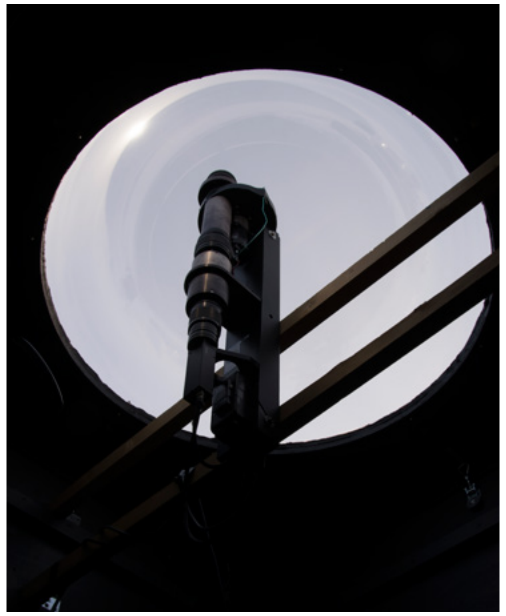
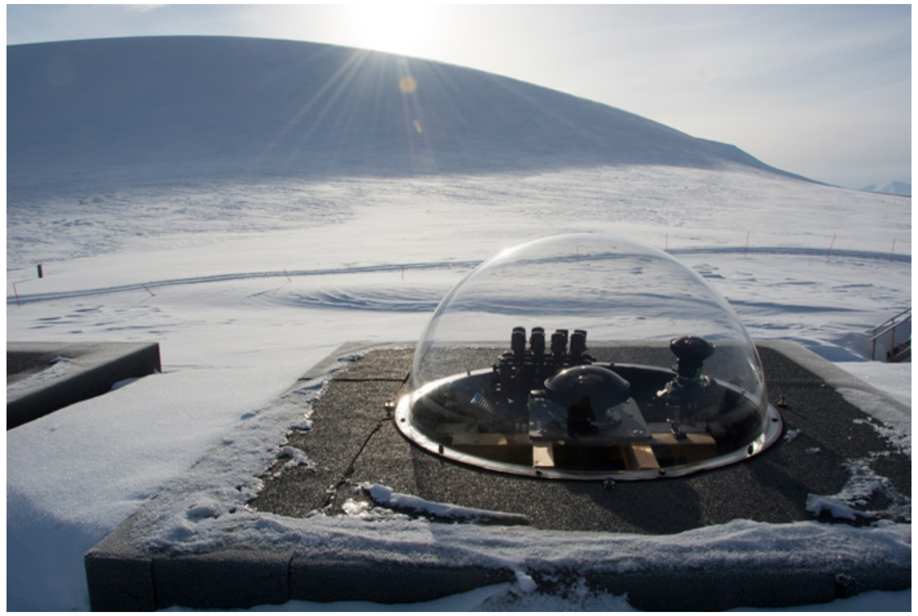
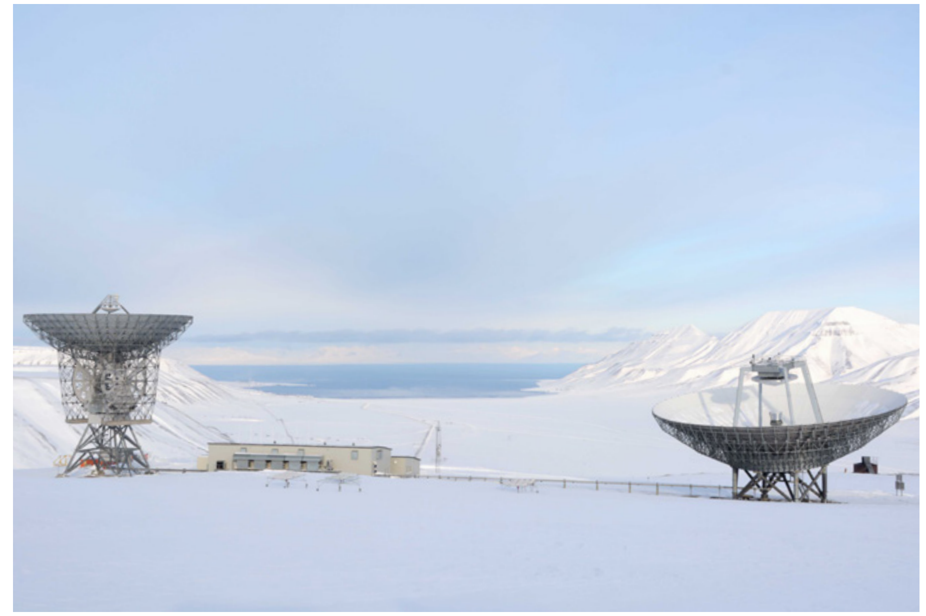
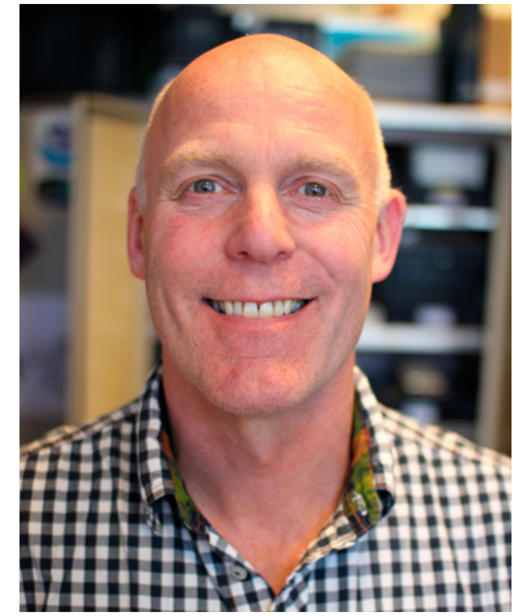




CREATING RELIABLE MODELS: In the same way that a meteorologist depends on reliable mathematical models to predict the weather, space researchers depend on reliable models to predict how electric currents move in space. ALL PHOTOS: KIM E. ANDREASSEN





GO NORTH! The Birkeland Centre for Space Science has a research outpost on the Svalbard islands, in the Arctic. From here they conduct trials to observe electric currents in space. The centre is headed by Professor Nikolai Østgaard, Department of Physics and Technology, University of Bergen.

Basic research in space

How is earth connected to space? That is one of the questions the researchers at the Birkeland Centre for Space Science are trying to answer. TEXT KIM E. ANDREASSEN

We have become a society that is ever more reliant on satellite communication systems, says Professor Nikolai Østgaard at the Department of Physics and Technology at the University of Bergen (UiB), "and as we become more reliant on space-based technology, we will become more dependent on good space forecasts."

Earth and the poles

Professor Østgaard is director of the Birkeland Centre for Space Science (BCSS), one of four Norwegian Centres of Excellence (SFF) at UiB. BCSS has set out four prime areas of research:

- Asymmetric Aurora: When and why are the aurora in the two hemispheres asymmetric?
- Dynamic Ionosphere: How do we get beyond the large-scale static picture of the ionosphere?
- Particle Precipitation: What are the effects of particle precipitation on the atmospheric system?
- Gamma-ray flashes: What is the role of energetic particles from thunderstorms in geospace?

Earth is, for the main part, connected to space via the magnetic poles. When electrically charged particles from space bombard our planet, visible light occurs; i.e. aurora borealis in the Northern hemisphere or aurora australis in the Southern hemisphere.

But as these electrically charged particles hit the atmosphere, this can interfere with communication systems. In addition, particle showers from space can lead to power outages and the destruction of transformers on the ground.

Studying aurora borealis in the Arctic

This is why the BCSS researchers have a particular interest in the ionosphere, a region of the upper atmosphere. It has practical importance because, among other functions, it influences radio propagation, i.e. the behaviour of radio waves, to distant places on Earth.

The ionosphere is at 85 to 600-kilometre altitude. This is where satellites orbit the Earth and also where the aurora becomes visible and creates problems for communication systems.

"Svalbard is the perfect place to study the aurora borealis," says Professor Dag A. Lorentzen at the University Centre in Svalbard (UNIS), who leads UNIS's part of BCSS. "We combine data from our base in Svalbard with data from European, American and Norwegian satellites and also Norwegian ground centres."

Among the most important aurora borealis instruments are the EISCAT Radar, the SPEAR Radar and the optical Kjell Henriksen Observatory, which are all located in Svalbard. The latter is run by the Arctic Geophysics Group at UNIS.

The Svalbard archipelago is located right below the point where the Earth's magnetic fields converge, and where the electric particles from space enter the atmosphere.

"It has been known for a long time how the aurora borealis evolves. There are, however, a number of unknowns when you look at the processes behind the lights, both when it comes to basic and applied research," says Lorentzen.

Using space as your lab

This combination of basic and applied research is at the heart of BCSS. The basic research component is about

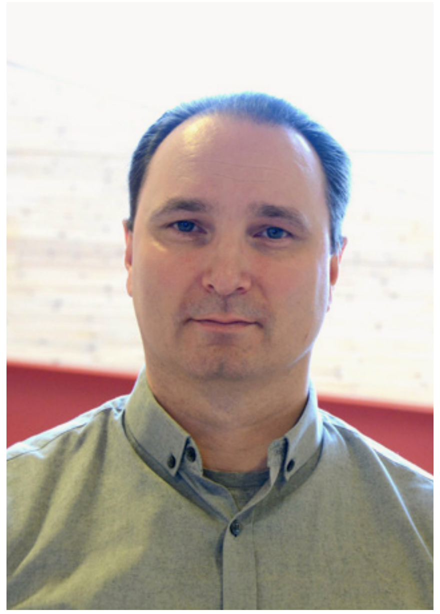
" As we become more reliant on space-based technology, we will become more dependent on good space forecasts. "

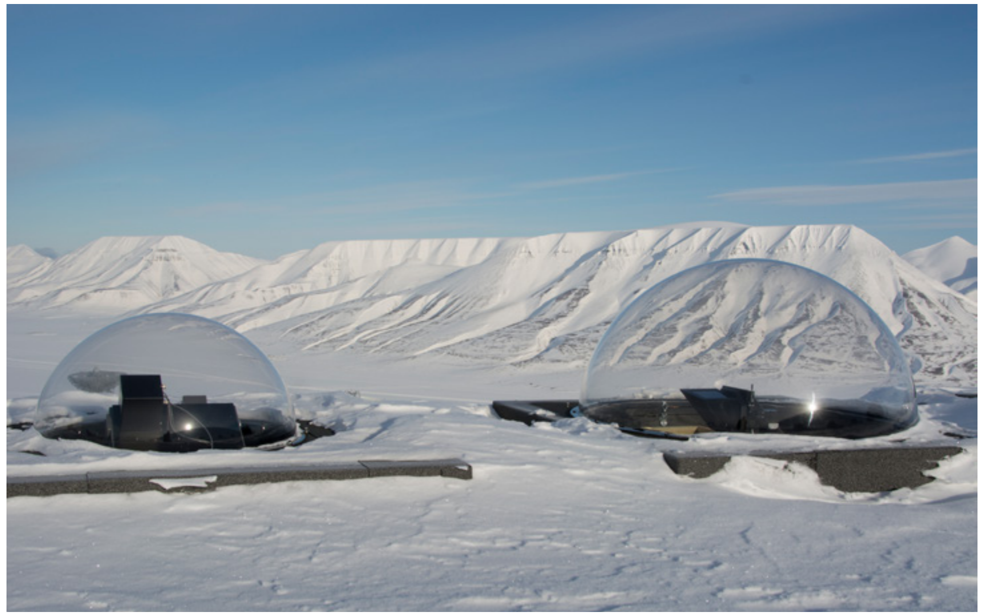
understanding the physical processes in the ionised gas, which is known as plasma. Around 95 per cent of the known cosmos consists of plasma.

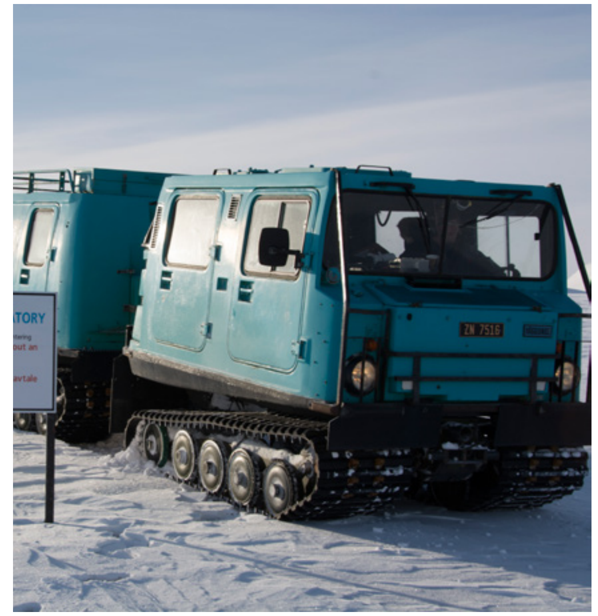
"As researchers we have a unique laboratory right above our heads. Space! Where a number of processes can be studied," says Lorentzen. "Curiosity is the main motivator for doing basic research."

The signals between Earth and the communication satellites are transmitted through the plasma in the ionosphere.

"We have seen how some of these signals are interrupted by the atmosphere, and want to attain a better understanding of these disturbances. ▸







INTO THE ARCTIC DESERT: Professor Dag A. Lorentzen, Arctic Geophysics Group, University Centre in Svalbard, in his office; and a visit to some of the locations where the Birkeland Centre for Space Science is active in Svalbard.

> **“ Svalbard is the perfect place to study the aurora borealis, and we have a unique laboratory right above our heads. Space! ”**

This is part of the applied research that we do," Lorentzen explains.

"The aurora borealis is visible evidence of the numerous electric processes taking place in the upper atmosphere. One of our main interests is to understand the processes before the light becomes visible."

Hunting for gamma ray blasts

But the electric currents in space are not only influenced by the particle showers hitting Earth.

"On Earth, lightning strikes about 45 times a second, i.e. several million times a day. Satellite pictures show how gamma ray blasts, or GRBs, occur in thunderstorms," says Nikolai Østgaard. "The GRBs are electrically charged particles that travel with the speed of light and in any direction in lightning and thunder."

In 2010, ten years of raw data of GRBs from the satellite Rhessi were made available. UiB's Department of Physics and Technology developed a search algorithm which performed better than the algorithms used by the satellite's owner.

The department found more than twice as many GRBs as were originally reported. Since then, the researchers at BCSS have developed a measuring device that is state of the art to improve the reading of GRBs.

BCSS is involved in designing and building a large X- and gamma-ray detector to be launched to the International Space Station (ISS) in May 2016. According to Østgaard, the European Space Agency (ESA) has recently approved the ground model of this instrument, and the group is now building the flight model.

"Lightning discharges function like a battery and create electric fields around Earth. It is, however, little known about what happens when GRBs from Earth or electric particles from space cross through the atmosphere," says Østgaard. "We move into an electric field and are hit by particles at the speed of light, but without really knowing what the implications of this action are."

Changes to the climate

One of the hypotheses the BCSS researchers are working on is that particles which seep into the atmosphere influence the chemical composition of Earth's weather systems.

"For example, some studies have implied that cosmic radiation makes clouds thicker. This is, however, a very controversial hypothesis," according to Østgaard.

The energy-rich particles and GRBs crossing the atmosphere may influence the weather locally around the geographical poles, and may thus be of interest for climate scientists as well.

"I want to be careful before stating without doubt that this influences the climate. There are, however, many unknowns in the relationship between space and climate change. And as long as this has not been researched, we cannot say anything without reasonable doubt," says Nikolai Østgaard. ●

FACTS

Birkeland Centre for Space Science (BCSS)

- Research centre that opened in March 2013.
- Headed by Professor Nikolai Østgaard.
- The University of Bergen (UiB) hosts the centre.
- One of the centre's main goals is to study the link between the Earth and space via the geographical poles.
- BCSS will also study gamma-ray bursts (GRBs) that occur during thunderstorms. These are electrically charged particles that fly off in different directions with the speed of light during lightning storms.
- The centre is also looking at electrically charged currents in space, and at how particle showers influence the Earth's climate.
- The centre consists of around 45 researchers, of whom 75 per cent are from the Department of Physics and Technology at UiB.
- The University Centre in Svalbard (UNIS) and the Norwegian University of Science and Technology (NTNU) are BCSS partners.
- There is an extensive international exchange programme at BCSS.
- UiB's Department of Physics and Technology are in charge of SuperMAG, which collects data about magnetic disturbances from electric currents in the atmosphere from around the world.
- For more information, visit: birkeland.uib.no

SFF at UiB

The Norwegian Centres of Excellence (SFF) scheme is a national programme under the auspices of the Research Council of Norway. The goal of the scheme is to establish time-limited research centres characterised by focussed, long-term research efforts of a high international calibre, and where researcher training is important. High scientific quality is the main criterion for the selection of the centres. The Research Council of Norway provides the basic source of funding for the scheme. SFF centres normally receive extensive funding for a 10-year period.

The first centres under the SFF scheme were announced in 2002, when three SFF were established at UiB: Bjerknes Centre for Climate Research, Centre for Medieval Studies, and Centre for Integrated Petroleum Research (CIPR). Their SFF status expired in 2012.

At present, four research environments hold SFF status at UiB, one of which is the Birkeland Centre for Space Science. The other three are:

Centre for Geobiology (CGB)
The centre opened in 2007. CGB's research focuses on extreme environments of the deep seafloor, the deep biosphere, and remnants of ancient crust. The centre brings together geologists, geochemists, microbiologists, and molecular biologists to study life in extreme environments, early Earth, and the roots of life. The centre is a hub for international research and researcher training, and undertakes interdisciplinary studies to generate new, fundamental knowledge about the interaction between the geospheres and biospheres. Professor Rolf Birger Pedersen is the director of the centre.

Centre for Cancer Biomarkers (CCBIO)
The centre opened in May 2012. CCBIO is one of two Norwegian cancer research environments with SFF status. The centre works to identify the mechanisms that control the interaction between cancer cells and their microenvironment, identify diagnostic characteristics of this interaction, and conduct clinical trials with tailor-made treatment. CCBIO consists of researchers from a number of cancer research groups at UiB: the Department of Clinical Medicine, the Department of Biomedicine, and the Institute of Medicine. The centre collaborates closely with colleagues at, amongst others, Harvard University in Boston and Karolinska Institutet in Stockholm. Professor Lars A. Akslen is the director of the centre.

Centre for Intervention Science in Maternal and Child Health (CISMAC)
The centre opened in October 2013. CISMAC conducts intervention studies on maternal and child health, whereby the effectiveness of preventive or treatment measures is examined. The centre has twelve specific projects on its agenda, ranging from the implementation of new vaccine trials to studying the effect of organisation of health care. CISMAC collaborates with the World Health Organization and seven partners in India, Nepal, Uganda, Ethiopia, Zambia, and South Africa. National partners are the Norwegian Institute of Public Health and Chr. Michelsen Institute (CMI). Professor Halvor Sommerfelt is the director of the centre.