Facing the ice. Several Bjerknes scientists did field work in Greenland in 2018. PHOTO: HANS CHRISTIAN STEEN-LARSEN
The Bjerknes Centre for Climate Research provides state-of-the-art insight and knowledge about climate for society. This service is made through many platforms. The main outlet is scientific publications. Each week we publish, on average, five papers and we are cited in 150 others. Our results are disseminated through international high profile journals, making impacts on the research agenda, on scientific assessments, and eventually on policy making.

The strong international position of the Bjerknes Centre is also manifested in the high number of research projects we either run or are partners in. Our researchers co-ordinate several large European consortia, and also hold seven prestigious European Research Council grants. And our climate model, developed together with good colleagues in Oslo, is one of the main tools for understanding how climate will evolve in response to human activities.

The Paris agreement gave the world a new hope that it was possible to limit global warming to 2-degrees and pursue the goal of 1.5-degrees. The importance of reaching this goal was clearly stated in the 1.5-degree report released in October 2018. In Katowice, two months later, all countries met to agree on an implementation plan for the Paris agreement. The stakes were high.

Recent years have arguably seen a shift from globalisation and multilateralism towards more populism and nationalism, and a more volatile political landscape. Despite this political backdrop, Katowice was considered a success by many. Global rules were set that are to be balanced, effective, and will possibly enable increased ambitions for the Paris agreement entering into force in 2020.

To reach the global climate goals set forth in national and international arenas, collaboration is needed. The World Climate Research Program has since its inception sought to determine the predictability of climate and the effect human activities may have on the climate system. A new co-ordination office handling regional activities has been established, with science co-ordinators at the Bjerknes Centre and in Hamburg. We foresee that this will facilitate increased international collaboration and awareness about climate change.

There is also a need for educating the new generation of scientists. An important part of our work is therefore related to research training. The renowned ACDC summer schools with American partners have been running every year since 2010, and the Nansen-Zhu summer schools with Chinese partners every second year since 2004. Other summer schools and courses are organised by the national research school CHESS. Eight new PhD students successfully defended their theses last year and many more are on the way.

We are in a continuous dialogue with society through the media and in many other arenas. School classes, business leaders, politicians, and NGOs are frequent visitors to our centre. Last year we welcomed President Andrej Kiska of Slovakia and H.R.H. Crown Prince Haakon, to mention but two. We collaborate with local high schools, and we organise discussions and debates at events like the Arctic Frontiers in Tromsø and the Arendal Week, our democratic meeting places. We do this for the benefit of society and for the sake of science.
The leader group is comprised of the Director, Head of Administration, Head of Communication, and research leaders of the Bjerknes Centre together with representatives from the partner institutions: Institute of Marine Research, Nansen Environmental and Remote Sensing Centre, and Uni Research. Their mandate includes the forging and implementation of the Centre’s strategic scientific development and to act as a channel of communication among the partners. Names and positions as of 1 January 2019.

**THE LEADER GROUP**

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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<tr>
<td>TORE FUREVIK</td>
<td>Professor (Director), Climate dynamics, UiB</td>
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<tr>
<td>KERIM HESTNES NISANCIOGLU</td>
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<td>RAGNHILD STOLT-NIELSEN</td>
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**RESEARCH THEMES**

| RT1 Global Climate          | CAMILLE LI (BJØRG RISEBROBAKKEN)             |
| RT2 Polar Climate           | TOR ELDEVIK (ANNE BJUNE)                     |
| RT3 Climate Hazards         | KERIM H. NISANCIOGLU (LINLING CHEN)          |
| RT4 Carbon System           | ARE OLSEN (JÖRG SCHWINGER)                   |

**CROSSCUTTING ACTIVITIES**

| Model Development           | MATS BENTSEN                                  |
| Data Management             | BENJAMIN PFEL                                 |
| Research Training           | THOMAS SPENGLER                               |
| Dissemination and Outreach  | GUDRUN SYLTE                                  |

**BOARD OF DIRECTORS**

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<td>ARVID HALLÉN</td>
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<td>MARGARETH HAGEN</td>
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<td>ELISABETH MARÅK STØLE</td>
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<td>SEBASTIAN H. MERNILD</td>
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**SCIENTIFIC ADVISORY COUNCIL**

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<tr>
<td>DOROTHEE BAXKER</td>
<td>University of East Anglia, UK</td>
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<td>COLIN JONES</td>
<td>MET Office, UK</td>
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<td>GUNHILD ROSQVIST</td>
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<td>TAPIO SCHNEIDER</td>
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<td>CLAIRE WAELEBROECK</td>
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**SECRETARIAT**

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<td>ELLEN GRONG</td>
<td>Senior Secretary</td>
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<tr>
<td>ØYVIND PAAASCHE</td>
<td>Senior Adviser</td>
</tr>
<tr>
<td>QUYNH-GIAO THIDO</td>
<td>Financial Officer</td>
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<tr>
<td>ELLEN VISTE</td>
<td>Communication Advisor</td>
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Global climate

Current climate change in a broader context.

1. Several past warm climate states were characterized by a reduced Arctic sea-ice extent, smaller ice sheets and poleward shifts in marine and terrestrial ecosystems relative to the preindustrial situation. By studying past warm climate periods, e.g. Miocene, Pliocene and interglacials, the Global team provide insight into potential future climate impacts over time scales not covered by projections.

2. In the Pliocene, 4.5 million years ago, the globe was 2–3 °C warmer than today, and there was less sea ice in the Arctic Ocean. Still, Bjerknes researchers have found the remains of algae that live only in sea ice, in ocean sediments from the Iceland Sea. Sea ice there would depend on the East Greenland Current bringing cold, fresh water and ice southwards from the Arctic Ocean. The findings support previous Bjerknes research arguing that the East Greenland Current appeared around that time.

3. Pacific sea-surface temperatures oscillate naturally between warm and cold periods lasting around 20 years each. A study by Bjerknes scientists shows that when the Pacific is warmer than normal, it can contribute to higher winter temperatures in the Arctic. Even though Arctic temperatures have increased dramatically in recent years, the Pacific has been cool and this could have dampened the Arctic warming.

4. The densely populated region by the River Yangtze in China is flooded in some years during the summer monsoon. Bjerknes scientists have mapped the flow patterns for moisture in the air. Before the monsoon, most of the rainwater comes from evaporation from the land and nearby ocean regions, whereas during the monsoon, moisture coming all the way from the Indian Ocean is added. Typical flood events are often linked to this long-range transport. Rain later in the year stems more from the north-west Pacific.

5. Icy winters in Siberia over the last decade contrast with our picture of a warming Arctic. Is there a connection? Probably not, according to model experiments coordinated by the Bjerknes Centre. The loss of sea ice critically affects temperatures near the surface in the Arctic, but the effect does not reach far. Cold winters on surrounding continents could be due to natural variations in the atmosphere and ocean elsewhere.

6. Abnormal cold in Antarctica may be self-reinforcing. The Antarctic oscillation is a phenomenon seen as alternating weak and strong pressure differences between Antarctica and the regions to the north, and thought to reflect the position of the storm tracks around Antarctica. Research at the Bjerknes Centre shows that the pattern is dominated by the pressure over Antarctica itself and can be related to temperature. When temperatures are low, the transport of milder air into Antarctica decreases, making it even colder.

7. In the Pliocene, 4.5 million years ago, the globe was 2–3 °C warmer than today, and there was less sea ice in the Arctic Ocean. Still, Bjerknes researchers have found the remains of algae that live only in sea ice, in ocean sediments from the Iceland Sea. Sea ice there would depend on the East Greenland Current bringing cold, fresh water and ice southwards from the Arctic Ocean. The findings support previous Bjerknes research arguing that the East Greenland Current appeared around that time.

Outlook

“The climate system is in constant evolution”, says Camille Li, leader of our Global climate research theme.

“We’ve seen hothouse Earth, snowball Earth and ice ages, and are currently on track to reach 1.5 °C warmer than pre-industrial times as early as 2030. We need to understand what these types of global changes mean for temperature, rainfall, winds and ocean currents.”

SOURCE: BASED ON BURKE ET AL., 2018
Polar climate

Arctic and Antarctic climate change.

Predicting Arctic warming

Global climate change is arguably most pronounced in the Arctic. Manifestations include “Arctic Amplification” – the Arctic warming that exceeds twice the global; Svalbard temperatures warmer than climatology for 100 consecutive months (and still counting as of April 2019); and a commercial ship – an LNG “super-tanker” – for the first time crossing the Arctic unassisted in the midst of winter in December 2017. The anticipation and, if possible, skilful prediction of the future state of the Arctic is key for society to cope with change. Bjerknes research includes the possible pathways of further sea-ice retreat with the poleward progression of the Gulf Stream’s northernmost limb; observed and palaeo-climatic reconstructions of the Arctic’s surface ocean connection back to the lower latitudes with the East Greenland Current; European continental climate’s reflection of a fluctuating ocean state; and how urban “heat islands” manifest in cold continental climates on a background of global warming.

Svalbard is coming out of the ice

The Arctic islands of Svalbard are coming out of the ice. Since 1971, winter temperatures in the Arctic islands of Svalbard have increased by 7 °C. This is stated in the recent report Climate in Svalbard – a knowledge base for climate adaption, commissioned by the Norwegian Energy Agency and published by the Norwegian Climate Service Centre, where the Bjerknes Centre is a partner. Except in the north-east, sea ice no longer surrounds the islands today, and open water is a major cause of successive mild winters. Temperatures more and more often rise above the melting point, causing the permafrost to thaw and snow to melt into rain before reaching the ground. With medium to high greenhouse gas emissions, the annual precipitation is estimated to increase by 45-65 percent by the end of the century.

Drilling through South Georgia’s past

South Georgia is Svalbard’s cousin in the Southern Hemisphere – accessible land in a region where increasing temperatures equate to thawing. The island is located at the core of the westerly wind belt and the Antarctic Circumpolar Current. This makes it particularly sensitive to even minor climatic fluctuations. Still, little research has been done in South Georgia. Sediment cores collected by Bjerknes scientists reveal how glaciers in South Georgia have varied over the last 7,000 years. This covers part of the last significant global warming phase, 9,000–5,000 years ago, in the Southern Hemisphere attributed to increased solar radiation and changes in the meridional position of the westerly wind belt. Understanding this early warming period can provide critical knowledge for prediction of the future climate.

Antarctic ice shelves melt from below

Satellites reveal that glaciers in West Antarctica are thinning at an increasing rate. As relatively warm sea water flows under the floating ice shelves, the ice melts from below. Though normally encircling Antarctica along the steep slope of the continental shelf, the warm water can turn southward through channels in the shelf and reach the base of the glaciers. Bjerknes scientists use observations, numerical models and laboratory experiments to understand how this happens, with a focus on the Weddell Sea and the Amundsen Sea. In the Weddell Sea, a broad continental shelf and a cold and fresh surface layer protect the ice, and melting is, so far, limited. In the Amundsen Sea, water as warm as 1.5 °C reaches all the way to the ice shelves. Consequently, glaciers here melt more rapidly than anywhere else on the continent.

Outlook

“The persistence and magnitudes of current Arctic warming are truly exceptional”, says Tor Eldevik, leader of our Polar climate research theme. “For a scientist, it is convenient and exciting to explore change where the signal rises well beyond the noise. But I am becoming increasingly concerned about the consequences that climate change is already generating. Even with a slightly increasing sea ice cover over the last two winters, Svalbard remains “out of the ice” and keeps thawing.”

PHOTO: LEA TOSKA OPPEDAL

Drilling through sediments, time and temperature.

PHOTO: LEA TOSKA OPPEDAL

How does it get there? From where? Observations show that warm water is found on the continental shelf around Antarctica. In a rotating tank in a Grenoble laboratory, our scientists set up experiments to study the processes that could allow warm water to reach the ice shelves.

PHOTO: MIRJAM GLESSNER
Carbon system

The flow of carbon in the Earth system.

About a quarter of the CO₂ emitted since the industrial revolution has been taken up by the ocean. Processes occurring in the North Atlantic are essential for maintaining this CO₂ sink. Understanding the present efficiency of the sink and whether climate change will affect it, are among the core activities of the Bjerknes Centre.

Two processes make the North Atlantic an efficient sink for CO₂. Both transport CO₂ from the surface to the deep ocean, in effect removing it from the atmosphere. Firstly, surface water cools and sinks in the North Atlantic, forming deep water. The sinking water carries large amounts of dissolved CO₂ into the deep. Secondly, CO₂ is carried to the deep in the form of organic carbon with decaying phytoplankton. These—the grass of the sea—bloom in the sunlit surface in spring and summer, then perish and sink. In the deep, the organic carbon is converted to CO₂ by bacteria and other heterotrophic organisms. Once in the deep, the CO₂ spreads through the global ocean, where it is stored for thousands of years.

Current climate impacts on the North Atlantic carbon sink

The efficiency of the North Atlantic carbon sink is sensitive to decadal variations in climate. Bjerknes Centre scientists have evaluated carbon data collected in the subpolar North Atlantic, the region where deep water forms, between 1991 and 2015. These data show larger uptakes of man-made CO₂ in periods of strong westerlies. Strong winds remove more heat from the ocean surface than weaker winds, cooling the water so that it sinks more efficiently. This is one of the key factors that drive the North Atlantic carbon uptake. Whether the deep water production and carbon uptake will be maintained in the face of the stronger ocean stratification expected under climate change is an important research question for us.

No indications of a reduced CO₂ uptake in the future

Will the North Atlantic remove CO₂ from the atmosphere as efficiently in the future as it does now? Earth system models disagree. In some models, rising emissions cause a stronger CO₂ uptake, in others the uptake remains at current levels, leaving more CO₂ in the atmosphere. Bjerknes scientists have evaluated the quality of various models and their future projections by comparing how well the models reproduce the current, observed carbon uptake. In models where the CO₂ uptake does not increase with emissions, the water column in the North Atlantic was found to be so strongly stratified and stable that the cooled surface water could not sink. As no deep water formed, CO₂ was not carried down from the surface. In the models that reproduce the sink as it works today, the uptake increases in the future. Having more confidence in these models, our scientists conclude that the North Atlantic will remain an important CO₂ sink for the years to come.

Outlook

“Carbon cycle science is fairly new”, says Are Olsen, leader of the Carbon System research theme. “Observational records start in the 1990s, and are only now starting to be long enough to let us evaluate how the ocean carbon sink varies through time. Variations from decade to decade appear stronger than previously thought and are underrepresented in models. Closing this gap will help us develop more accurate projections for the future.”
Climate hazards

Extreme events and abrupt changes to the climate system.

Sudden drainage of glacial lakes
From one day to the next, in September 2009, a lake near the ski resort at the Folgefonna glacier disappeared. The meltwater in the lake had simply lifted the ice and created a tunnel under it. In the past, such sudden drainage of glacial lakes has several times caused catastrophic flooding in the valleys around the glacier. Bjerknes researchers have used a CT scanner to analyse sediment cores from the lake Buarvatnet on the eastern side of Folgefonna. In a core going back 10,000 years, they identified thirteen 0.5 centimetre thick layers of clay and fine sand, each corresponding to an outburst from a glacier-dammed lake higher up in the watershed. The last occurred in 2002. In a warmer climate the glacier withdraws, and this specific lake will not form again. Other lakes are currently under surveillance.

The lake before and after the drainage in 2009. PHOTO: JOSTEIN BAKKE

Improving projections of storms and precipitation
Winter storms from the Atlantic bring heavy rain, snow, and floods to Western Norway. In most global climate models, the storm tracks are displaced southwards, steering lows into Central Europe and leaving Norway drier than it really is. Interpreting local climate from such models may give the wrong impression, especially as the resolution – the number of data points per area – of global models is too low to reflect the rugged, mountainous terrain. In an attempt to overcome this, Bjerknes researchers corrected the known storm-track bias in the Norwegian Earth System Model and used the results as input to a regional model with a more detailed terrain. This improved the distribution of precipitation in Southern Norway – allowing for more realistic projections of precipitation in a changing climate.

From fresh snow to ancient ice
Over the last decades, Greenland’s biggest ice stream, the Northeast Greenland Ice Stream has doubled its speed. More and more glacier ice is transported from the inland to the ocean, contributing to sea-level rise. For the third summer in a row, in 2018 Bjerknes scientists participated in the international ice-core drilling project EastGRIP. The goal is to drill a 2,700-metre long core through the ice stream. Not only ice, but also fresh snow is sampled. Water isotopes in snow or ice reflect the temperature and humidity in the atmosphere when the snow crystals formed. Studying isotopes increases our knowledge of the hydrological cycle. Also, understanding how temperatures affect the isotope composition in the snow today, allows us to estimate temperature from isotopes in ancient ice.

Sampling snow at EastGRIP. PHOTO: HANS CHRISTIAN STEEN-LARSEN

Outlook
“People are becoming increasingly aware of the risks associated with climate change”, says Kerim H. Nisancioglu, leader of the Climate Hazards research theme. “Society will have to undergo fundamental transformations in the coming years. We need to make sure that the unique knowledge of our scientists is available throughout that process.”
Modelling

Making climate projections for the coming centuries is a global endeavour: That is why climate scientists are so busy right now.

A new IPCC report is scheduled for 2021–2022, and any science to be included must be submitted in 2019. This is why, in 2018, climate centres around the world worked hard to get their climate models ready for the sixth phase of the Coupled Model Intercomparison Project, CMIP6. The CMIP6 will produce the climate model input to the report.

In Norway, the work goes into the Norwegian Earth System Model (NorESM), developed through a cooperation between Norwegian climate institutions since 2007. Various model simulations for CMIP6 will be run in the first half of 2019.

The numerical climate lab

Change the amount of CO2 in the atmosphere and see what happens! Surface temperatures at the end of the century may be seen as a typical climate model output. But as importantly, climate models can be used to understand how the climate system actually works.

Changing the temperature and seeing how rainfall responds can tell us about the mechanisms producing rain today. Past climate can be modelled and studied by changing the distribution of continents, ice sheets, and sea level in the model as well as the atmospheric composition and the orbital parameters of the Earth that control the distribution of solar radiation. At the Bjerknes Centre, we model and study climate millions of years back in time.

Predictions for seasons and decades

Making climate projections for the coming century means simulating climate-system responses to changes in land-use, solar forcing, and emissions of greenhouse gases and aerosols. When predicting the climate on timescales of seasons to decades, we combine procedures from weather forecasting and climate models. At the Bjerknes Centre, we are involved in developing decadal predictions as part of CMIP6, as well as seasonal predictions tailored for energy companies, the shipping industry, and insurance companies.

An infrastructure for modelling

From 2018, the development of the NorESM is funded through the Research Council of Norway’s National Financing Initiative for Research Infrastructure through the project INES.

Bjerknes Climate Data Centre

An archive for the future.

Data records forgotten in a drawer or on a floppy disc are technically lost to the world. An article in Nature in 2013 warned that 80 percent of research data are lost within 20 years. Often, data were stored waiting to be documented properly, but something else came in between. Researchers come and go and take data with them. Institutions keep paper records that have not been digitised. Our time will be known as the Digital Dark Age, and not just for code, software, and pictures.

In order to avoid future data loss, strict policies are being introduced, and every project funded by the Research Council of Norway or the European Research Council needs a data management plan. The plan must describe how to ensure that data are open access and preserved in a long-term archive. The Bjerknes Climate Data Centre has specialised in the services needed regarding data obtained and synthesised by our scientists, in collaboration with national and international data repositories. As an accredited data centre, we serve large European research data infrastructure and global initiatives such as the Global Carbon Budget and the Sustainable Development Goal target 14.3. We have also advised various communities such as UNESCO and OECD on data management services.

Find climate data at www.bcdc.no

Outlook

“In the coming years, we will have a polar focus in the NorESM work”, says Mats Bentsen, leader of the model development activity at the Bjerknes Centre and coordinator of the new national climate modelling infrastructure project. “Temperature inversions in the winter atmosphere, for example, will be better represented. This is important for the generation of low-level clouds in the Arctic.”
Climate science requires researchers who have in-depth knowledge of their specific parts of the climate system, but at the same time a broader knowledge of an Earth system where the ocean, the atmosphere, ice sheets, forests, and algae interact. Also, the demand from society can only be met when researchers are able to communicate with experts from other disciplines as well as the general public. At the Bjerknes Centre, this is taken care of through the Research School on Changing Climates in the Coupled Earth System (CHESS), and the annual Advanced Climate Dynamics Courses (ACDC).

Research training

CHESS organised an Arctic field course for PhD candidates on Disco Island, Greenland, in March 2018. The participants learned to collect ice samples and to drill for cores in both glacier ice and sea ice.

PHOTO: MORVEN MULWILJ

September snow did not stop the participants at the ACDC summer school in 2018. At Finse, Norway, the participants collected sediment cores from a lake.

PHOTO: ØYVIND PIAASCHE
In 2018, Bjerknes scientists provided supervision and training in climate research to 57 candidates. The following successfully defended their dissertations.

**June 28th, 2018**
Tamara Trofimova
The development and application of stable oxygen isotope records of Arctica islandica (Bivakai) shells in Holocene marine climatic reconstructions for the northern North Sea

Many molluscs form annual rings in their shells, just like trees. So, just as for tree rings, changes in the size of the shell rings reflect past climate and ecological conditions. Not just the size of the rings, but also their chemical composition depends on the temperature when the rings form. Some species are very long-lived, such as Arctica islandica, which can live up to 500 years. Tamara Trofimova has used live-collected and subfossil shells of this bivalve species Arctica islandica. This species forms annual growth increments which can be counted similar to tree rings. The variability in size reflects climatic changes. Geochemical properties of the shells provide additional climatic information. The analysis of shells from the Faroe Shelf, shows that the temperature in the northeastern North Atlantic has increased over the last 300 years and fluctuations in temperature resemble patterns reconstructed for the European continent. His results also suggest that in the Faroe area phytoplankton production has undergone strong fluctuations.

**February 11th, 2018**
Fabian Georg Wulf Bonitz
Molluscan scienechronology on the Faroe Shelf – Climatic and ecological conditions inferred from shell properties of the bivalve species Arctica islandica

Fabian Bonitz has reconstructed the marine climate based on the shells of the long-lived (>500 years) bivalve species Arctica islandica. This species forms annual growth increments which can be counted similar to tree rings. The variability in size reflects climatic changes. Geochemical properties of the shells provide additional climatic information. The analysis of shells from the Faroe Shelf, shows that the temperature in the northeastern North Atlantic has increased over the last 300 years and fluctuations in temperature resemble patterns reconstructed for the European continent. His results also suggest that in the Faroe area phytoplankton production has undergone strong fluctuations.

**May 9th, 2018**
Sigríður Lind
The northern Barents Sea during 1970–2016: From seabed to surface in the Arctic warming hotspot

The Arctic Ocean is stratified with cold Arctic water protecting the sea ice cover from warmer Atlantic water below. In her PhD, Sigríður Lind investigated the role of ocean stratification in Arctic warming and sea-ice loss, using observations from 1970 to 2016 in the northern Barents Sea. Her research shows that recent reductions in sea-ice inflows may have led to freshwater loss, weakened ocean stratification and increased vertical mixing, bringing heat and salt up from the deep Atlantic layer. The heat can explain why the region has greater atmospheric warming and sea-ice loss in winter. The salt invades a positive feedback that further weakens the stratification, and the region is transitioning towards an Atlantic climate, without sea ice and Arctic water.

**January 9th, 2018**
Henning Åkesson
Deglaciation of the Norwegian fjords

At the end of the last ice age, western Norway resembled Greenland today, with glaciers and ice streams following what we now know as fjords. Fjord glaciers are highly at risk as the world gets warmer, as these glaciers are exposed both to warmer air and to warmer sea water. Henning Åkesson’s PhD shows that the quality of the ice sheets on Greenland and in Antarctica may be improved by studying Norwegian glaciers in the past. His work also shows that the sixth largest glacier in Norway, Handan gerjøkulen, may be gone by the end of this century, should climate emissions remain unabated. This would be a challenge for the hydropower industry and tourism, as well as for plants and animals in the region.

**March 21st, 2018**
Patrik Bohlinger
Extreme precipitation in Nepal – Trends and key processes

In Nepal, heavy rain may lead to flooding and landslides, damaging infrastructure, agriculture, hydropower and homes. Using observations from 1971 to 2015, Patrik Bohlinger found that the number of days with extreme precipitation in Nepal has not changed, though the amount of rain on such days has increased in western parts of the country. For a rainfall event to be extreme, the air must contain large amounts of water vapour. Patrik Bohlinger’s work shows that evaporation from land areas plays a much larger role than previously thought. Previous rainfall events in India and Nepal likely influence how much it rains on the rainiest days in Nepal.

**November 8th, 2018**
Inge Althuizen
The importance of vegetation functional composition in mediating climate change impacts on ecosystem carbon dynamics in alpine grasslands

Climate change leads to higher temperatures and changes in precipitation, both important drivers of ecosystem processes. Inge Althuizen has studied the effect of specific plants on the carbon dynamics at 12 localities in western Norway – from mild lowlands to cold mountain tops, and from wet, western places to drier places farther east. She also analyzed the decomposition of organic material along the various climate gradients. The variation in species between the warmer lowlands and the cold mountain tops was found to influence the carbon uptake. The type of plants also affected the temperature of the soil.

**January 9th, 2018**
Lea Toska Oppedal
Holocene climate and glacier trends at sub-Antarctic South Georgia

Glaciers are fed by ice and snow deposited on the highest parts of the landscape. A glacier forms when the accumulation of ice and snow exceeds the rate of melt from the glacier surface and sides. In getting smaller, glaciers change the landscape and the lives of the people who live around them. In her PhD, Lea Toska Oppedal studied the mechanisms controlling the inflow of warm oceanic water to the Weddell Sea continental shelf. The Weddell Sea is an important site for dense water production, feeding into the lower limb of the global thermohaline circulation. She studied the density water variability, and found that presence of this water mass hinders warm inflow. If global warming reduces the dense water production, warm inflow may contribute to ice shelf basal melting.
Engagements 2018

GLOBAL DIMENSION
Argo Programme
Kjell Arne Mark is a member of the Argo Steering Team.

Arctic-Subarctic Ocean Fluxes (ASOF)
Tor Eidevik, Svein Østerhus, Øystein Skagseth and Kjell Våge are members of the international scientific steering group.

Biogeoosciences
Christoph Heine is associate editor.

Climate of the Past
Bjørg Risbo Bakken is on the editorial board.

Earth System Dynamics
Christoph Heine is a member of the editorial board.

Forum for Research on Ice Shelf Processes (FRISP)
Elín Darelus is an early-career scientist representative and Svein Østerhus represents Norway.

Framework of Ocean Observing (FOO/GOOS)
Christoph Heine is a member of the Ocean Observing Panel for Biogeochemistry.

Global Climate Forum (GCF)
BCCR is a member of the Global Climate Forum (GCF), a non-profit organization located at the Potsdam Institute for Climate Impact Research.

Global Ocean Acidification Observing Network (GOA-ON)
Benjamin Pfeil is an executive council member.

Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP)
Emil Jeansson is a member.

Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO)
- IOC-UNESCO: Peter M. Haugan is chair.
- Global Ocean Surface Underway Data (GOSUD): Benjamin Pfeil is a scientific steering group member.

- IOC-UNESCO and SCOR's International Ocean Carbon Coordination Project (IOCSCP): Siv Lauvset and Benjamin Pfeil are scientific steering committee members.
- IOC-UNESCO's methodology working group on LUN's SDG target 14.3. Benjamin Pfeil is a member.

International Arctic Science Committee (IASC)
Thomas Spengler is a representative for Norway in the Atmospheric Working Group (AWG) and currently elected as chair of the AWG.

International Commission on Dynamical Meteorology (ICDM)
Thomas Spengler is elected vice president.

International Council for the Exploration of the Seas (ICES)
- Working Group on Hydrography: Kjell Arne Mark, Svein Østerhus and Øystein Skagseth are members.
- Study Group on Ocean Acidification: Are Økland is a member.
- Working Group on Integrated Assessments of the Norwegian Sea WBGMD: Morten Skogen is a member.
- Working Group on Operational Oceanographic Products for Fisheries and Environment
- Working Group on Integrative Physical-Biological and Ecosystem Modelling WIPREM: Morten Skogen, Sofiild Hjfolio, Shuang Gao and Annette Samuelsson are members.
- Working Group on Seasonal-to-Decadal Prediction of Marine Ecosystems (SSGSD): Anne Brit Sandå is a member.

International Eurasian Academy of Science (IEAS)
Igor Esaïs was elected full member.

International Geosphere-Biosphere Programme (IGBP) and World Climate Research Programme (WCRP)
- Climate and the Cryosphere Project (CIC): Lars H. Smedsrud is a member of the scientific steering group.
- Integrated Marine Biogeochemistry and Ecosystem Research (IMBER): Ken Drinkwater is co-chair of the regional program Ecosystem Studies of Isabelline Seas.
- Past Global Changes (PAGES): Ulsses Ninemman is in the scientific steering committee of IMAGES, the marine component of PAGES.
- PAGES Arctic Working group: Joossein Bakke is co-leader.
- PAGES Ecological Allotropism:olas is the leader.
- PAGES Early Career Network: Madein Matto and Tamara Trofla are steering committee members.
- PAGES/CLIVAR joint working group: Eystein Jansen is a member.
- CLIVAR Atlantic Region Panel: Noel Keenlyside is a member.
- CLIVAR Climate Dynamics Panel: Keenlyside is a member of CLIVAR Global Synthesis and Observation Panel.
- Are Økland is a member.
- CLIVAR Ocean Model Development Panel: Mats Bentsen is a member.
- CLIVAR/CICLOR Northern Oceans Regional Panel (NORP): Tor Eidevik and Laurence Bertino are members.

IBS Center for Climate Physics, Busan South Korea
Eystein Jansen is a member of the scientific advisory board.

International Marine Global Changes Program (IMAGES)
Uloos S. Ninemaa is the Norwegian representative.

International Surface Ocean Lower Atmosphere Study (SOLAS)
Siv Lauvset is the national representative from Norway.

North Atlantic Virtual Institute (NAVIS)
Tor Eidevik is a member of the NSF collaborative project’s steering committee.

OceanSITES
Svein Østerhus is a member of the steering committee.

Pan-European Project (PEEP)
Igor Esaïs is a member.

PANGAEA – Data Publisher for Earth and Environmental Science
Benjamin Pfeil is a member of the editorial board.

Integrated Marine Biogeochemistry and Ecosystem Research (IMBER): Ken Drinkwater is the external advisory board.

East Greenland Ice core drilling project (EGIRP)
Karim H. Nisancioglu is the Norwegian representative and member of the steering committee.

ECORD Science Support and Advisory Committee (ESSAC)
Benjamin Pfeil is a team coordinator for data.

World Universities Network (WUN) Global Challenge – Responding to Climate Change
Tore Furevik is in the steering group.

EUROPEAN DIMENSION
Academia Europaea Bergen Region Knowledge Hub
Eystein Jansen is Academic Director with responsibility for the Nordic, Baltic, Arctic region.

Bolin Centre, University of Stockholm
Eystein Jansen is member of the scientific advisory board.

Coordinated Regional Downscaling Experiments (Euro-CORDEX)
Stefan Sobolowski is co-coordinator and point of contact.

CORDEX Flagship Pilot Studies (CORDEX-PS)
Stefan Sobolowski is co-leader of the PS on Convective processes over Europe and the Mediterranean.

International Quaternary Map of Europe (IQUAME)
- Nele Meckler is a member of the scientific steering committee.
- Anne Britt Sandø and Laurent Berthier are participants in the FPS on Land use and climate across scales (LUCAS).

COST – European Cooperation in Science and Technology
- Svein Østerhus is member of the COST action Everyone’s Gliding Observatories for Arctic Environment.
- Arve Sand and Laurence Bertino are members of the COST Action Evaluation of Ocean Syntheses.

Durham Arctic Research Centre for Training and Interdisciplinary Collaboration (DurhamARCTIC)
Bjørg Risbo Bakken is on the external advisory board.

East Greenland Ice core drilling project (EGIRP)
Karim H. Nisancioglu is the Norwegian representative and member of the steering committee.

ECORD Science Support and Advisory Committee (ESSAC)
Benjamin Pfeil is a team coordinator for data.

Helga F. Kleiven is the Norwegian national delegate.

European Climate Research Alliance (ECRA)
- Lars H. Smedsrud is co-chair of the programme on Arctic Climate Stability and Change.
- J. Even S. Nilsen is co-chair of the collaborative programme on Sea Level and Climate Change.
- Eystein Jansen is member of the executive board of ECRA.

European Geoscience Union Outreach Committee: Matthew Stiller-Reeve is a member.

European Marine Board
Helga F. Kleiven is the Norwegian academic representative.

European Science and Technology Advisory Group (E-STAG)
Jenny Sjostedt-Hagen is a young scientist representative.

Joint Programming Initiative (JPI) Climate – Module 1
Tore Furevik is national representative.

Joint Programming Initiative (JPI) Climate – Action Group Next generation of climate sciences in Europe
J. Even S. Nilsen is a member.

Joint Programming Initiative (JPI) Oceans
Tore Furevik is a member of the national reference group.

International Quaternary Map of Europe (IQUAME)
Anna Hughes is on the scientific advisory board.

SeaDataCloud
Benjamin Pfeil is a member of the scientific committee.

COPERNicus Marine Environmental Monitoring System in Situ TAC
Benjamin Pfeil is a member of the scientific committee.

RINGO
Benjamin Pfeil is an executive board member.

MOSAIC
Benjamin Pfeil is a team coordinator for data.

Nansen Environmental and Remote Sensing Centre
Sofiild Hjfolio is a member of the Scientific Council.

Nansen Legacy (Arven etter Nansen) – a national consortium for a coordinated research programme
Nils G. Kvarme is a member of the steering committee and Tore Eidevik is Co-PI.

Norwegian Climate Foundation
Helga F. Kleiven is on the board of directors.

Norwegian Climate Science Centre
Tore Furevik is board leader.

Research Council of Norway: KLIIMAFOREK programme board
Tore Furevik is vice chairman.

Research Council of Norway: Norway-India Programme Advisory Committee
Eystein Jansen is a member.

Scientific Committee of Oceanographic Research (SCOR)
Peter M. Haugan is national chair.

Subsurface CO2 storage – Critical Elements and Superior Strategy (SUCCESS)
Truls Johannessen is the University of Bergen’s board member.

UNIS – Universitetsenteret på Svalbard
Helga F. Kleiven is deputy of the board of directors.

MARUM, University of Bremen
Nleik is a member of the scientific advisory board.

NATIONAL DIMENSION
Arctic Frontiers
Tore Eidevik is a member of the steering committee.

Arts Council Norway
Karim H. Nisancioglu is a member of the Climate panel.

Orekonferanse
Jostein Bakke is a board member and Karim H. Nisancigul is an alternate member.

Notor/Norstore Resource Allocation Benjamin Pfeil is a member.

Nansen Environmental and Remote Sensing Centre
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Making science 2019

Engagements 2018
The Bjerknes Centre in numbers 2018

DOCTORAL DISSERTATIONS
- 13 PhD candidates successfully defended their thesis

PUBLICATIONS
- 271 publications
- 15 in Nature and Science journals

PROJECTS
In total 63 research projects:
- EU – 18
- NFR – 38
- Other – 9
- ERC Grants – 7
  - 1 ERC Synergy Grant
  - 1 ERC Advanced Grant
  - 3 ERC Consolidator Grant (1 starting in 2019)
  - 2 ERC Starting Grant

247 AFFILIATED RESEARCHERS, TECHNICIANS, AND ADMINISTRATIVE PERSONNEL
- From 36 nations

STAFF
<table>
<thead>
<tr>
<th>Category</th>
<th>UIB</th>
<th>NORCE</th>
<th>NERSC</th>
<th>IMR</th>
<th>Total</th>
<th>Foreigners %</th>
<th>Women %</th>
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<td>Scientists</td>
<td>58</td>
<td>36</td>
<td>28</td>
<td>14</td>
<td>136</td>
<td>62 %</td>
<td>27 %</td>
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<td>31</td>
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<td>1</td>
<td>1</td>
<td>41</td>
<td>83 %</td>
<td>39 %</td>
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<tr>
<td>PhD candidates</td>
<td>51</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>57</td>
<td>60 %</td>
<td>58 %</td>
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<tr>
<td>Total</td>
<td>140</td>
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<td>30</td>
<td>17</td>
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FUNDING
- Ministry of Research and Education: 31,202
- University of Bergen: 6,616
- European Commission: 41,216
- Research Council of Norway: 99,103
- Other: 20,479

Total income: 198,616
Morven Muilwijk with an ice core at a field course for PhD candidates on Disco Island, Greenland.
PHOTO: NICHOLAS RATHMANN

Anne Kari Øhman Meisingset in the Denali national park in Alaska, as part of the 2018 summer school of the TRACICE project.
PHOTO: LARS H. SMEDSRUD

Phoebe Chan and Carin Andersson Dahl during field work in Svalbard.
PHOTO: PHOEBE CHAN

Sigve Naustdal describing measurements performed at the vessel Nuka Arctica.
PHOTO: ANDREAS HADSEL OPSVIK

Hand launch of the unmanned research aircraft SUMO for an atmospheric profiling mission up to 1800 m above ground.
PHOTO: KRISTINE FLACKÉ HAU ALAND

Botany field work at Upsete.
PHOTO: ANNE BJUNE

Bergen seen from the mountain Ulriken.
PHOTO: ERIK KOLSTAD