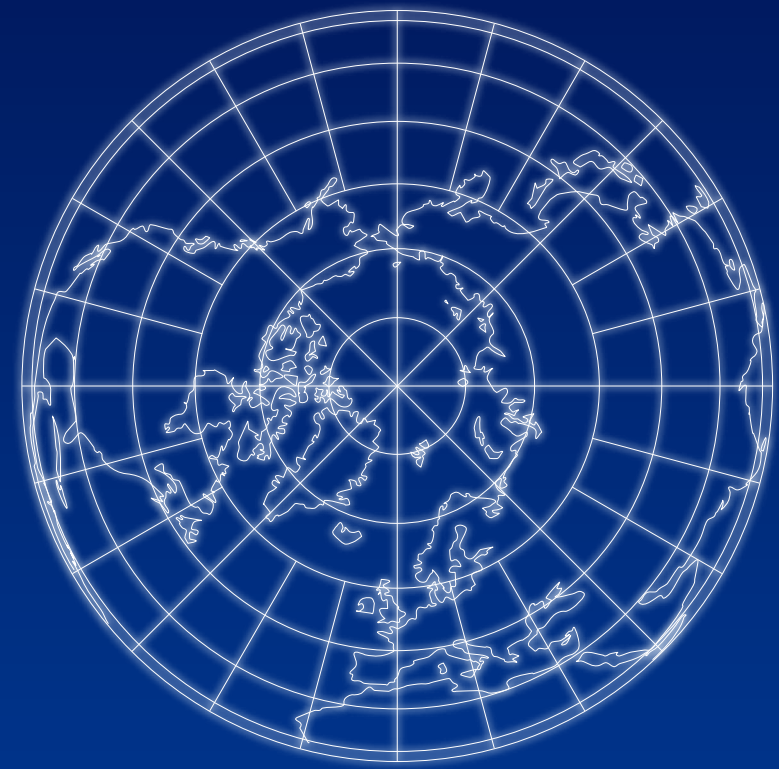




Hokkaido University

Arctic and Antarctic Science Curriculum



Hokkaido University
Arctic and Antarctic Science Curriculum

Graduate School of Environmental Science / Institute of Low Temperature Science / Arctic Research Center

Institute of Low Temperature Science, Kita 19, Nishi 8, Kita-ku, Sapporo
TEL. 011-706-5445

URL <https://www.arc.hokudai.ac.jp/en/aasc/>

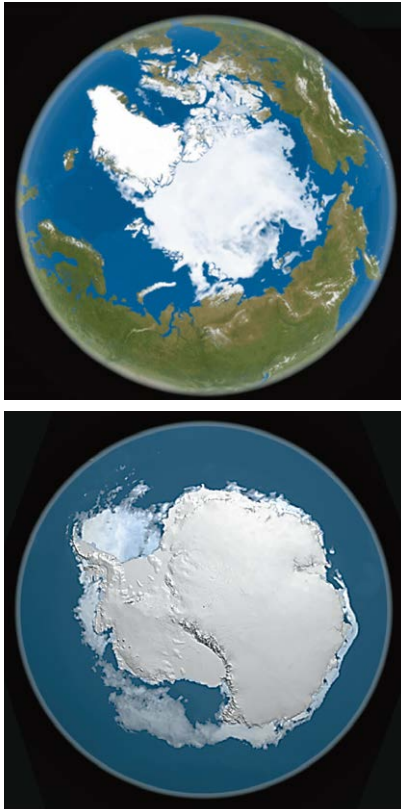


Studying Global Climate and Environmental Changes in the Arctic and Antarctic

The Arctic and Antarctic regions are rapidly changing under the recent climate change. In the Arctic, temperatures are rising three to four times faster than the global average, leading to a dramatic reduction in sea ice extent in the Arctic Ocean, and accelerated melting of the Greenland ice sheet and mountain glaciers. In Antarctica, the extent of sea ice shows a reducing trend, and the massive Antarctic ice sheet is gradually losing ice. These changes in the polar regions have critical impacts on Earth's surface heat balance, sea levels, and ocean circulation. Moreover, these changes are affecting not only natural environments but also causing significant impacts on society.

In 2007, Hokkaido University established the "Antarctic Science Curriculum", a graduate program for comprehensive studies on polar regions and cryosphere environments with a special focus on Antarctica. From 2007 to 2026, 144 students earned certificates upon completing the program, and more than 20 graduates conducted research in Antarctica. In 2026, against the backdrop of the growing importance of the Arctic region, the program partnered with the nationwide Arctic research project ArCS III (Arctic Challenge for Sustainability III) and launched a new initiative, "Arctic and Antarctic Science Curriculum". Hokkaido University has a long history and proven track record of research activities in both the Arctic and Antarctica. We have cultivated leading experts in these fields as a university that promotes a pioneer spirit in uncharted territories. Hokkaido University is promoting its Arctic and Antarctic Science Curriculum to nurture individuals who demonstrate international leadership in research on the polar regions, which remain the last frontiers of the Earth.

Arctic and Antarctic Science Curriculum program managers
Arctic Research Center, Hokkaido University: Shin SUGIYAMA
Institute of Low Temperature Science, Hokkaido University: Shigeru AOKI



Satellite images of the Arctic and Antarctic regions. In the Arctic, sea ice covering the Arctic Ocean is rapidly shrinking and the Greenland ice sheet and glaciers are melting in accelerating rates. In Antarctica, sea ice and ice sheets are gradually shrinking, raising concerns about more significant changes in the future.

Arctic and Antarctic Science Curriculum

Since 2007, Hokkaido University has been offering an "Antarctic Science Curriculum" in collaboration of the Graduate School of Environmental Science and the Institute of Low Temperature Science. Under this curriculum, more than 2,000 graduate students have studied polar and cold regions, global environmental change, and snow and ice science. In April 2026, with the participation of the Arctic Research Center, the curriculum will be relaunched as the "Arctic and Antarctic Science Curriculum" by including the keyword "Arctic", which is drawing attention in science and society. The curriculum has expanded its programs to include courses on the relationship between natural and social environments, a topic of significant importance in the Arctic region.

The Arctic and Antarctic Science Curriculum is a globally unique program designed for a broad range of students, including those with a general interest in the Arctic and Antarctica, as well as those aspiring to become polar researchers. Moreover, the program is not only for students of the Graduate School of Environmental Science but rather is open to any graduate student at Hokkaido University. Furthermore, with support from the ArCS III (Arctic Challenge for Sustainability) project, graduate students from outside Hokkaido University can take field courses and lectures. By providing a venue for studying with domestic and international students, this program serves as a gateway to the next generation of Arctic and Antarctic researchers.

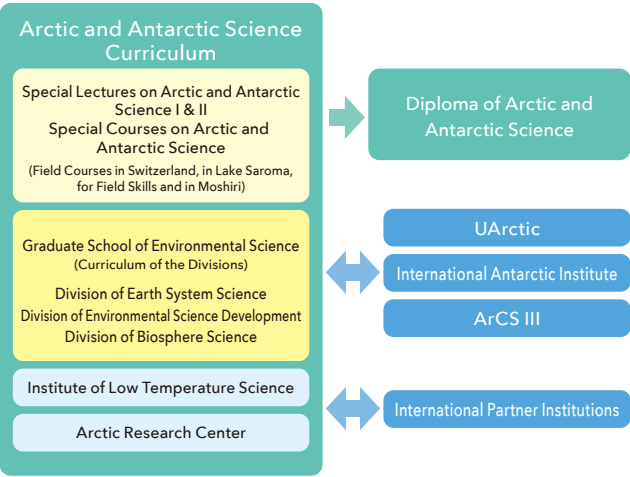
The curriculum consists of (1) lectures on Arctic and Antarctic science, (2) field courses on Arctic and Antarctic science, and (3) lectures and courses on polar science within the Graduate School of Environmental Science. The lectures will provide a comprehensive understanding of polar science, ranging from fundamental principles to cutting-edge research, through lectures delivered by domestic and international experts. The field courses provide opportunities to learn about and experience snowy and icy environments in Hokkaido and abroad. The lectures and courses are targeted to various aspects of polar regions and the cryosphere, thus allowing students to acquire specialized knowledge from a wide range of disciplines tailored to their interests. Students who complete the required number of credits from the curriculum will be awarded the Diploma of Arctic and Antarctic Science.

[Requirements for Completing the Arctic and Antarctic Science Curriculum]

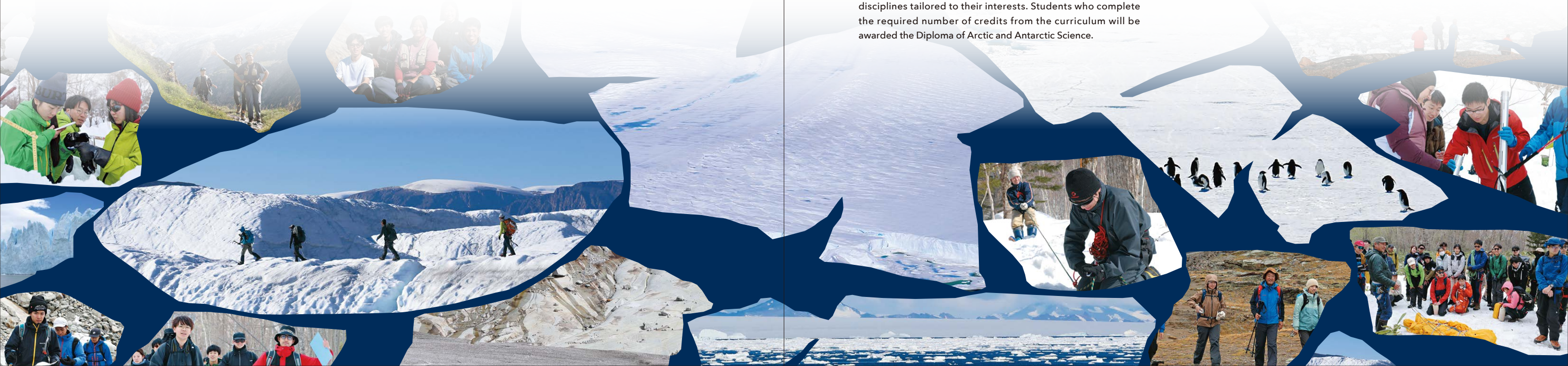
The curriculum is completed by earning a minimum of 14 credits, including 4 credits of compulsory lectures (Special Lectures on Arctic and Antarctic Science) and at least 10 elective credits, of which at least 2 must be from the elective compulsory courses (Special Courses on Arctic and Antarctic Science).

[Diploma of Arctic and Antarctic Science]

The diploma is awarded to students who have completed the curriculum, in addition to the master's or doctoral degree obtained from the departments. It serves as official certification that the recipient has completed a comprehensive study in polar science.



The overview of the Arctic and Antarctic Science Curriculum. The curriculum consists of Special Lectures and Courses on Arctic and Antarctic Science, and lectures and courses broadly distributed in the programs of the Graduate School of Environmental Science. Those who complete the curriculum are awarded the Diploma of Arctic and Antarctic Science.



Through the field courses, students acquire the fundamental skills necessary for field research in the cryosphere.



Gorner Glacier

Special Course on Arctic and Antarctic Science I

Glacier Field Course in Switzerland

Approximately 70% of Earth's freshwater is stored as snow and ice, with most of it distributed in mountain glaciers and polar ice sheets. Glaciers play a vital role as a freshwater resource and represent an important indicator of climate change. Studying glaciers is increasingly important to understand the consequence of global warming in the cryosphere.

In collaboration with the Swiss Federal Institute of Technology Zurich, this program offers a two-week field activity in Switzerland. On glaciers in the Swiss Alps, participants conduct observations of ice thickness changes, stream discharge, and meteorological conditions. The obtained data are processed and analyzed to present the results in a seminar. Students also attend lectures by Swiss researchers and visit the high-altitude observatory. Through activities in Switzerland, students gain a deeper understanding of glaciers and glacier landscapes while developing the fundamental skills necessary for field research in the cryosphere.

[Course Program in 2025]

Program goals

- Acquire field observation techniques on glaciers.
- Observe glaciers and glacial landforms to understand glacial and periglacial processes.
- Visit research institutions and observatory in Switzerland to learn about cutting-edge earth science.
- Interact with foreign researchers and graduate students.

Period

23 August to 6 September 2025

Activities

- **Rhone Glacier**
GPS elevation surveys, meteorological observations, albedo measurements, proglacial discharge measurements, and glacial geomorphological surveys, and observations of glacial phenomena (crevasses, glacial lakes, and sediments) and surrounding landforms.
- **Grindelwald region**
Observations of glacial geomorphology in Grindelwald, observations of Unteraar Grindelwald Glacier and its proglacial lake, visit the accumulation area of Aletsch Glacier, and study visit to the Jungfrauoch High Altitude Research Station.
- **Zermatt region**
Visit Gorner Glacier, observations of glacier landforms and periglacial processes around Zermatt.
- **Lectures at ETH Zurich**
- **Presentation and discussion of the field data from Rhone Glacier**



1) Eiger Glacier 2) Lecture at ETH Zurich 3) Field observation at Rhone Glacier
4) Glaciers and 4,000-meter peaks viewed from Gornergrat 5) Jungfrauoch High Altitude Research Station 6) Rhone Glacier

Student voices

- Interaction with highly motivated students was truly inspiring and significantly boosted my own passion for research.
- The vast natural landscape of Switzerland and discussions with students from diverse backgrounds were invaluable experiences for my future research.
- I realized that academic specializations do not matter when we share the excitement of research and field activities.
- Talking and thinking alongside students and professors with diverse interests, all while surrounded by magnificent nature, represented an irreplaceable experience in my life.

(Feedback from participants)



Message from the Lecturer

Arctic Research Center
/ Institute of Low Temperature Science

Prof. Shin SUGIYAMA

This field course is designed not only for students specializing in snow and ice but also for those with a broad interest in the global environment. Set against the backdrop of the beautiful Swiss Alps, participants will learn essential field techniques and observation skills while experiencing both the magnificence and challenges of nature. By visiting Swiss universities and research institutes, students will be exposed to cutting-edge research. It is my sincere hope that this experience will serve as a cornerstone for future research as you take wing and engage with the world.

Through the field courses, students acquire the fundamental skills necessary for field research in the cryosphere.



Sea ice sampling and observations in the freezing cold temperature of early morning

Special Course on Arctic and Antarctic Science II

Sea Ice Field Course at Lake Saroma

The Okhotsk coast of Hokkaido is characterized by seasonal sea-ice formation. In the global climate system, sea ice serves as a critical interface between the atmosphere and the ocean. On the other hand, it exhibits complex microscopic physical structures and characteristics. Sea ice also functions as a vital habitat within a specialized and distinct ecosystem. Although remote sensing enables long-term monitoring over large areas, in situ observations of the physical and ecological processes of sea ice are essential.

This course provides an intensive one-week observational program at Lake Saroma and other sites along the Okhotsk coast. Participants explore the physics and biogeochemical properties of sea ice and its multifaceted interactions with the marine environment. Specifically, students characterize the internal structure of the ice and analyze the correlations between ice-associated phytoplankton and environmental variables, such as salinity and temperature. These field activities will be complemented by lectures from distinguished international researchers at the forefront of sea ice and polar oceanography.

[Course Program in 2025]

Program goals

- Characterization of the internal structure of sea ice
- Measurement of sea ice thickness and floe morphology
- Assessment of the underwater optical environment and sea ice ecosystem
- Evaluation of stratification through oceanographic observations

Period

23 February to 27 February 2026

Activities

- Safety training
- Field observation at Lake Saroma
- Processing and analysis of acquired data, followed by a final reporting session
- Lectures on polar science by domestic and international researchers



1) Hands-on training with a sea ice coring drill 2) Laboratory analysis of ice samples 3) Frost flowers formed on the sea ice surface 4) In situ observations of sea ice cores 5) Sea ice thickness survey using an ice drill 6) Group photo of students and staff in February 2025

Student voices

- I gained a deeper understanding of how seasonal sea ice in the Arctic and Antarctic impacts climate and biological activities. Discussion on our field data helped me acquire essential academic skills. Furthermore, I learned safety protocols for conducting research in hazardous outdoor environments.
- It was an invaluable experience to use ice saws and drills for sampling and to record the distribution of ice thickness in collaboration with my group members.
- I have developed profound insights into sea ice and recognized its distinct characteristics compared to glacial ice.
- The experience in the subpolar environment of Lake Saroma significantly deepened my understanding of the cryosphere and the pivotal role of sea ice.

(Feedback from participants)



Message from the Lecturer

Institute of Low Temperature
Science

Prof. Shigeru AOKI

Another compelling aspect of the Arctic and Antarctic Science Curriculum is the opportunity to interact with peers of the same generation. Our field courses are open to students from universities and research institutions both within Japan and abroad. It will become an asset for your future research to interact with international researchers and students from diverse academic backgrounds and expose yourself to their broad perspectives during your formative years.

Through the field courses, students acquire the fundamental skills necessary for field research in the cryosphere.



Route finding with a map and compass

Special Course on Arctic and Antarctic Science III

Course for Field Skills

Field observations on glaciers and in snow-covered regions require skills and equipment for safety and comprehensive knowledge of polar environments, avalanches, and high-altitude sickness. In this program, students will learn essential field techniques from experts with extensive experience with the Japanese Antarctic Research Expedition (JARE) and other instructors engaged in polar and alpine research. As a unique and distinctive course within the Arctic and Antarctic Science Curriculum, this program provides the fundamental knowledge and technical skills necessary for scientific field activities in polar regions, including risk management and emergency response protocols. The curriculum begins with indoor lectures and practical training, followed by numerous opportunities to apply the knowledge in the field, such as the spring program on Mt. Teine and the summer program on Mt. Shioya-Maruyama. After acquiring techniques and knowledge, students are able to take their first step toward becoming a field scientist capable of exploring global climate and the environment.

[Course Program in 2025]

Program goals

- Learn about field navigation techniques and equipment for outdoor observations.
- Understand potential hazards and safety measures during field activities.
- Develop skills for emergencies, including life-saving methods, casualty transport, and crevasse rescue.
- Acquire the meteorological knowledge for field activities.

Period

April to June 2025 : Indoor lectures and practical training
April 27-28, 2025 : Spring field training (Mt. Teine)
June 8, 2025 : Summer field training (Mt. Shioya-Maruyama)

Activities

- Equipment, personal gear, and clothing for outdoor activities
- Ropework and belaying
- Avalanches, high-altitude sickness, and hypothermia
- Map, compass, and GPS
- First aid, transport techniques, and taping
- Mountain meteorology and weather forecasting
- Designing and planning of field observation



This program is supported by
RaaX Co., Ltd. in Sapporo.



1) Rope rescue 2) Drawing a weather chart 3) Ropework 4) Map reading 5) Feature identification on a map
6) Summer field training at Shioya-Maruyama

Student voices

- A smartphone is all we need in town, but it doesn't work in the mountains. I learned practical skills from experienced instructors, which help me in unexpected situations in the field.
- I was surprised by how much can be done with analog tools such as ropes and compasses. This was an opportunity to consider how my own wisdom can be used in harsh environments.
- This course provided a valuable opportunity to learn directly from those experienced in Antarctica. The classroom and field programs were full of hands-on practice. The interaction with students and participants from diverse fields was an important attraction, as well.

(Feedback from participants)



Message from the Lecturer

Sapporo Mountain Guide Center

Lecturer: Yuka ABE

This practical training program is specifically for those who want to challenge themselves with fieldwork but may feel anxious about the conditions. In nature, although knowledge is required, fundamental skills for safety and decision-making are also vital. Through my field activities, I have learned that accumulated daily experience builds the strength to protect oneself and colleagues. Even in harsh environments and situations, those fundamental skills and knowledge provide support to your activity. Let's take this opportunity to learn with your peers!

Through the field courses, students acquire the fundamental skills necessary for field research in the cryosphere.



Snow survey with a sampler

Special Course on Arctic and Antarctic Science IV

Snow and Ice Field Course in Moshiri

The snow and ice covering the Antarctic and Arctic regions have unique properties that underscore the importance of the polar regions to the global environment. Winter in Hokkaido offers an excellent opportunity to learn about snow and ice. Against the backdrop of a beautiful snowy environment in northern Hokkaido, we can experience cryosphere environments and observe snow and ice-related processes. This course focuses on the characteristics of snow and ice, meteorology, and hydrology in the cryospheric environment. The program is held at Hokkaido University's Uryu Experimental Forest in Moshiri, one of Japan's snowiest and coldest regions. Participants investigate snow exceeding 2 m deep to develop a deeper understanding of the structural changes in snow crystals and the physical properties of snowpack. We also conduct meteorological observations to understand atmospheric processes at temperatures below -30°C . This program offers a valuable opportunity to experience an extreme environment in the polar regions.

[Course Program in 2026]

Program goals

- Experience Japan's coldest and snowiest regions.
- Acquire knowledge and observational techniques on snow and meteorology.
- Learn how to move in deeply snow-covered terrain.
- Exchange of knowledge and techniques of snow and ice observation.

Period

January 19-23, 2026

Activities

- Snow pit observations
- Meteorological observations
- Snow depth and water-equivalent amount surveys
- Data analysis and presentation



1) Snow survey in the forest 2) Meteorological observation 3) Snow structure observation 4) Snow pit observation
5) Data analysis 6) Discussion of survey results

Student voices

- The field experience in the heavy snowfall region of Moshiri, Hokkaido, was a rare and precious experience in my life. I enjoyed various snow measurements, including pit observations and surveys in the forest.
- The most important aspect of this program is to experience the entire process, from observation and data analysis to reporting the results. The skills to perform field measurements in one of Japan's leading heavy-snowfall areas will be a great asset for my future fieldwork in Antarctica and other polar regions.
- I have gained techniques for snow observations and knowledge of snow physical properties during the program. They are very useful not only for snow and ice research but also for other field observations.

(Feedback from participants)



Message from the Lecturer

Institute of Low Temperature Science
Assistant prof.
Masahiro MINOWA

This field program takes place in Moshiri, northern Hokkaido, one of Japan's coldest regions with the heaviest snowfall. You perform field measurements and analyze data yourself. The data tell you about the processes controlling cold weather, snowpack characteristics, and snow distribution. I am looking forward to working with you all in Moshiri, where cold temperatures and deep snow await you!

Arctic and Antarctic Science Curriculum

[Lectures and Field courses]

Special Lectures on Arctic and Antarctic Science

Approximately 70 years have passed since Japan began its Antarctic research expedition, and more than 15 years have passed since Japan launched its comprehensive Arctic research projects. Observations in the Arctic and Antarctica have provided crucial knowledge on the role of polar regions in the global environment and clarified the state of the cryosphere, which are changing rapidly due to global warming.

Human beings reached the North and South Poles only 100 years ago. Therefore, many of the natural environments and climatic processes remain to be revealed in the Arctic and Antarctica. In this lecture, students learn about the climate and natural environment of the Arctic and Antarctica with the goal of understanding the critical role of the cryosphere in the global environment. This is also a valuable opportunity

for students to engage with cutting-edge science in polar regions, deepening their understanding of polar science and the critical roles of the polar regions in human society.



Instructors covering a broad range of Arctic and Antarctic science

Special Lecture on Arctic and Antarctic Science I

Inviting experts in polar research as lecturers, this program offers a series of lectures on the basic features of the Antarctic and Arctic regions. The lecture subjects include ice sheets, polar oceans, the polar climate system and ecosystems, and the conditions and mechanisms driving change in the Arctic and Antarctica. Further, the lectures cover the societal impacts caused by climate-induced changes in the polar regions. Students learn about environmental changes in the Arctic region and their societal and economic impacts, as well as the international cooperation framework based on the Antarctic Treaty.

[Lecture Program in 2025]

1. Cryosphere in the polar oceans
2. Ice sheets and glaciers: Dynamics of ice sheets
3. Climate change: Paleo and present environments explored with sediment cores
4. Polar biology: Life and ecosystems in extreme environments
5. Mysteries of ice: Ice crystals are alive
6. Antarctic research today
7. The Antarctic Treaty: An international law scholar sets foot in Antarctica!

Student voices

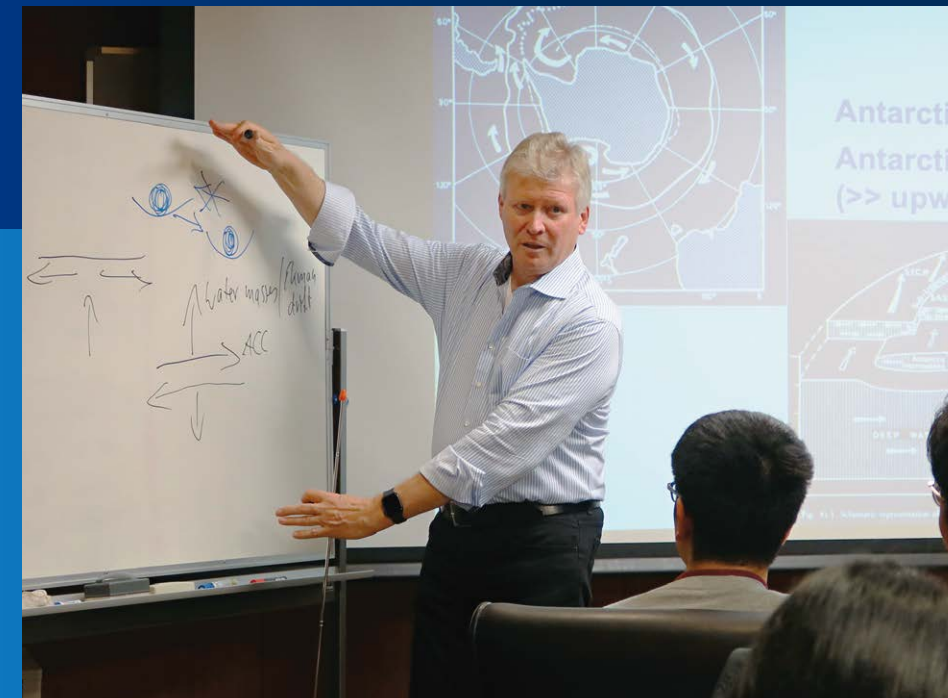
- I was fascinated by the diverse perspectives on Antarctica that emerged from research across disciplines. I want to explore Antarctica's multifaceted nature on my own.
- I have participated in this course after conducting fieldwork in Greenland. The insights into research activities in Antarctica and other Arctic regions broadened my understanding of polar science beyond my own experience.



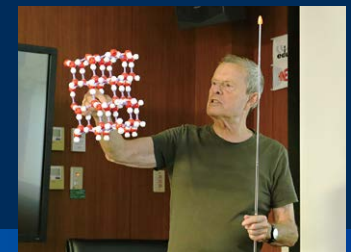
Presentations by students



Online lectures by a researcher abroad



Professor Wilhelm Hagen (University of Bremen)



Professor Heinz Blatter (ETH Zurich)



Professor Ralf Greve
(Hokkaido University)

Special lecture on Arctic and Antarctic Science II

Leading researchers from around the world offer this lecture series on cutting-edge topics in polar science. By attending lectures and participating in discussions in English, students acquire world-class knowledge in polar science. By delivering oral presentations on Arctic and Antarctic science, the participants can also acquire the skills to present and conduct discussions in English.

Student voices

- This program opened my eyes to disciplines other than my own research field. I learned a broad perspective of polar regions, including sea ice, glaciers, and even plankton.
- The climate system in the polar regions, where ice sheets, the atmosphere, and the oceans interact, was particularly interesting to me. I understand that significant changes in glaciers and ice sheets, and their subsequent impacts on the climate system and sea-level rise, represent major research challenges under a warming climate.

[Lecture Program in 2025]

1. Cryospheric science
 - ① Cryosphere and climate
 - ② Land ice and snow
 - ③ Sea ice
 - ④ Glaciers and ice sheets
 - ⑤ History and future of the cryosphere
2. Polar marine biology
 - ① Ecosystems of the Southern and Arctic Oceans
 - ② Ecosystems in the Southern and Arctic Oceans
 - ③ Antarctic zooplankton and krill
 - ④ Marine mammals in the polar oceans
3. Cutting-edge topics in polar science
 - ① Sediments and submarine topography
 - ② Icebergs and calving glaciers
 - ③ Ice sheets variations and numerical modeling
 - ④ Tourism in the Arctic and Antarctica
 - ⑤ Optical fiber networks on the polar seafloor
4. Climate change seminar
(presentation by students)

Diploma of Arctic and Antarctic Science



Diploma awarding ceremony



Graduate students who have completed the Arctic and Antarctic Science Curriculum by earning the required credits are awarded the Diploma of Arctic and Antarctic Science by the Graduate School of Environmental Science. This diploma is granted independent of the Master's or Doctoral degrees awarded by each department. It serves as certification of systematic studies on polar science. Over the 19-year period from 2007 to 2025, 126 students have received this diploma. Graduates are contributing to society in their respective career paths;

i.e., becoming university faculty after doctoral programs, engaging in national policy as civil servants working for public and private research institutions, and joining companies in weather forecasting and environmental consulting. By the year 2026, 28 students from this curriculum had participated in research expeditions to Antarctica. Many more students are conducting research activities in the Arctic, including Greenland, Alaska, Canada, Svalbard, Siberia, and the Arctic Ocean. Their experience in the curriculum supports their activities in universities, research institutions, and private enterprises.



Determining the depth of an ice core drilled at Dome Fuji Station II. The ice core is in the right foreground of the image.

Graduate Voices

Mai MATSUMOTO
Graduate School of Environmental Science,
Hokkaido University

When I was enrolled in this program, field courses and lectures were held online due to the COVID-19 pandemic. Consequently, I was unable to travel to the field sites in Teine, Moshiri, and Switzerland. However, the lectures in this program were comprehensive, and I found it very rewarding to study snow and ice, oceans, and biology in Antarctica, subjects I had never studied systematically before. When I later participated in the Japanese Antarctic Research Expedition, the knowledge and experience gained through this program were instrumental in understanding research fields outside my own expertise.



Participated in the Southern Ocean observation as a member of the New Zealand Antarctic Program.

Graduate Voices

Hana ISHII
Victoria University of Wellington

I enrolled in this curriculum because of my impression of "Antarctica is so cool!" However, through the lectures, I learned the significant impact of the Antarctic ice sheet on the global environment. During the field course in Switzerland, I witnessed the rapid retreat of glaciers. These experiences became the catalyst for me to consider my potential contributions to the research field. Currently, I am pursuing a PhD at the Antarctic Research Centre in New Zealand, focusing on reconstructing past Antarctic ice sheet variability and its impacts on sea levels and the environment. If you have even a slight interest in polar research, I encourage you to take that first step!

Graduate Voices

Shuntaro HATA
National Institute of Polar Research

I was enrolled in the Arctic and Antarctic Science curriculum because I was studying glacier changes. Since I primarily used satellite data, I was interested in what was actually happening in the field. I was greatly inspired by the lectures and field courses, engaged with a wide range of disciplines in polar science, and exposed to cutting-edge research in the Arctic and Antarctica. The knowledge and experience I gained through this curriculum assisted my participation in the Japanese Antarctic Research Expedition and field campaigns in the Arctic (Svalbard and Greenland) after my doctoral program.



Glacier observations in Svalbard (the author is on the left)



During the overwintering at Syowa Station, Antarctica

Graduate Voices

Shuntaro HYOGO
Dartmouth College

This curriculum was perfect for me, as I entered graduate school with a strong interest in Antarctic research. In particular, the lectures by polar researchers from Japan and abroad were incredibly inspiring. During the field course in Switzerland, I was overwhelmed by the massive glaciers and learned the importance of field visits and observations. These experiences led to my subsequent oceanographic observations in the Sea of Okhotsk and Southern Ocean, participation in the Japanese Antarctic Research Expedition as a wintering member, and current polar research at Dartmouth College in the United States. I believe this curriculum generated an irreplaceable foundation for my current and future work.