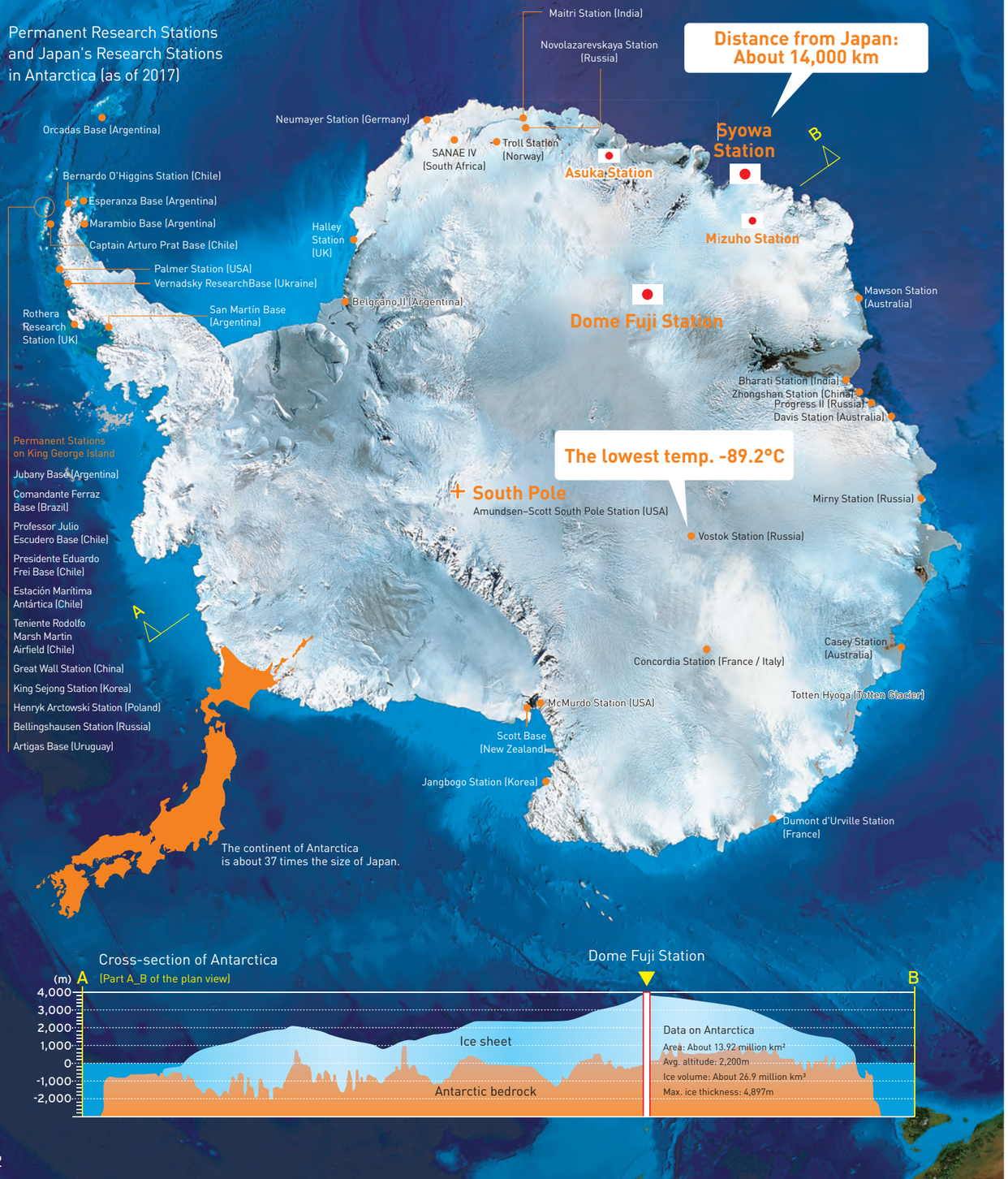
南極観測

JAPANESE ANTARCTIC RESEARCH PROGRAM

WHAT WE LEARN FROM ANTARCTICA

The world is observing Antarctica to decipher the Earth's future



Antarctica—the common heritage

Antarctica. Nearly two centuries have passed since humankind first set foot on this icy continent. In the past, Antarctica was an explorer's dream, a stage where nations put their pride at stake, and at times, the subject of territorial disputes. Now, through international cooperation, researchers are exploring the continent's natural phenomena to both learn about the Earth's past and forecast its future. Since there is almost no human activity on the continent, Antarctica is one of the few places where the Earth's natural environment can be monitored accurately. Nations of the world need to cooperate with each other to conduct observations, research and monitor the global environment. To do this, Antarctica must be preserved and regarded as a common heritage of humankind that belongs to no one.

The future of Antarctica is the future of humankind

The environmental information obtained through Antarctic research does not only affect certain nations or regions—it benefits all of the people on the Earth. For example, the massive ice sheet in Antarctica is a record of the movement and deformation of the Earth's crust. The vast numbers of diverse meteorites found by researchers on the continent are records of the evolution of solar system. Analyzing these records tell us about how the Earth has changed from past to present, the mechanisms driving those changes, and they can also aid in future projections.

About 70% of the Earth's fresh water lies in Antarctic ice sheet that acts as a massive heat sink that slows global warming. The cold and salty seawater produced on the Antarctic coast is the starting point of the ocean circulation that rounds the Earth and affects the climate of the regions they pass. Antarctica may be a faraway frozen continent, but the activity there is intricately linked to our daily lives in Japan. This is why we need to monitor Antarctica closely and find out what exactly is happening there.


Ice sheet

History of Antarctic research by Japan

Japan's Antarctic research began over 100 years ago in 1912 with a scientific expedition by Nobu Shirase's Antarctic expedition team. Japan established Syowa Station in 1957 and has continued opening new frontiers of knowledge with ongoing research since that time, becoming the first to discover masses of meteorites (1970s), the Antarctic Ozone Hole (1982), and huge forests of 'moss pillars' on the bottom of Antarctic lakes (1995). Japan successfully drilled through a 3,000-meter-thick ice sheet in 2006 and clarified the mechanisms underlying the showers of aurora-generating high-energy electrons and their effect on the atmosphere in 2019. These are some of the major achievements of the Japanese Antarctic Research Expedition (JARE), and the data they collect are shared with the world to help preserve the global environment and advance scientific knowledge.


The flags of the original signatories of the Antarctic Treaty at the South Pole

Countries join forces to protect the Antarctic

As of 2021, 54 nations have ratified the Antarctic Treaty. Japan was one of the original 12 signatories and has played an important role in the Treaty since it entered into force in 1961. At meetings, representatives discuss how to protect the environment of the Antarctic.

Antarctic expeditions were the adventure of the century

On November 8, 1956, the first JARE departed Harumi Pier, Tokyo, on Japan's first Antarctic research vessel, "Soya." The team established Syowa Station on Ongul To (Ongul Island), Antarctica, on January 29, 1957. Thus began the era of Japan's Antarctic research.

Inferring the future global environment system by investigating the past and present of Antarctica

Various research activities are conducted as Prioritized Research Project in Phase X

JARE meets present-day demands

In the current era in which environmental changes are a global issue, the importance of Antarctic research is increasing. This is because changes in the Antarctic environment can have a marked impact on global climate systems. It is therefore imperative to clarify the changes that have occurred in the ice sheet, atmosphere, and ocean circulation of the Antarctic from past to present in order to understand the mechanisms underlying these environmental changes and predict the global environment in the future.

Japan has conducted Antarctic research according to a six-year Japanese Antarctic Research Projects laid out by the Japanese government. Phase X of the Japanese Antarctic Research Project that began with the 64th Japanese Antarctic Research Expedition (JARE) in 2022 includes both Fundamental Observation aimed at continually obtaining and publishing important scientific data that is demanded internationally and socially, and conducting innovative and pioneering Research Project on the unique features of Antarctica. Prioritized Research Project findings in Phase X focus on characterizing the future global environment system as inferred through investigating the past and present of the Antarctic. The project also includes a broad range of other activities, such as international collaboration, reaching out research outcomes to the public, and collaborating with educational organizations.

The forefront of JARE (1)

Shedding light on climate change over the past million years

Million-year-old time capsule

How will the global environment change? What does humankind need to survive? The answers to these questions lie in the Antarctic. This is because Antarctica and the surrounding regions contain numerous undisturbed records of changes in the environment and ice sheet over a very long time, which are suitable for studying the past changes and their mechanisms.
One of the most important research subjects is the ice that forms the Antarctic ice sheet. The Antarctic ice sheet is formed by the snow that has fallen for more than hundreds of thousand years being compacted into ice. Consequently, this ice contains a record of the temperature at each time period as well as the air and dust when the snow accumulated. Near Dome Fuji Station, which is located approximately 1,000 km inland from Syowa Station, there may be ice that contains the environmental histories over a million years. Analyzing ice core samples that are collected by drilling columns of ice from the interior part of the ice sheet can tell us about changes in the temperature and atmospheric composition going back a million years.

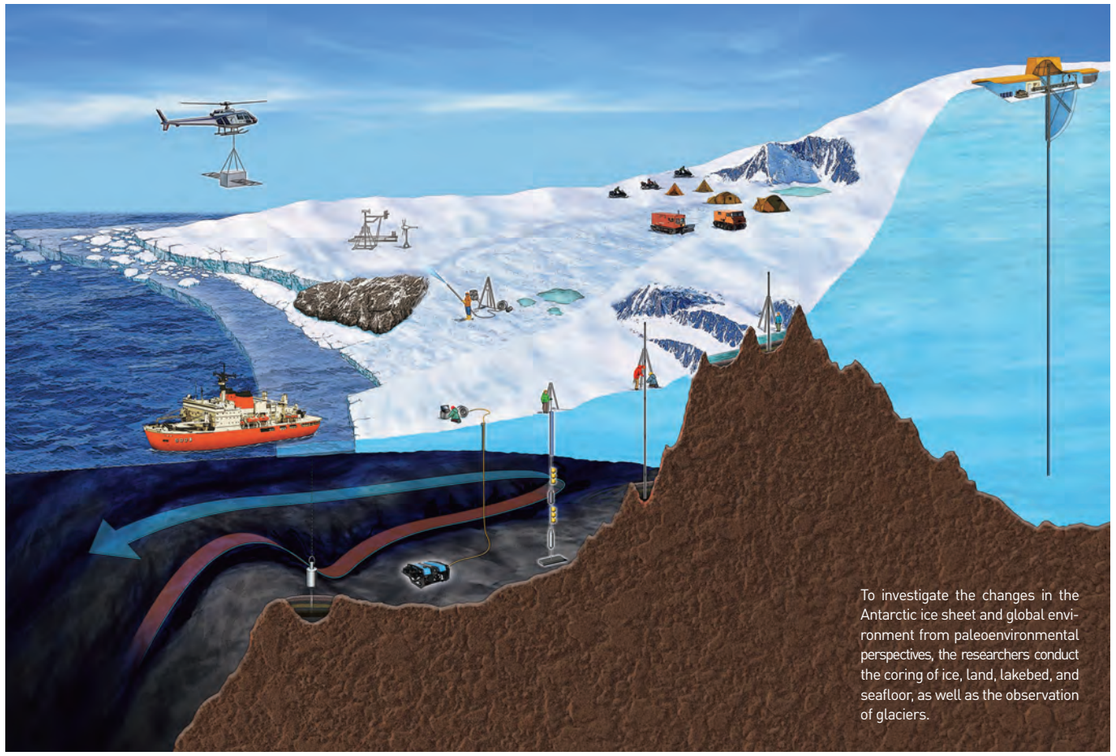
Knowing the past to better understand the future

The Antarctic ice sheet has expanded and retreat repeatedly since it was formed. Records of these fluctuations are found in the topography of the land and seafloor, lake- and marine sediments in the coastal region surrounding the Antarctic ice sheet. The changes of the East Antarctic ice sheet since the last interglacial period (about 120,000 years ago) in a region where Syowa Station is located remain largely unknown. Comprehensive and systematic sampling and analysis of the glacial landform, glacial deposit, and sediment on the lake and seafloor that are sensitive to environmental changes have allowed us to precisely reconstruct when, how, and under what conditions the East Antarctic ice sheet changed in the past.
As part of the Japanese Antarctic Research Program, samples that show the record of climate and ice sheet changes over the long term in the East Antarctica are collected and analyzed. These data are subjected to further analysis and contribution to numerical modeling for improved future projections. Beyond the direct observations of ongoing changes, we can quantitatively reconstruct the various environmental changes in the past and compare them on a common time scale to clarify the mechanisms that underlie the changes in the global environment and gain crucial insights into the future. Such knowledge will help humankind prepare for the future that lies ahead.

Unravel the indeterminate process of major climate change

The Earth has experienced the alternation of glacial and interglacial periods, currently on a 100,000-year cycle. About a million years ago, the periodicity of the cycle changed from 40,000 years to the current 100,000 years, but the driver and mechanism for the change are currently unknown. Ice cores containing records of the past one million years may hold the key to unlocking this mystery.


Second deep ice coring project (2001-2007) at Dome Fuji Station


To investigate the changes in the Antarctic ice sheet and global environment from paleoenvironmental perspectives, the researchers conduct the coring of ice, land, lakebed, and seafloor, as well as the observation of glaciers.

Clues about climate change from sediments

In the coastal East Antarctica, past climate and ice sheet changes are recorded in glacial landform, glacial deposit, and sediment on the lake and seafloor. Sampling and analyses of them can help us to identify past instances of glacial melting in Antarctica with high accuracy, which also lead to better projection of future sea level rise.

Exploring the mechanism of ice sheet melting

The Antarctic research vessel "Shirase" is used extensively for coring of marine sediments in Lützow-Holmbukta (Bay) where the Syowa Station is located, as well as in the waters off the Totten Hyoga (Totten Glacier). The analyses of sediments from various sites give us a precise picture of ice sheet changes in the past.

The forefront of JARE (2)

Elucidating the mechanisms of ice sheet basal melting and biogeochemical cycles

Achieving precise sea level rise predictions

The Antarctic ice sheet contains approximately 90% of all ice on land. If the entire ice sheet melted, the surface of the oceans on Earth would rise by about 60 meters. If global warming alters even a small part of the ice sheet, the result could have a significant impact on global sea levels (the height of the ocean surface relative to land) in the future. Accurately predicting future increases in sea level requires observations of the current situation to determine if the Antarctic ice sheet is changing, and research to determine the causes and effects of such changes.

Syowa Station is located on the eastern part of the Antarctic ice sheet, which is particularly large. This region was previously considered to be more stable than the western regions, but recent research has shown that glacier flow, ablation and discharge of icebergs are accelerating flows and the depletion of ice at the edge of the East Antarctic ice sheet, including the area near the Totten Hyoga (Totten Glacier) and calving, are all accelerating. The world is particularly interested in Japan's research activities on how Circumpolar Deep Water around Antarctica affects the Antarctic ice sheet and Southern Ocean sea ice.

Pioneering research with the latest technology

Melting ice sheet spilling masses of fresh water into the oceans would not only cause a rise in sea level, but it would also have an enormous impact on the sea ice formation process.

Suo Takekuma / KYODO News

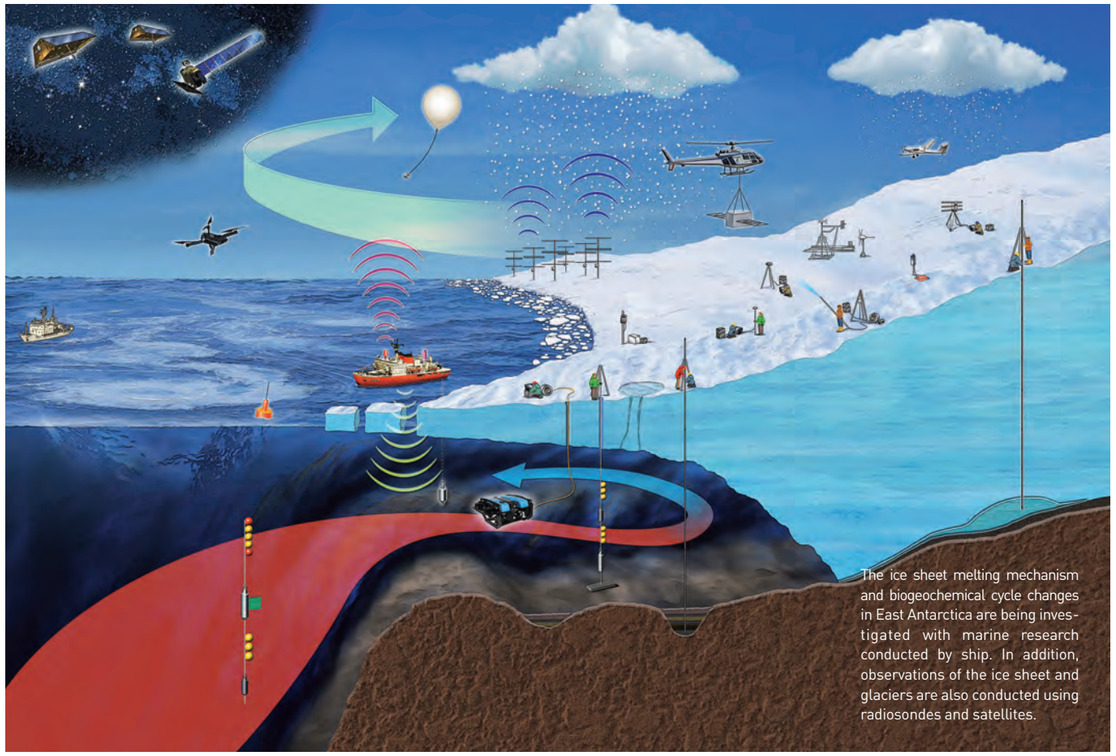
'Warm seawater' melting the Antarctic ice

We have learned that 'warm seawater' is melting the ice from below the Totten Hyoga (Totten Glacier) and other parts of the edges of the East Antarctic ice sheet. In research conducted aboard the Antarctic research vessel "Shirase", scientists are using the latest technologies to observe how this warm seawater is altering the edge of the ice sheet and the effects that it is having.

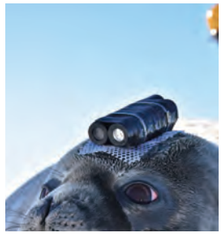
Changes in sea ice in the Southern Ocean affect the global climate through fluctuations in biological production and biogeochemical cycles, and also through deep circulation. To learn more about these phenomena, we need to observe the interior and the sub-glacial of the Antarctic ice sheet, a feat that is difficult using traditional methods, and observe the Southern Ocean around the ice sheet. To achieve these aims, Japan has improved its existing ship-borne research capabilities and moored observation methods. Japan has also developed cutting-edge research technologies, such as a hot water drilling system and an unmanned autonomous vehicle, and was the first nation to apply these advances to research in the field. These research efforts have facilitated multidisciplinary research initiatives and these activities promise to significantly advance our understanding of the mechanisms and impacts of changes currently occurring at the end of the Antarctic ice sheet.

Shedding light on the processes associated with mass loss from the East Antarctic ice sheet and analyzing the impact of this loss on the marine environment and biogeochemical cycle has advanced our understanding of the complex interactions among ice sheet, sea ice, and the ocean. In addition, this research has vastly improved the precision of our predictions of global environmental changes, including those related to changes in sea level and climate systems.

Hot water drilling system to investigate the process of glacier discharge into the ocean

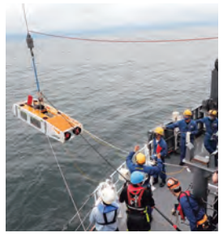


The ice sheet melting mechanism and biogeochemical cycle changes in East Antarctica are being investigated with marine research conducted by ship. In addition, observations of the ice sheet and glaciers are also conducted using radiosondes and satellites.



Exploring ecosystems in the Antarctic

Studying the living organisms in the Antarctic is essential as they are acutely sensitive to changes in the Antarctic environment. Some of the research being conducted also involves attaching cameras and recorders to animals to observe the marine environment in places that are not accessible to humans, or at times when observations are difficult.



Exploring under the Antarctic ice

Using a fully automatic autonomous underwater robot named the Mobility Oriented Nadir AntarctiC Adventurer (MONACA), scientists are studying closely the shape of the undersides of ice shelves and sea ice to shed light on changes in Antarctic ice and the impacts of those changes.

The forefront of JARE (3)

Examining the general circulation of the atmosphere and the effects from space on the Earth's environment

Full use of the Antarctic largest atmospheric radar

Atmospheric phenomena appear at various spatiotemporal scales around the Earth and at a wide range of altitudes. These phenomena are considered to impact each other and create a large-scale atmospheric circulation, which is referred to as 'general circulation of the atmosphere' and is considered to be the main cause of climate change. Antarctica is both the starting point and the end point of general circulation of the atmosphere, and is therefore considered to play a key role in atmospheric dynamics that influence the Earth's climate. Thoroughly understanding the current state of general circulation of the atmosphere and quantitatively clarifying the mechanisms underlying these changes are critical to predicting the future climate of the Earth. The large atmospheric radar (PANSY) installed at the Antarctic Syowa Station in 2011 is one of the world's largest atmospheric radars, with over 1,000 antennas spread over a 300-meter diameter. This radar is used in conjunction with other tools, such as optical observation instruments, to conduct continuous and precise observations up to 500 km above the surface at Syowa Station.

In addition to augment the observations made using the PANSY radar, scientists also conduct campaign-based research to observe the wind and temperature conditions across Antarctjca using balloons that are advected at a constant altitude by in-situ winds over the Antarctic region.

Collaborating with scientists around the world

To explore the behavior of the atmosphere across the Earth, scientists are conducting a global project using large atmospheric radar systems (Interhemispheric Coupling Study by Observations and Modeling: ICSOM) to clarify how the Arctic and Antarctic atmospheres interact, the mechanisms underlying those interactions, and the interannual changes over a long period. We also conduct atmospheric observations to advance our understanding of the material transport from the atmosphere to the cryosphere, which is a critical process in the formation, maintenance, and fluctuation of atmospheric circulation. In addition scientists also focus on researching cosmic rays and auroras, as well as furthering our understanding of the effects of cosmic origin phenomena (such as cosmic radiation phenomena) on the Earth's environment.

These multifaceted observations and international collaboration activities provide information on Antarctic atmospheric phenomena at temporal resolutions ranging from minutes to 11 years, which is the length of the solar activity cycle, facilitating the exploration of interannual changes and characteristics of polar phenomena. Obtaining quantitative observation data of various atmospheric phenomena in the Antarctic also helps to improve the precision of future predictions of how the Earth's atmospheric environment will change.

Special optical observation devices for observing phenomena like auroras

Fluctuations in atmospheric circulation and the effects from space are explored using the PANSY radar system and balloons. Optical instruments and satellites are used to examine aurora, and cosmic ray observations are also conducted.

Seeing the future with the PANSY radar

PANSY is the largest atmospheric radar in the Antarctic region. This project went into full-scale operation in 2015. A network of 1,045 antennas spanning the size of a baseball stadium operates as a single atmospheric radar. This radar collects research data over the medium- to long-term that we can use to learn about atmospheric phenomena that are unique to the polar region, as well as the meteorological and climate systems of the entire world.

On the frontline of aurora observation

An international auroral optical observation network covering the polar cap region at high latitudes including Dome Fuji, Amundsen-Scott South Pole, McMurdo, and Zhongshan Stations and the future network extension will shed light on deeper understanding of space weather, space climate and their effects on the Earth.

Balloons circling Antarctica

Super-pressure balloons are special balloons that can fly at approximately the same altitude for long periods. Since they are advected by in-situ winds, their trajectories can cover a wide area in the Antarctic region. Their observations enable us to obtain horizontal distributions of temperature, pressure, and winds over Antarctica.

“Hub Station” of JARE

Syowa Station is ongoing eco-friendly station

Supporting JARE at Syowa Station

Syowa Station was opened by the first Japanese Antarctic Research Expedition (JARE) team on January 29, 1957, on Ongul To (East Ongul Island), an island about 4 km from the continent of Antarctica. The station began with only four buildings, but has since expanded to approximately 60 buildings. The station has become a scientific hub with a wide range of research equipment that is operated by experts in each field (i.e., atmospheric sciences, geology, glaciology, and biology) who collaborate on multidisciplinary global research. The station has been maintained, managed, and operated for over half a century as Japan's main station in the Antarctic, with up to about 100 people in summer and 30 in winter, including researchers, engineers, and graduate students conducting research, as well as logistics personnel who support day-to-day activities and research.

Striving for an eco-friendly station

A major challenge faced by Syowa Station is related to securing enough energy to run the station. It currently runs mostly on electricity generated by diesel generators using fuel brought in once a year on the Antarctic research vessel "Shirase"; however, efforts are underway to make the station cleaner with greater use of renewable energy sources, such as wind and solar powers.

In addition, to protect the unique Antarctic environment, all of the waste that is produced during research activities is taken back to Japan, and the station follows sewage treatment rules that are even stricter than Japan's effluent treatment standards to keep research activities green.

Supporting research in the extreme inland environment

Dome Fuji Station is an inland Antarctic station located approximately 1,000 km from Syowa Station at an altitude of approximately 3,800 m above 3,000 m of ice. One of the projects conducted here involves drilling the oldest ice core, and the research facility is being developed for that purpose. Given the extreme nature of the area, the research is conducted in an indoor environment to keep the facility safe and comfortable for team members. The research uses advanced technology and strong lightweight equipment to minimize the cost of transporting equipment overland.

Syowa Station at the center of the Japanese Antarctic Research Program

More than 60 years have passed since the station first opened, and the aging buildings and equipment are being updated. Maintaining a safe and efficient facility is essential to lighten the load on team members and ensure stable research activities in Antarctica.

Second deep ice-core drilling location at Dome Fuji Station at the time of construction

Wind turbines at Syowa Station

Antarctica Mobile Station Unit

The new Dome Fuji Station research facility uses portable station units. The simplicity and modular nature of the units make them easier for expedition members to transport and assemble, and they use natural energy for heating.

World-class icebreaker

The Antarctic research vessel "Shirase" is one of the world's strongest icebreakers, consistently breaking through 1.5-meter-thick ice as it moves stern. In addition to transporting people and goods, it is used for marine and atmospheric research in areas with thick sea ice that are not accessible to other research vessels.

Snow vehicles are indispensable for inland traverse

Snow vehicles are essential for inland and winter activities in the Antarctic. They become a home base for expedition members when transporting people and goods inland and are also used for construction and research activities at drilling sites.

Informing the future with JARE in collaboration with community and education

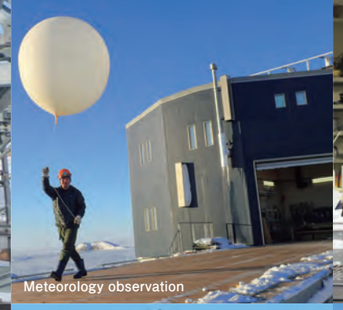
Various programs are conducted to present the findings of Antarctic research activities and make them available to educators. In a Teachers' Antarctic Program that began in 2009, school teachers interested in polar science and research are sent to the Antarctic and hold Antarctic Lessons using the satellite connection from Syowa Station as a member of the Japanese Antarctic Research Expedition (JARE) team.
Since installing an Intelsat satellite communication antenna at Syowa Station in 2004, wintering team members do live report about a current look at the research team to educational institutions such as elementary, junior high, and high schools in Japan. The children who see these lives may one day become researchers and conduct science research for Japan, or they may become expedition team members that conduct activities in the polar region.
Graduate students in polar science are also actively encouraged to join JARE and efforts are focused on fostering young researchers.

Fostering the next generation of field scientists

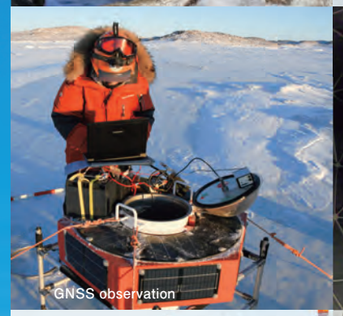
Graduate students who participate in JARE conduct a variety of studies and research activities with the researchers. These experiences on the front line of Antarctic research can develop them to become future team members and conduct high-quality Antarctic research in Japan.

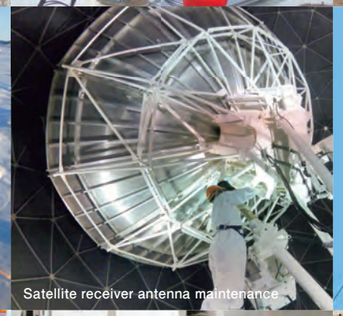

Ecosystem monitoring


Electrical equipment inspection


Meteorology observation


Wastewater quality testing


GNSS observation

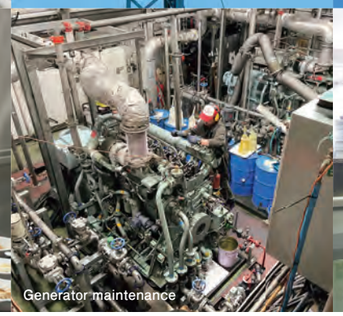

Satellite receiver antenna maintenance


Atmospheric sampling


Field research support


Vehicle maintenance


Cooking


Generator maintenance


Medical care

Team of experts from diverse fields

Welcome to JARE

Antarctic research is supervised by the Headquarters for the Japanese Antarctic Research Expedition (JARE) (Antarctic Headquarters, Director: Minister of Education, Culture, Sports, Science and Technology) as a national project. Ministries, agencies, universities, research institutes, and private companies cooperate and take on different duties, such as research and transport. The National Institute of Polar Research (NIPR) serves as the core organization that is responsible for running expeditions. It formulates research plans, creates expedition teams, and manages the research facilities. The Antarctic research vessel "Shirase" is operated by the Japan Maritime Self-Defense Force (JMSDF).
JARE team is broadly divided into research members and logistics staff. Research members are staff dispatched from organizations, such as the National Institute of Information and Communications Technology (NICT), the Japan Meteorological Agency (JMA), the Japan Coast Guard (JCG), the Geospatial Information Authority of Japan (GSI), and the National Institute of Polar Research, all of whom conduct basic research, and researchers from universities and research institutes who also conduct research. Other staff, whose work includes, but is not limited to, maintaining the facility equipment, servicing vehicles and machines, maintaining communications, cooking, medical care, and construction all support research activities by maintaining the infrastructure required for daily activities at the station serves as the home base for the research members. Some of these members are selected through public recruitment. If you are passionate and have expertise and experience that can assist JARE, you too can join us.

See here for details ▶

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