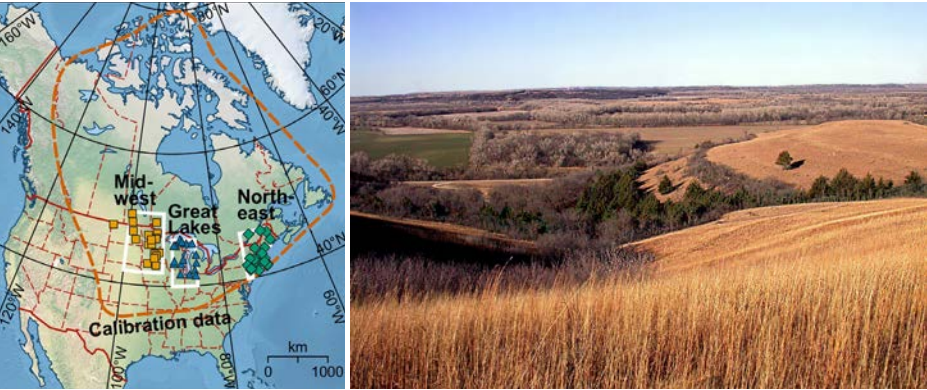
Stokes Bay, SA, Australia. Photo: Vlad Kutepov @pexels.com

RT3 | Warming trends drove past megadroughts in North America during the Holocene

Rapid greenhouse gas-driven warming will strongly reshape regional hydrology, yet climate models often disagree even on the direction of future precipitation changes. For ecosystems, the key question is whether any increase in rainfall can offset rising evapotranspiration. A new study involving researchers from Research Theme 3 uses paleoclimate records and climate model simulations to investigate these dynamics. The study focuses on the Holocene expansion and retreat of the North American prairies, where proxy reconstructions and climate models have long disagreed on millennial-scale water balance trends, until now.

Evidence of past megadroughts

The Dust Bowl of the 1930s is a haunting example of the severe ecological and agricultural destruction that can result from a combination of natural and human factors. But how unusual are multi-year periods of severe drought like those experienced during the 1930s?



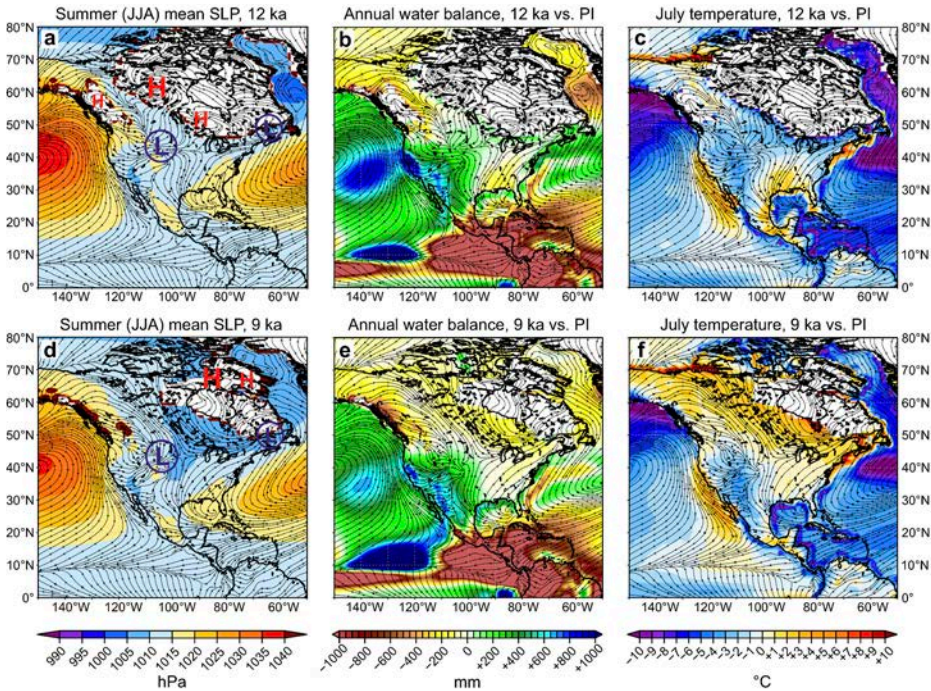
East-west transect across the prairies and transitional areas with temperate forests.
Photo: Edwin Olson/Wikimedia Commons

Proxy evidence from the past approximately 12,000 years suggests that recent millennia have been relatively humid. Earlier in the Holocene, however, millennial-scale megadroughts caused a much wider expansion of prairies, particularly during the mid-Holocene. New multi-method pollen-based reconstructions in this study, comparing traditional statistical approaches with new machine-learning methods, largely confirm previous results.

For several decades, older climate model simulations disagreed with this proxy evidence, preventing scientists from confidently identifying the drivers of these megadroughts. In the new study, high-resolution paleoclimate simulations performed at the Bolin Centre resolve this inconsistency for the early Holocene using CESM1 and for the past 8,000 years using EC Earth, with the results further supported by MPI-ESM simulations from Hamburg.

Disentangling the drivers of millennial megadroughts

In addition to July temperatures, climate calibrations based on modern pollen surface samples confirm that the reconstructions perform well in capturing annual water balance. When applied to the past, changes in pollen retrieved from lake sediments reflect the effects of annual water balance on vegetation over time and space, providing evidence for millennial-scale megadroughts in North America.

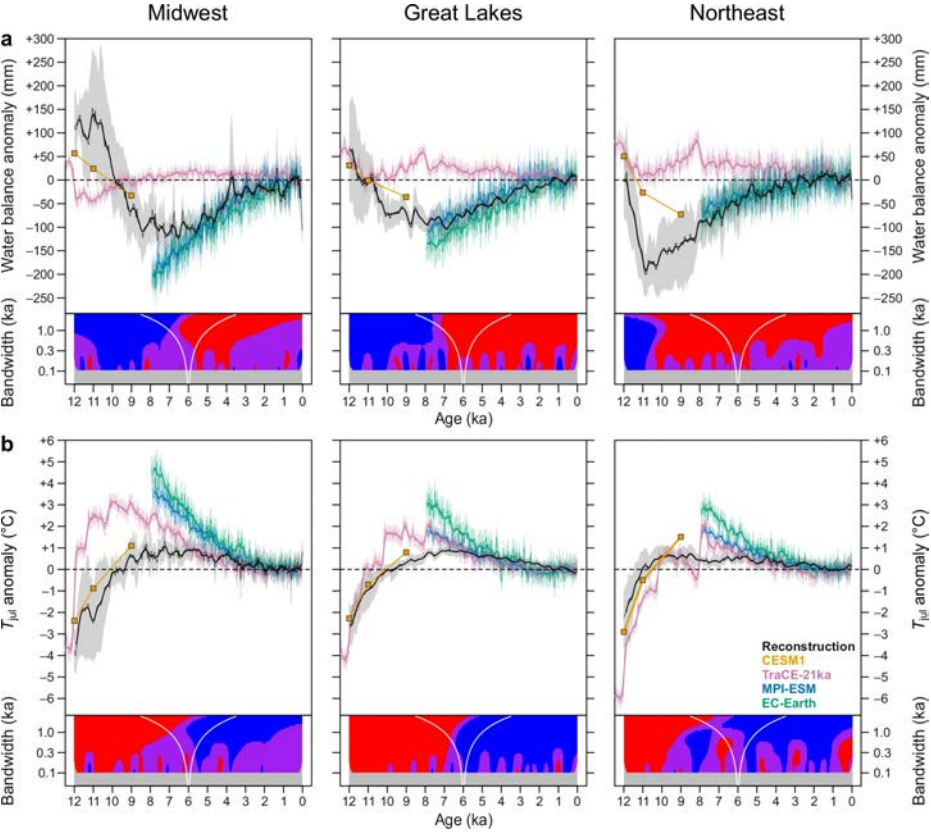


Climate models can then help disentangle the main drivers of these water balance trends by separating the effects of annual precipitation and temperature-driven potential evapotranspiration.

In the early Holocene, cold summers and low evaporation allowed relatively humid conditions to persist despite very low annual precipitation. As summers rapidly warmed, evaporation increased strongly while precipitation remained low, resulting in millennial-scale megadroughts driven by high summer temperatures. Neoglacial cooling during the last millennia, together with a continued increase in annual precipitation, led to the relatively humid conditions experienced today. Simulations for the future indicate a return to drier conditions, again driven by warming.

Retreating Laurentide Ice Sheet changes the North American climate

High-resolution climate simulations with CESM1 reproduce the northward retreat of anticyclonic circulation as the Laurentide Ice Sheet disappeared during



Pollen-based reconstructions compared with climate model simulations of long-term trends in annual water balance anomalies and July temperatures in North America. Reconstructions show the ensemble mean and spread of multiple methods. Snapshot (CESM1) and transient model simulations (TraCE-21ka, MPI-ESM and EC Earth) are used for comparison. The new high-resolution models reproduce reconstructed long-term trends and spatial shifts in annual water balance.

the early Holocene. The shift from humid towards increasingly dry conditions was further enhanced by high summer insolation. Warmer summers increased evapotranspiration, contributing to the westward expansion of prairies.

This research highlight is based on the scientific publication *Patterns and drivers of Holocene moisture variability in mid-latitude eastern North America*, by Salonen et al., published in Nature Communications in 2025. The visuals are from the original publication, unless stated otherwise. DOI: [10.1038/s41467-025-58685-7](https://doi.org/10.1038/s41467-025-58685-7).

RT4 | The ocean economy's blind spot: why corporate transparency matters for marine sustainability

The ocean economy is expanding rapidly. Industries such as shipping, seafood production, offshore energy, tourism, and marine biotechnology are transforming how humans use the ocean, creating economic opportunities while placing growing pressure on marine ecosystems. A new study led by Research Theme 4 members examines how major corporations report their environmental impacts and reveals a surprising gap: while climate-related impacts are increasingly well-documented, many pressures on marine ecosystems remain largely invisible.

Who is shaping the future of the ocean?

A relatively small number of large companies dominate the global ocean economy. These corporations influence vast areas of the ocean through activities such as fishing, shipping, energy production, and resource extraction. Understanding how these activities affect marine ecosystems is essential for managing ocean sustainability and protecting biodiversity.

Many companies publish annual sustainability reports outlining their environmental performance. These reports are increasingly important tools for investors, regulators, researchers, and the public, helping them evaluate environmental risks and track progress toward sustainability goals.

Plenty of climate data, little information about biodiversity

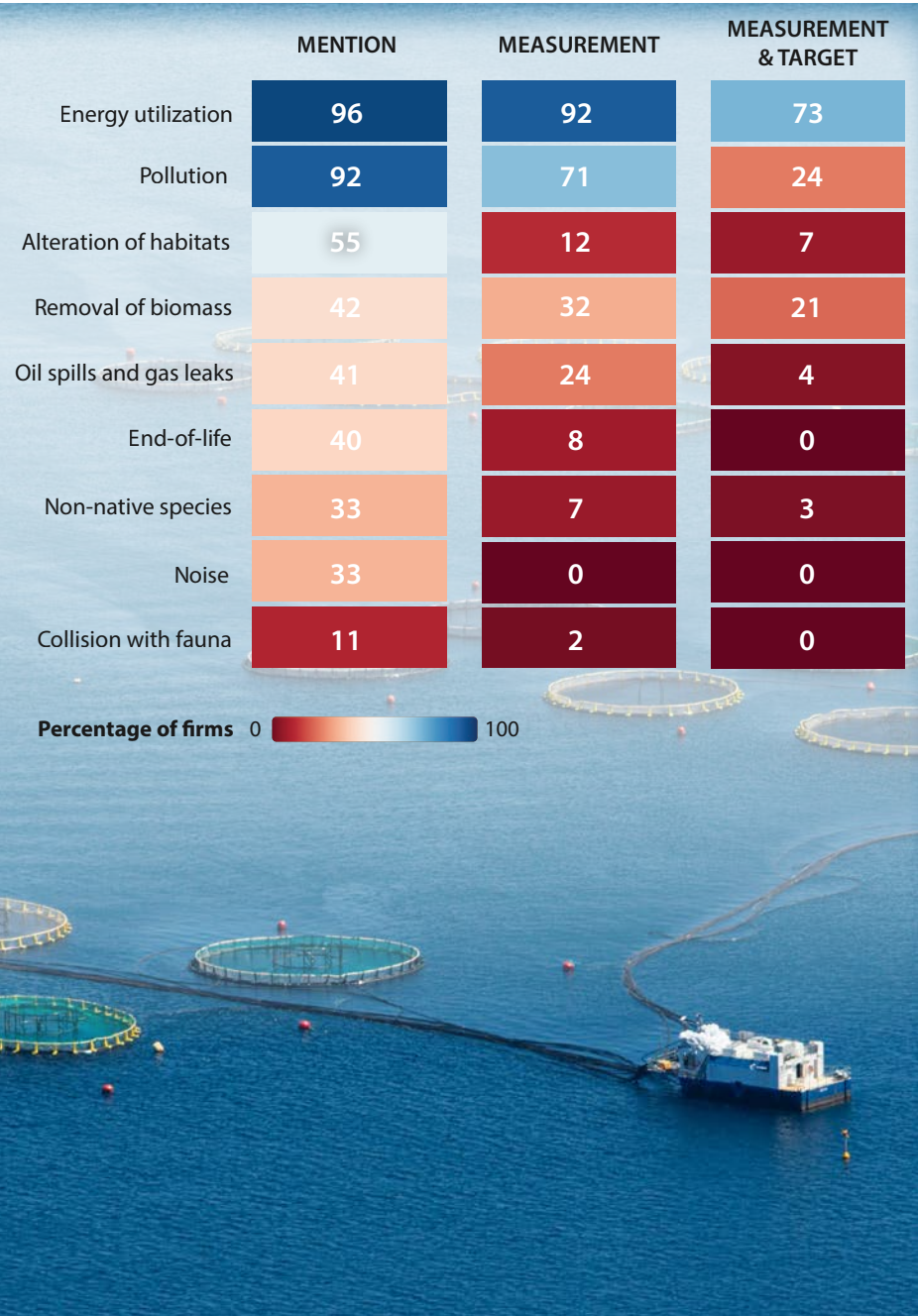
The researchers analysed sustainability and annual reports from 75 of the world's largest companies operating across eight major ocean industries. The goal was to understand which environmental impacts are measured, how they are reported, and whether companies establish targets to reduce them.

The results revealed a stark contrast between climate reporting and reporting of other ocean impacts. Most companies disclosed information about greenhouse gas emissions and energy use, reflecting the growing influence of climate reporting standards. However, impacts such as habitat destruction, overfishing, underwater noise, and the spread of invasive species were reported far less frequently.

The study identified 443 different environmental indicators across company reports, indicating little agreement on what should be measured and reported. Biodiversity-related impacts were particularly poorly represented: fewer than one-third of companies reported any biodiversity indicators, and no single indicator was used consistently across the sector.

Why transparency matters

Effective environmental governance depends on reliable information. Without consistent reporting, it becomes difficult to assess environmental performance, compare companies, identify risks, or evaluate whether sustainability commitments are being achieved.



The study highlights how climate reporting has advanced considerably over recent decades, while reporting on biodiversity and ocean ecosystem impacts has lagged behind. As governments, financial institutions, and businesses increasingly recognise nature-related risks, improving transparency around corporate impacts on marine ecosystems will become increasingly important.

Supporting a more sustainable ocean economy

Whether the ongoing industrialisation of the ocean ultimately supports sustainability or accelerates environmental decline depends in part on society's ability to hold companies accountable for their impacts. The researchers argue that improved disclosure standards could help make those impacts visible, allowing policymakers, investors, scientists, and civil society to make better-informed decisions.

By identifying major gaps in existing reporting practices, the study provides an important step towards strengthening environmental accountability and ensuring that future growth of the ocean economy occurs within ecological limits.

This research highlight is based on the scientific publication *Identifying and closing gaps in corporate reporting of ocean impacts*, published in Nature Sustainability (2025), DOI: [10.1038/s41893-025-01631-8](https://doi.org/10.1038/s41893-025-01631-8).

Table: Analysis of sustainability reports from 75 major ocean-economy companies revealed extensive reporting on greenhouse gas emissions and energy use, but far less disclosure of impacts on marine biodiversity, habitats, and ecosystem health.
Photo: Norbert Buduczki on Unsplash.com

RT4 | Did plants learn to survive the cold by first surviving drought?

Today, grasses grow almost everywhere on Earth, from tropical savannas to Arctic tundra. Yet the ancestors of many modern grasses evolved in much warmer climates. How plants acquired the ability to survive freezing temperatures remains one of the key questions in plant evolution. A new study involving Research Theme 4 members explores whether an unexpected trait may have paved the way: drought tolerance.

A surprising connection between drought and frost

At first glance, drought and freezing conditions appear completely different. One is typically thought of as occurring in hot, dry environments, while the other is characteristic of cold climates. However, both stressors affect plants in remarkably similar ways.

During droughts, plants struggle to obtain water from dry soils. During freezing conditions, water is locked up as ice and is no longer available to plant tissues. In both cases, cells face dehydration, risking damage to membranes, proteins, and other essential structures.

This similarity has led scientists to propose the “drought-before-cold” hypothesis: the idea that traits originally evolved in response to drought may later have enabled plants to persist in freezing environments.

Following millions of years of grass evolution

To test this hypothesis, the researchers analysed a large evolutionary tree of grasses; a plant family containing more than 11,000 species found worldwide in a variety of climates. By tracing the evolutionary history of drought tolerance and frost tolerance, they investigated whether one adaptation consistently appeared before the other.

The results revealed a complex picture. In some grass lineages, drought tolerance evolved first and was followed by frost tolerance, supporting the hypothesis. In others, frost tolerance appeared before drought tolerance. Rath-

er than identifying a single pathway, the study uncovered multiple routes through which grasses adapted to challenging environments. Remarkably, some groups of species had also lost their ancestral adaptations, with present-day species being either drought or frost specialists, and suggesting that there may be limits to which or how many different environmental stressors plants can adapt to.

Evolution builds on existing solutions

Although the details differed among grass groups, the results suggest that adaptations to drought and cold frequently share evolutionary connections. Instead of evolving entirely new solutions, plants often build upon traits that already exist.

This process helps explain how grasses successfully expanded from warm environments into increasingly cold, dry and seasonal climates as Earth's climate changed over millions of years. It also highlights how evolutionary innovations often emerge through the modification of earlier adaptations rather than through entirely new developments.

Lessons for a changing climate

Understanding how plants evolved to tolerate environmental stress is not only important for reconstructing the past – it can also help scientists anticipate how modern species may respond to future climate change.

As many regions experience more frequent droughts and shifting temperature extremes, including severe freezing exposure due to reduced snow cover, understanding the links between different stress-response traits may help identify vulnerable species, improve conservation strategies, and support efforts to develop more resilient crops.

By revealing how past adaptations shaped the evolutionary success of one of the world's most important plant groups, this study provides new insights into the mechanisms that allow life to persist in a changing environment.

This research highlight is based on the scientific publication *Drought tolerance as an evolutionary precursor to frost and winter tolerance in grasses*, published in *Evolution* (2025), DOI:10.1093/evolut/qpaf006.



Rambergstranda, Ramberg, Norway. Photo: Ashutosh Gupta on Unsplash.com

Writing the next chapter of *Tellus*

In 2025, the Bolin Centre for Climate Research took on a new role as the scientific home of *Tellus*, one of the oldest climate and Earth system science journals in the world.

Founded in 1948 by Carl-Gustaf Rossby, *Tellus* has played an important role in advancing atmospheric, oceanographic, and climate research for more than seven decades. The journal emerged alongside the development of modern climate science and provided a platform for many of the discoveries that helped establish Earth system science as a field. In 2025, the journal entered a new phase through a relaunch led by the Bolin Centre in collaboration with Stockholm University Press.

The relaunch brings the former journals *Tellus A* and *Tellus B* back together into a single journal with a broader scope. The renewed *Tellus* now welcomes research spanning the atmosphere, oceans, land, cryosphere, and biosphere, with a focus on the interactions that shape the Earth system in a changing climate.

A major milestone in this transition was the *Tellus* Relaunch Symposium, held at the Royal Swedish Academy of Sciences in Stockholm on 26–27 May 2025. The symposium brought together researchers, editors, and publishing professionals to discuss both the future of Earth system science and the future of scientific publishing. Discussions highlighted scientific quality, transparency, openness, and community responsibility as core values for the renewed journal.

At a time when scientific publishing faces growing concerns about commercialisation and concentration of ownership, while evolving towards new models to ensure long-term accessibility of scientific knowledge, participants highlighted the importance of strong researcher-led publishing initiatives. The relaunch of *Tellus* reflects a belief that this is the right moment to strengthen community-driven alternatives rooted in scientific values.

The ambition for *Tellus* is not only to publish excellent science, but also to provide a publishing environment that strengthens scientific integrity, fosters debate, and supports the global Earth system science community.

The relaunch also establishes a new international editorial structure led by Editors-in-Chief Ilona Riipinen and Stefano Manzoni together with a broad team of Senior and Topic Editors representing multiple career stages and disciplines within climate and Earth system research.

A further milestone was reached in October 2025, when the renewed *Tellus* officially opened for new submissions. From 2026 onwards, the journal operates as a not-for-profit, diamond open-access publication with an expanded scope reflecting the interconnected nature of Earth system science.

For the Bolin Centre, the relaunch of *Tellus* represents an important investment in the future of researcher-led scientific publishing. Building on a legacy that connects Rossby, Bolin, and generations of Earth system scientists, the journal links the history of climate science with its future development. By providing an independent, community-driven platform for Earth system research, *Tellus* strengthens the Bolin Centre’s contribution to international science while supporting a more open, transparent, and sustainable publishing environment.

The Relaunch of Tellus Timeline	
Date	Milestone
End of 2024	Bolin Centre made a strategic decision to take over Tellus
26–27 May 2025	Tellus Relaunch Symposium held in Stockholm
Summer 2025	New editorial structure established and journal platform prepared
September 2025	Tellus A and Tellus B close for new submissions
October 2025	Renewed Tellus opens for submissions with expanded scope
2026	First articles published in the relaunched journal

” Rossby concluded his interview for *Time* in 1956 by saying ‘Nature can be vengeful. We should have a great deal of respect for the planet on which we live’. Revitalizing *Tellus* feels like the right way to pay these respects, and now feels like the right time to do so.
– Ilona Riipinen, Editor-in-Chief

” Tellus is an ethical choice.
– Stefano Manzoni, Editor-in-Chief



Tellus Symposium 2025. Photo: Maria Basova

The Bolin Centre Database

—provides open access to climate and Earth system data

The database serves to promote and visualise research results and data, allowing us to highlight the stories that emerge from the data. By providing accessible and reusable literature, data, and program code to scientists, students, journalists, and the general audience, our data repository actively contributes to the global movement towards Open Science. As such, it plays a crucial role as an integral component of the Bolin Centre.

Data management is vital in scientific research, enabling transparency, reproducibility, and reusability. At the Bolin Centre, we understand the significance of effective research data management and provide comprehensive support to our scientists.

In 2024, we published 83 datasets, of which about half provide data collected during expeditions in the Arctic Ocean with the Swedish icebreaker Oden as a research platform. The other half represents a broad range of research, ranging from climate model simulations to fieldwork on peat and soil to measurements of aerosol concentrations in clouds.

Data life cycle and Open Science

Adopting an Open Science approach, the Bolin Centre recognises the importance of making scientific processes transparent. A key aspect of Open Science is ensuring that produced data is well-documented, understood, and reusable. To achieve this, we embrace the concept of the data life cycle, which encompasses various stages from planning to archiving.

Supporting the Data life cycle

Plan

Research funders often require a Data Management Plan (DMP) for funded projects. To assist researchers, Stockholm University offers centralised support and an online tool with a template for the Bolin Centre. By integrating DMP into the early stages of research planning, we ensure that data management considerations are addressed comprehensively.

Create and analyse

Depending on the research type, data can be generated through diverse methods. The Bolin Centre provides support for high-performance computing and storage through SNIC (Swedish National Infrastructure for Computing). This empowers our scientists by providing them with access to large-scale data resources, thereby facilitating efficient data creation and analysis.

Share and store

To promote collaboration and secure data storage, the Bolin Centre offers two general data storage alternatives. Scientists can utilise Sunet Drive and Swe-store for intermediate data storage and sharing.

Publish, reuse, and archive

Journals and research funders increasingly emphasise the publication of data following the FAIR principles (Findable, Accessible, Interoperable, and Reusable) in open repositories. The Bolin Centre strongly recommends utilising the Bolin Centre Database for data publication, ensuring compliance of data with FAIR principles. Additionally, the database provides digital object identifiers (DOIs) for enhanced discoverability, integrates with Git for version control, and connects with Stockholm University's e-archive, ensuring long-term data archiving.

Effective Research Data Management is dominant in modern scientific practices. The Bolin Centre's collaboration with Bolin Centre Modelling Coordination, has resulted in comprehensive documentation and support for Research



Anders Moberg. Photo: Maria Basova

Data Management. By following the data life cycle and embracing Open Science principles, we empower our scientists to generate high-quality, transparent, and reusable data. With access to HPC resources, storage alternatives, and the Bolin Centre Database, researchers can confidently navigate the com-

plexities of data management, enabling collaboration and innovation, and helping the researchers to make impactful scientific contributions.

Read more here: bolin.su.se/data/support

Bolin Centre Modelling Coordination

Numerical models of the global climate system are essential tools in research carried out at the Bolin Centre. Earth system models are used across the research areas to study topics covering deep ocean circulation, land surface processes, atmospheric composition and dynamics and upper atmospheric physics. Bolin Centre researchers are also participating in the development of the next generation of Earth system models. The Modelling Coordination team at the centre ascertains that the necessary computational resources are available for the Bolin Centre researchers to be able to carry out this work.

Since 2025, the Bolin Centre and thereby the modelling coordination team has had a new role in coordinating advanced user support for climate-related high-performance computing within NAISS (National Infrastructure for Supercomputing in Sweden). This activity is supported by ear-marked faculty funds from SU.

Climate models – which are extensive and often involve complex computer codes – require hardware with high capacity both in terms of computational speed and storage. High-performance computing facilities of this kind are part of the Swedish research infrastructure at the national level, and even larger facilities are available within Europe. The Bolin Centre Modelling Coordination team's primary task is to ascertain that adequate resources are available for the researchers within the Bolin Centre.

Climate models are important tools for improving our understanding of climate behaviour and the predictability of its effects on seasonal, annual, decadal, centennial, and millennial time scales. The Bolin Centre uses the climate models EC-Earth and NorESM to understand how the Earth's climate varies in time and space, and how physical and biogeochemical cycles, including human activities, interact with the climate system.

Bolin Centre researchers also use more detailed models than climate models to better understand different processes and interactions within the climate system; for example, models covering a single column of the atmosphere and ocean, ice sheet models, hydrological models, and large eddy simulations.

Modelling support activities at the centre

The modelling coordination team held a kick-off meeting for scientific programmers in the broader climate HPC community in September 2025. The meeting hosted participants from SU, SMHI, KTH, Lund U, Uppsala U, and addressed, e.g., strategies for organising support and for meeting common challenges, including those related to GPU-porting and data storage. Representatives from NAISS were also present, including the NAISS co-director.

The impending transition from CPU-based to GPU-based hardware poses a challenge to the climate modelling community, as the codes are often large, complex, and heavily optimised for CPUs. These codes are primarily developed by weather forecasting centres and large national and international consortia.

In April the climate modelling coordination team organised a workshop on the theme of weather-prediction and climate-modelling codes on GPU hardware, with invited experts from across Europe. Bolin Centre members were invited to learn about current status of these codes in terms of GPU compatibility and ongoing efforts to adapt and optimise codes for GPU hardware. The modelling coordination team will continue working on this topic, as the new supercomputer hosted by NAISS, Arrhenius, has a much larger GPU partition compared to the CPU partition. In parallel, the modelling coordination team is helping members gain access to available CPU resources.

The modelling coordination team also participated in, among others, the NAISS user forum, the Bolin Days, and the KSCS inauguration at KTH.



The Modelling Coordination team, Anna Lewinschal (middle) and Frida Bender (right) chairing the session Fifteen years of climate modelling at the Bolin Centre together with RT1 co-leader Ramón Fuentes Franco (left) at the Bolin Days 2025. Photo: Laila Islamovic

Communication and coordination

The Communication and Coordination Team at the Bolin Centre works to facilitate effective communication and coordination throughout the organisation. Their responsibilities include creating content for diverse channels, organising outreach events, and coordinating both internal and external meetings and gatherings, such as the Bert Bolin Climate Lecture and Bolin Days. Additionally, they manage and produce engaging content for the Bolin Centre website, along with providing regular newsletters to its members.

ForskarFredag 2025 *Exploring the Earth beneath our feet*

On 26 September, the Albanova University Centre hosted ForskarFredag, where the Bolin Centre for Climate Research engaged visitors with hands-on science and current research. Professor Nina Kirchner (NG) presented *Glaciäråret 2025*, followed by Professor Alasdair Skelton’s (IGV) *Klimatkrisen och hoppet*, both inspiring discussions on glaciers and climate change. At the House of Science, ACES ran a permafrost workshop led by PhD student Larissa Frey, introduced by Professor Gustaf Hugelius (NG), who explained the importance of permafrost in climate research.

At the science fair, visitors explored the Bolin Centre’s fossil exhibition under *Exploring the Earth beneath our feet*. Natasha Barbolini guided students through the *Homo naledi* expedition, while PhD student Daniela Quiroz (both from DEEP) helped compare ancient plant fossils with modern species. Together, these activities provided an engaging glimpse into research helping us understand and protect our planet.

The Bolin Days 2025

The Bolin Centre for Climate Research hosted the 17th annual Bolin Days on November 26–27, 2025 at Stockholm University, bringing together researchers to share new findings and strengthen collaboration. The conference opened with remarks by Director Ilona Riipinen and Deputy Director Gustaf Hugelius, followed by a session marking fifteen years of climate modelling at the Centre, highlighting advances in methods and improved projections using tools like machine learning and emergent constraints. The programme continued with



1. Overview of the exhibition “Exploring the Earth beneath our feet” during the science fair at ForskarFredag 2025. 2. Panel discussion on communicating research about the AMOC in media during Bolin Days 2025. From the left: Thorsten Blenckner (SU), Michael Tjernström (SU), Susan Ritzén (SVT) and Therese Bergstedt (Svenska Dagbladet). Photo: Laila Islamovic

a poster session for PhD students and early-career researchers, and a series of polar science talks on the Arctic seabed, Antarctic sea-level rise, and Arctic carbon cycle databases.

In the afternoon, discussions focused on how climate science informs policy and society, including contributions on governance, community engagement, and the artistic performance *Glacial Traces*, illustrating new ways to communicate climate change. The first day concluded with a conference dinner at Koppartälten in Hagaparken, featuring live music by Stämbröderna and a céilidh.

Day two highlighted interdisciplinary research, with talks linking biology and climate science – from marine ecology to palaeogenetics – followed by a second poster session and presentations on land-surface processes. The final session addressed changes in the Atlantic Meridional Overturning Circulation (AMOC) and included a panel with journalists on communicating “high-impact, low-likelihood” events. The conference ended with closing remarks and the announcement of poster competition winners, underscoring Bolin Days’ role in fostering collaboration, supporting early-career researchers, and advancing climate science within the Centre.

Book launches:

Arrhenius, Our Time, Klimatet och människan

Over the past year, the Bolin Centre has expanded its public engagement activities by creating a new platform for members and Centre-affiliated researchers to share their work as authors. For the first time, we organised a series of book events that connected climate research with broader questions of history, society, and humanity’s relationship with the Earth.

The three events highlighted different perspectives on climate and climate research. Author Jan Malmberg presented his biography of Svante Arrhenius, linking the history of one of Sweden’s early climate pioneers to the origins of modern climate science. Former Bolin Centre Director Alasdair Skelton launched *Our Time*, drawing on Earth’s deep history to reflect on the present climate crisis and possible futures. Professor Fredrik Charpentier Ljungqvist



1. Author Jan Malmberg reads an excerpt from his book Svante Arrhenius: Nobelpristagare, kosmopolit och klimatpionjär during an author event hosted by the Bolin Centre in autumn 2025. 2. Director Ilona Riipinen chatting to attendees of the Swedish Oikos Meeting 2025 about the Bolin Centre, as well as the then-upcoming launch of the Tellus Journal. Photo: Laila Islamovic

(Dept. of History) presented the revised edition of *Climate and Humanity over 12,000 Years*, exploring how historical climate research can deepen our understanding of current change. Together, the events demonstrated the breadth of expertise within the Bolin Centre and the value of creating opportunities for researchers to engage with audiences outside of academic publications.

Exploring new venues: Swedish Oikos Meeting, the Swedish Biodiversity Symposium, and the Forum for the Arctic and Antarctic Research

For the 2025–2026 period, the Bolin Centre also established a presence at three new conference venues, broadening its engagement with research communities beyond its traditional climate-science networks. The Swedish Oikos Meeting 2025 brought together researchers and students from across Sweden to discuss ecological research and solutions for a changing world, providing a natural point of connection between climate and ecological research.

The Swedish Biodiversity Symposium, co-organised by the Bolin Centre and RT4, brought together more than 400 participants from research, governmental agencies, municipalities, companies and NGOs to strengthen the connection between biodiversity research, policy, and transformative change. The Forum for the Arctic and Antarctic 2025, jointly organised by the Bolin Centre, the Swedish Polar Research Secretariat, Luleå University of Technology, and the Arctic Centre at Umeå University, provided a new platform for strategic dialogue on Sweden’s polar research landscape, including future research priorities, infrastructure, funding, and international engagement.



Maria Basova joined the Bolin Centre in September 2022 as coordinator. Photo: Uly Konstantinow



Sara Gershagen joined the Bolin Centre again in November 2024 as a coordinator and event support. Photo: Luliana Domina



Laila Islamovic joined the Bolin Centre again in September 2023 as a communicator. Photo: Maria Basova

The Bert Bolin Climate Lecture 2025 by Professor Paulo Artaxo

Professor Bert Bolin was a pioneer of climate research and one of the founding figures of the IPCC, which was awarded the Nobel Peace Prize in 2007. In recognition of his contributions, the Faculty of Science at Stockholm University established the annual Bert Bolin Climate Lecture. Each year, a distinguished climate scientist is selected by the Dean of the Faculty of Science, following nominations from Bolin Centre members, to deliver both a public lecture and a scientific seminar, fostering dialogue and knowledge exchange within the research community and beyond.

In early May, we had the honour of welcoming Professor Paulo Artaxo from the Center for Amazonian Sustainability at the University of São Paulo, Brazil, to Stockholm. The lecture, titled *Climate Change and the Amazon Forest: A Close Relationship*, drew more than 400 upper secondary school students, together with their teachers and mentors, as well as members of the public, to Aula Magna at Campus Frescati.

Professor Artaxo’s lecture highlighted the profound and interconnected impacts of climate change on the Amazon rainforest, one of the world’s most important ecosystems. He discussed how rising temperatures, changing rainfall patterns, and more frequent climate extremes are already altering the biological functioning of the Amazon, with consequences that extend far beyond South America. Particular attention was given to the forest’s role as a major global carbon store, containing an estimated 120 billion tonnes of carbon, and the risks posed if this carbon is released into the atmosphere. The lecture also explored the links between the Amazon and the global hydrological cycle, emphasizing the urgent need for sustainable solutions that can protect both ecosystems and human societies in a rapidly changing climate.

Professor Paulo Artaxo is one of the world’s leading climate scientists and a member of both the Brazilian Academy of Sciences and The World Academy of Sciences (TWAS). He has contributed as a lead author to multiple assessment reports of the Intergovernmental Panel on Climate Change (IPCC), which was awarded the Nobel Peace Prize in 2007. Professor Artaxo also has longstand-

ing ties to Stockholm University, where he conducted postdoctoral research and was awarded an honorary doctorate in 2009.

With the help of the university media production team, we were able to record and share the lecture with whoever is interested – please find it by going to bolin.su.se and typing in the lecture title in the search bar.



The Bert Bolin Climate Lecture 2025 hit record attendance, with more than 400 people gathered in Aula Magna to listen to lecturer Professor Paulo Artaxo. Photo: Laila Islamovic

Lecturers

- 2025 | Professor Paulo Artaxo**
Climate Change and the Amazon Forest: a close relationship
- 2024 | Professor Ricarda Winkelmann**
When giants falter: Tipping points in Greenland and Antarctica
- 2023 | Professor Trude Storelvmo**
The big unknown in future Climate projections
- 2022 | Professor Hans Joosten**
The Great Rewetting: Why we must stop draining peatlands worldwide and as fast as possible
- 2021 | Professor Emeritus William F Ruddiman**
For how long have humans affected the climate?
- 2020 | Professor Roberto Buizza**
Climate Change: How can we motivate transformation?
- 2019 | Professor Maureen E. Raymo**
Climate, CO₂ and Sea Level: Past, Present and Future
- 2018 | Professor Veerabhadran Ramanathan**
Bending the Curve: Climate Change Solutions
- 2017 | Dr. Thomas Cronin**
Biological response to climate change: What would Bolin say?
- 2016 | Sir Brian Hoskins**
The Challenge of Climate Change: How large is it and can we meet it?
- 2015 | Professor Ulrike Lohmann**
Uncertainties in climate projections related to clouds and aerosols
- 2014 | Professor Corinne Le Quéré**
The role of the carbon cycle in regulating climate

Recordings of this year’s (and some previous) Bert Bolin Climate Lectures are available on our website, where you can also find a complete list of all Bert Bolin Climate Lecturers.
Visit www.bolin.su.se/research/events-and-conferences



Bolin Climate Lecture 2025

Climate Change and the Amazon Forest: a close relationship

Lecture by Professor Paulo Artaxo, Center for Amazonian Sustainability, University of São Paulo, Brazil

The biological functioning of Amazonia is changing with the climate, impacting the global hydrological cycle. Prof. Artaxo will discuss how to deal with these critical aspects and build a sustainable society that could protect the ecosystems we depend on, and ourselves.

The lecture will be given in English.



Register and read more by scanning the QR-code.

Welcome!

07

MAY

Time: 14h00–15h00

Place: Aula Magna, Stockholm University



The Bolin Centre Board

The Bolin Centre is led by the Bolin Centre Board, which comprises representatives from all of its collaborative partners: six departments at Stockholm University, the Swedish Meteorological and Hydrological Institute, and the KTH Royal Institute of Technology. In addition, the board includes an external member and a student representative.

Professor Regina Lindborg

Chair of the Bolin Centre Board, Department Physical Geography (NG), Stockholm University.

Professor Johan Nilsson

Vice-chair of the Bolin Centre Board, Department of Meteorology (MISU), Stockholm University.

Professor Anna Sobek

Department of Environmental Science (ACES), Stockholm University.

Professor Annica Ekman

Department of of Meteorology (MISU), Stockholm University.

Professor Sara Cousins

Department of Physical Geography (NG), Stockholm University.

Professor Kristoffer Hylander

Department of Ecology, Environment and Plant Sciences (DEEP), Stockholm University.

Professor Niclas Kolm

Department of Zoology, Stockholm University.

Professor Helen Coxall

Department of Geological Sciences (IGV), Stockholm University.

Professor Fredrik Lundell

Teknisk Mekanik, Royal Institute of Technology (KTH).

Professor Helena Martins

Swedish Meteorological and Hydrological Institute (SMHI).

Anna Strekalovskaya

PhD student, Department of Physical Geography (NG), Stockholm University.

Daniella Lillieroth Charalambous

Department of Physical Geography (NG), Master's Student.

Professor Ilona Riipinen

Ex Officio, Director of the Bolin Centre, Stockholm University.

Professor Gustaf Hugelius

Ex Officio, Vice-Director at the Bolin Centre, Stockholm University.

Maria Basova

Ex Officio, Coordinator at the Bolin Centre, Stockholm University.

Laila Islamovic

Ex Officio, Communicator at the Bolin Centre, Stockholm University.

Please note that the list of Board members is accurate as of December 2025. Changes to the list of Board members may have occurred since. You will find the most up-to-date information on bolin.su.se, by navigating to “About the Centre” and then clicking “Organisation”.



The External Science Advisory Group

The Bolin Centre has appointed an ESAG composed of leading national and international scientists working within climate research. The group's main tasks are to inform the Bolin Centre of its strengths, weaknesses, and possibilities for development, as well as to increase the Bolin Centre's contacts with international networks and research groups within the climate research area.

Professor Jay Famiglietti (chair)

Arizona State University, School of Sustainability, College of Global Futures, The United States of America.

Professor Karen E. Kohfeld

Director and Professor, School of Environmental Science Professor, School of Resource and Environmental Management at Simon Fraser University, Burnaby, Canada.

Professor Camille Parmesan

NMA Chair in Public Understanding of Marine Science & Human Health, School of Biological & Marine Sciences, Plymouth University, United Kingdom.

Professor Peter Cox, CBE

Professor of Climate System Dynamics and Director of the Global Systems Institute at the University of Exeter, United Kingdom.

Professor Victor Brovkin

Max-Planck Institute for Meteorology, Department of Climate Dynamics, Germany.

Professor Trude Storelvmo

University of Oslo, Department of Geosciences, Meteorology and Oceanography Section, Norway.

Please note that the list of ESAG members is accurate as of December 2025. Later changes to the ESAG membership may have occurred. You will find the most up-to-date information on [bolin.su.se](https://www.bolin.su.se)



Photo: Martin Jakobsson

Bert Bolin – a world-leading scientist and science organiser

Bert Bolin joined the newly created Department of Meteorology (MISU) at ¹Stockholm University in 1948 as an assistant to Professor Carl-Gustaf Rossby. Apart from a few brief absences, Bert Bolin remained an active member of the department staff until his death in 2007.

During a productive period as Rossby's student he wrote several fundamental papers on atmospheric circulation and on the basic principles for numerical weather prediction. After he received his PhD in 1956, he broadened his interests to include studies of biogeochemical cycles of key life elements. This became the introduction to his world-leading research on the carbon cycle in the atmosphere, oceans and biosphere.

Bert Bolin was not only a prominent scientist; his role as an inspirer and organiser of international climate research has been of outstanding importance. Due to his broad and deep scientific knowledge, his unusual ability to see the big picture, his eminent ability to express himself orally and in writing, and his diplomatic talent, he became a natural leader. He initiated several research programmes focusing on the global environment including the World Climate Research Programme and the International Geosphere-Biosphere Programme.

Bert Bolin's most important achievement was his contribution to the formation and development of the Intergovernmental Panel on Climate Change (IPCC) under the UN. He chaired this panel during its first ten years (1988–1997). His extremely important role as the founder and initial leader of the IPCC has been confirmed by many. The IPCC received the Nobel Peace Prize in 2007.

¹Stockholm University was formed in 1960 from Stockholms Högskola, which was founded in 1878.

The legacy of Bert Bolin remains alive among climate scientists at Stockholm University and at many other places through the inspiration that he brought with lectures, supervision, his scientific approach and his commitment to making research results available to policy makers and the public.

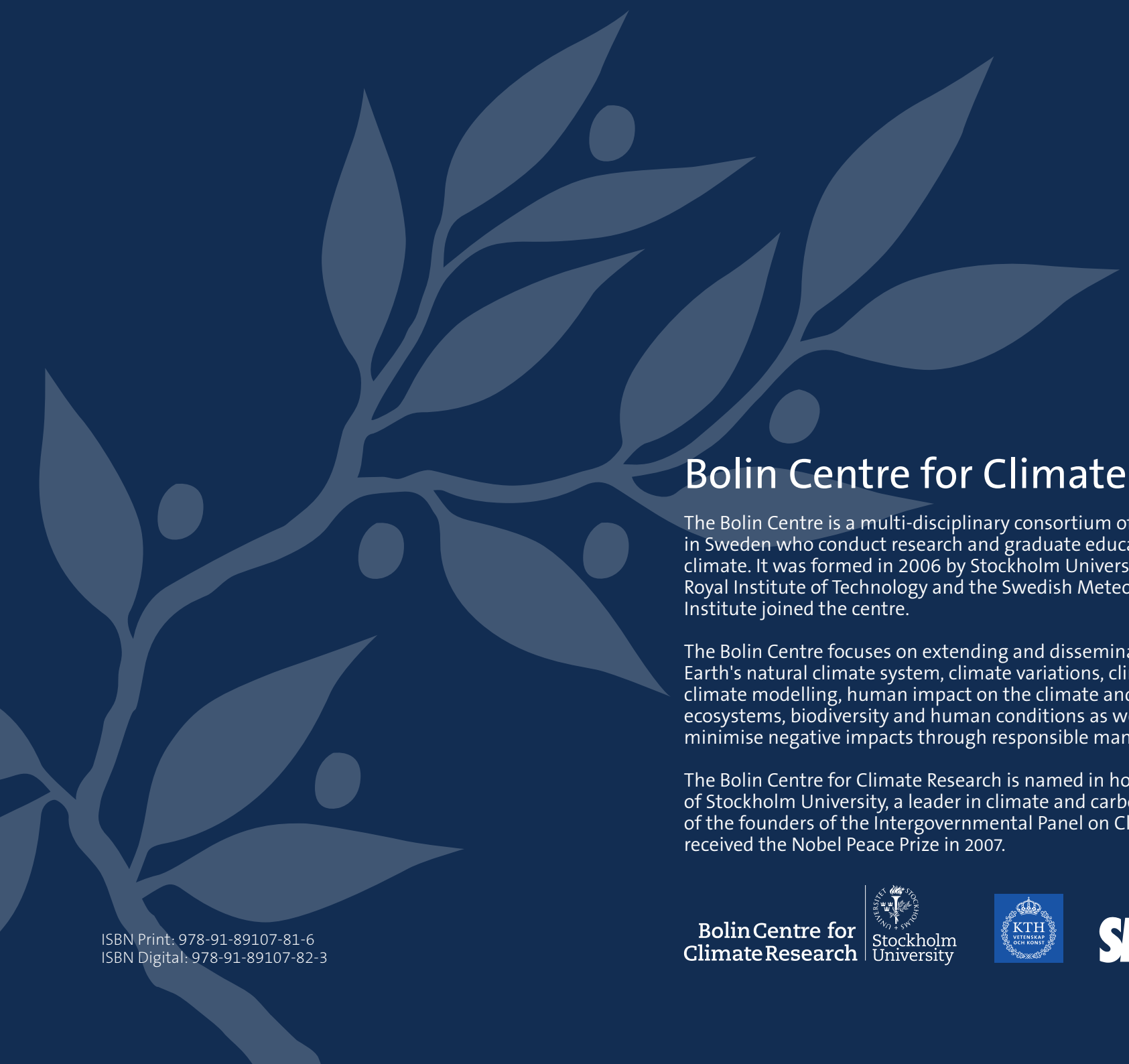
*Henning Rodhe
Bert Bolin's student, colleague and friend*



You can watch a slide show about Bert Bolin and the Bolin Centre for Climate Research at www.su.se/english/about-the-university/cultural-heritage-and-history/the-history-of-stockholm-university/bert-bolin-founder-of-the-climate-panel-and-world-leading-scientist-1.531330



... mot förintelse (54.5×65.5 cm, 1982, translated as Towards Oblivion), is a copperplate etching by the late artist Svenerik Jakobsson. Deeply engaged with nature and its preservation, Jakobsson's work reflects a profound sensitivity to the fragile relationship between humanity and the natural world. Photo: courtesy of the family

A large, stylized graphic of a leafy branch, rendered in a lighter shade of blue than the background, occupies the left side of the page. The branch curves upwards and to the right, with several elongated, pointed leaves and small circular fruits or buds.

Bolin Centre for Climate Research

The Bolin Centre is a multi-disciplinary consortium of more than 400 scientists in Sweden who conduct research and graduate education related to the Earth's climate. It was formed in 2006 by Stockholm University, and in 2010 the KTH Royal Institute of Technology and the Swedish Meteorological and Hydrological Institute joined the centre.

The Bolin Centre focuses on extending and disseminating knowledge about the Earth's natural climate system, climate variations, climate impacting processes, climate modelling, human impact on the climate and climate impacts on ecosystems, biodiversity and human conditions as well as how society can minimise negative impacts through responsible management.

The Bolin Centre for Climate Research is named in honour of Professor Bert Bolin of Stockholm University, a leader in climate and carbon cycle research and one of the founders of the Intergovernmental Panel on Climate Change (IPCC), which received the Nobel Peace Prize in 2007.

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**Bolin Centre for
Climate Research**



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