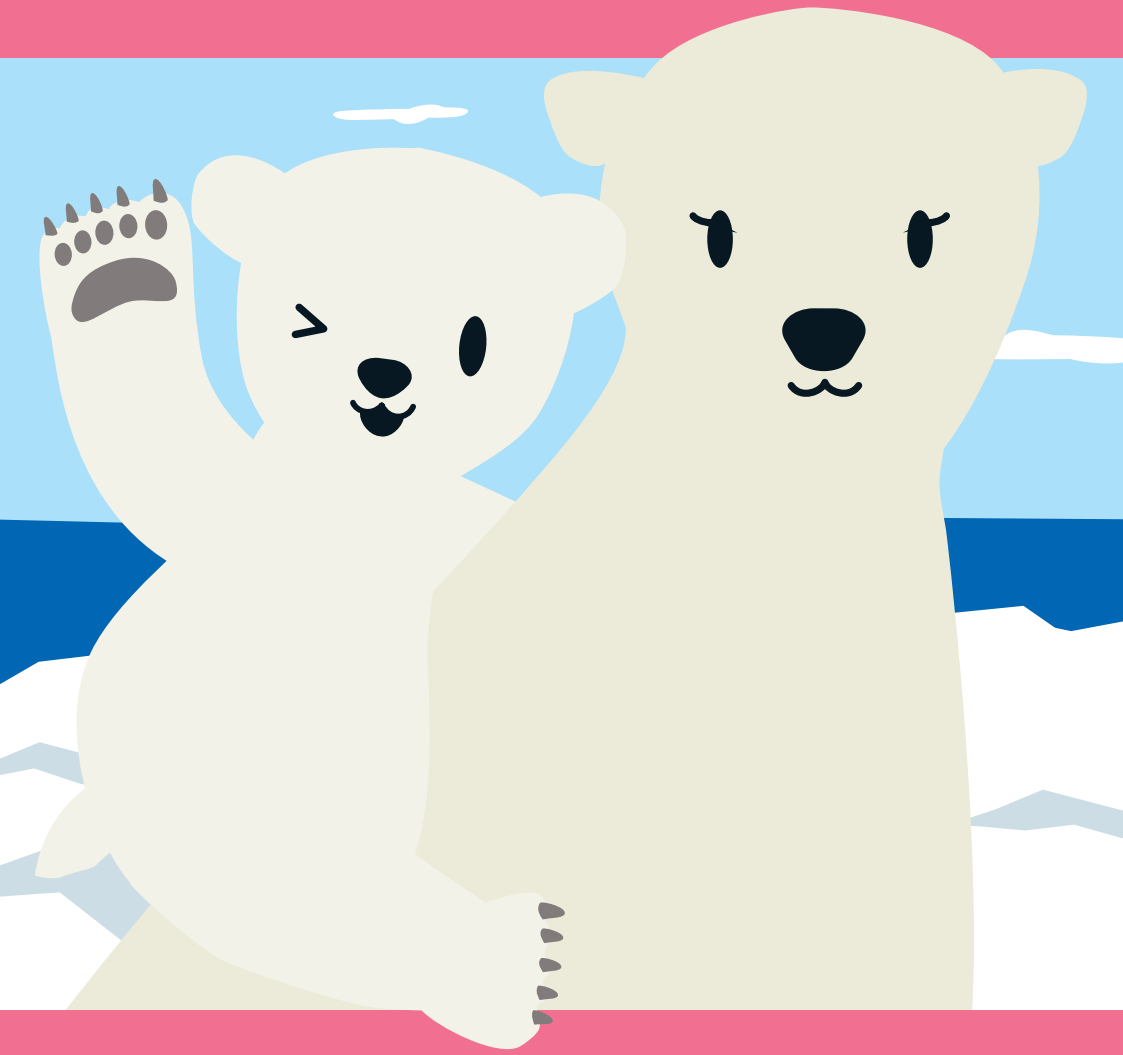
# Secrets of the Arctic



NIPR
KYOKUCHIKEN

# Welcome to the Arctic!


## Contents





Try this fun quiz on Arctic trivia!

**Q1** How many countries have territories in the Arctic? A. 4 B. 8 C. 10

The answer is on the next page ▶

# What is the Arctic like?

Is the Arctic at the very top of the globe?

This top part of the globe where the red arrow is pointing is the North Pole, located at 90° North latitude.

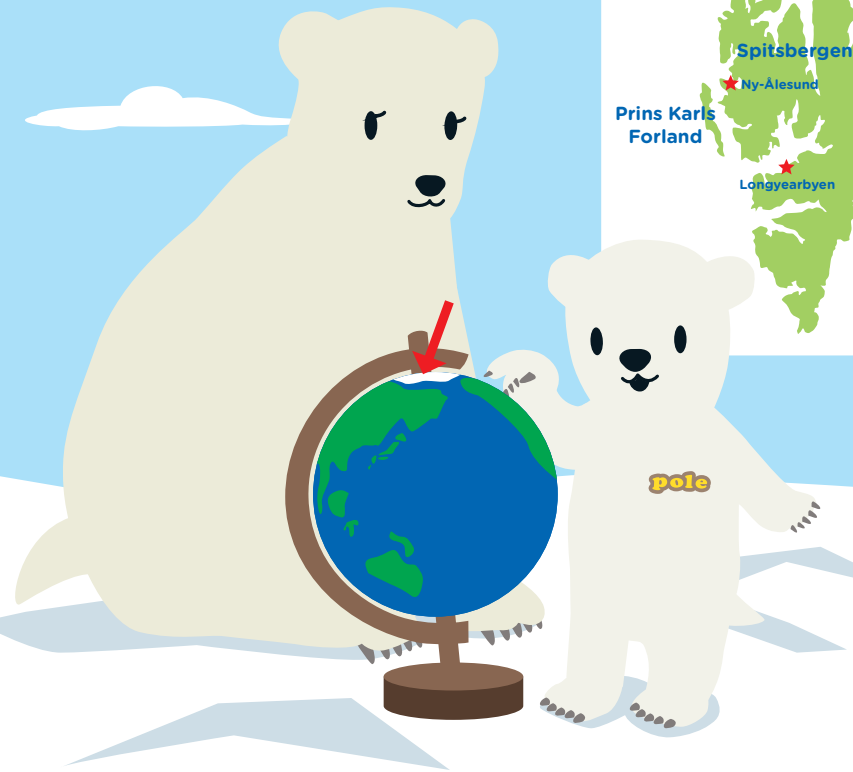
What we all call the Arctic is actually the area within higher latitude above 66.5°N, with the North Pole at its center: the area circled with a dotted blue line in the picture.

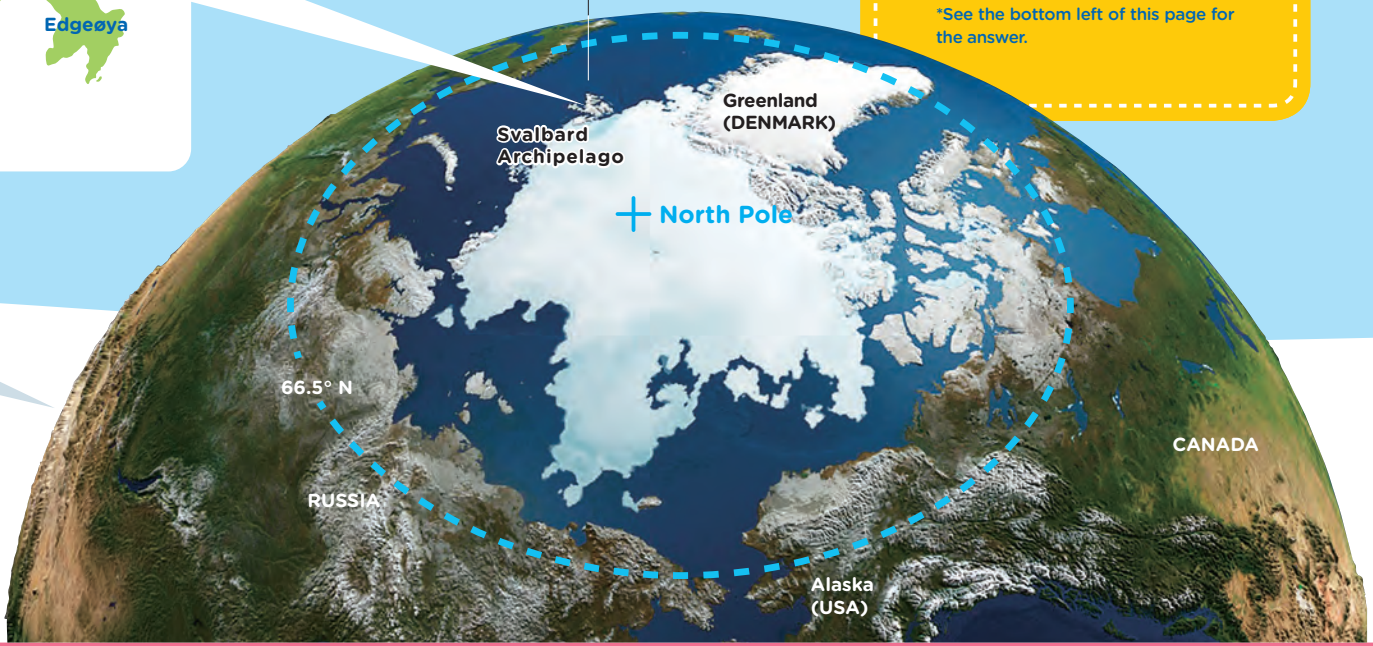
That is right. Parts of Greenland, Alaska, Canada, and Russia are all in the Arctic.

Does Japan have a research observatory in the Arctic?

It sure does! It is in the Svalbard Archipelago in Norway.

Ny-Ålesund in Spitsbergen Island, Svalbard.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## How are the Arctic and the Antarctic different?

Basically, the Antarctic is on land, and the Arctic is in the ocean. The North Pole sits on sea ice in the ocean. Its border is not well-defined, so people have different ideas about where it starts. Some people think it is the northern area beyond the tree line where trees cannot grow, while others think it is the area where the warmest month of the year is colder than 10°C on average. Perhaps the biggest difference between the Arctic and the Antarctic is that the Arctic is areas where people actually live there. Eight countries have territories in the Arctic. Do you know which ones?

*See the bottom left of this page for the answer.



**A1** B is correct. The United States, Canada, Denmark, Iceland, Norway, Sweden, Finland, and Russia, all have territories in the Arctic.

**Q2** How big is an adult polar bear?



The answer is on the next page ▶

# Come meet our friends in the Arctic.

Many animals, including polar bears like me, live in the Arctic.

Do you know why so many animals live here?

Is it because polar bears have lots to eat?

No, silly! It is because the Arctic is connected to land. Also, nutrient-rich water flows into the Arctic Ocean from rivers on land, which makes the ocean full of living creatures.

Oh, I see! So, the land and ocean are both rich with life.

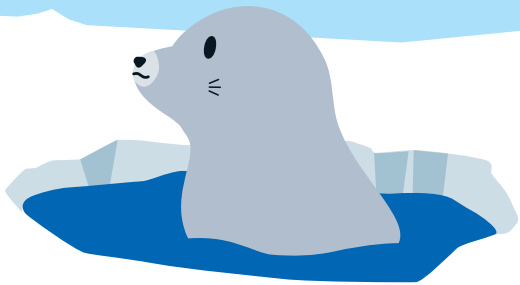
Muskox

Bearded seal

Walrus

Polar bear

Arctic fox



## Are there penguins in the Arctic, too?

The name 'penguin' was what people called murres, a type of seabird that is quite common in the Arctic. A remarkably similar bird was later discovered in the Southern Hemisphere, and they called them 'penguins' too. If you look at the picture, you can see that both penguins and murres are black and white. They are both excellent swimmers and can dive almost 200 meters deep! Nevertheless, they are totally different species.

Thick-billed murre of the Arctic

Adelie penguin of the Antarctic



A2 Adult polar bears are about 2 to 2.5 meters long, and adult males weigh up to 600 kg. Polar bears are the biggest carnivore on the globe.

Q3 What do polar bears like to eat?



The answer is on the next page ▸

# The Arctic has flower gardens, too!


Polar willow


Dense cotton-grass


Apetalous catchfly


Purple mountain saxifrage


Cushion-pink


Polar poppy


Eight-petal mountain-avens


Members of the fireweed

Look, look! All of the flowers on this page grow in the Arctic.

If you think the Arctic is just ice-bound world, think again.

Most of the Arctic consists of tundra where trees do not grow (*see the page on the right), but the area of the tundra is full of these beautiful flowers.

Some of these flowers are like the ones that grow at high mountains in Japan.

They are also food for you and your friends.

That is right! They are not just pretty; they also nourish the animals living in the Arctic.

*

## The tundra is a treasure trove of living things.


Reindeer

Most of the land in the Arctic tundra is covered by permafrost, which is ground that stays frozen all year round. But it is not barren land. In the Arctic, we have polar nights in midwinter because the sun does not rise, and we have midnight sun in midsummer because the sun does not set. During that short summer, the surface of the permafrost melts and plants sprout all at once. Then, herds of reindeer and other grass-eating animals move to the tundra. Meat-eating carnivores, like arctic foxes and Blakiston's fish owls, also come to the tundra. The Arctic is full of life and busy in summer!



A3 They like to eat seals. They catch them on sea ice.

Q4 Is a muskox really an ox?



The answer is on the next page ▶

# Competition to reach the North Pole first

When did humans first arrive in the Arctic?

Indigenous Inuit and Sámi people have lived in the harsh Arctic environment for a very long time.

Records show that Europeans had already crossed the Arctic Ocean before the Common Era, but it was not until the 15th century that actual exploration of the region began. However, the harsh environment of the North Pole did not make it easy for them. It was not until the 20th century that explorers finally made it to the North Pole.

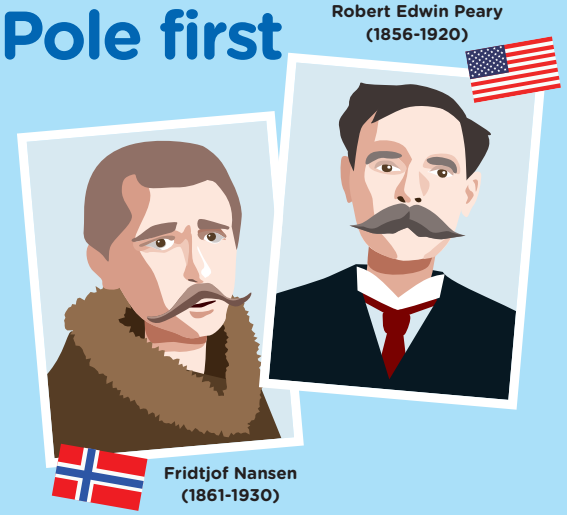
Who was the first person to reach the North Pole?

An American named Robert Peary (1909) claimed to be the first person to reach the pole, but recent studies suggest that the proof he provided was fake.

Really? I guess we will never know the truth.

A Norwegian named Fridtjof Nansen did not reach the North Pole himself, but he is called the father of polar exploration. He attempted to reach the North Pole onboard a ship named *Fram* that he designed himself, by drifting along the ocean current with sea ice. His observations of ocean currents made much progress in marine research. The *Fram* was also used by another Norwegian explorer named Roald Amundsen who successfully reached the South Pole.

Their successes were actually due to the indigenous people. They taught both Nansen and Amundsen everything about survival skills in the polar regions, from how to use dog sleds to how to find food.



Robert Edwin Peary (1856-1920)

Fridtjof Nansen (1861-1930)


## Indigenous people and the Mythology of the Northern Lights

Indigenous Inuit and Sámi people have a unique nomadic way of life, hunting seals and walruses, and herding reindeer. The beautiful Northern Lights are described variously in the legend, connecting this world to the afterlife, the spirits of the dead playing a ball game with walrus tusk, spirits of old women dancing in the afterlife. Maybe the aurora borealis was feared by many because of its appearance in the night sky. When we think about the Arctic, we must never forget these people who live closely with nature.



Q 5 Can you visit the Arctic from Japan by plane?



The answer is on the next page ▶

# The ice in the Arctic is melting!

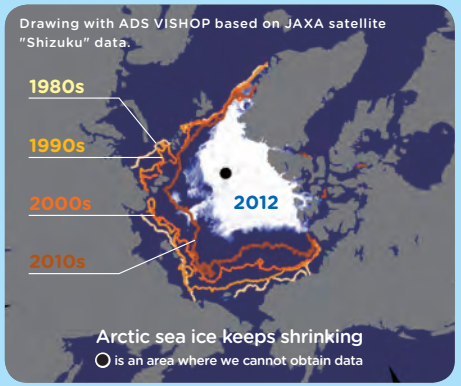
About a century has passed since explorers first reached at the North Pole. The Arctic climate has changed a lot since then.

The sea ice that once covered the Arctic Ocean is shrinking.

That is right! Observations have shown that the area covered by sea ice in summer of 2012 was less than half the size in the 1980s. And it is not just sea ice; glaciers are also shrinking.

Why is this happening?

Scientists believe that these changes are being caused by global warming. They think that it is due to the increase of greenhouse gases, like carbon dioxide, which is produced when we burn oil and coal in large amounts to make our livelihood more comfortable and convenient.





The map at the top left shows the area of averaged sea ice extent on September 16 calculated from different years.
The Arctic Ocean was covered by ice up to the yellow line in the 1980s.
Then, in the 1990s and 2000s, the area of ice cover shrank until it only occupied the minimum extent in 2012, marked by the white area.

## Is there anything good about global warming?

There are some people who think that global warming is a good thing. They want to take advantage of the shrinking ice to develop new, shorter sea routes that connect the Atlantic and Pacific Oceans. Other people want to exploit many resources from the sea floor. But a challenge in the Arctic is a challenge for the whole planet, and we need to act together to secure the planet. The Arctic Council was formed by eight countries with territories in the Arctic, with permanent participants of indigenous organizations. The role of the council is to create international rules to protect the Arctic, and to make sure it's sustainable use.


The distance between Europe and Japan would be about 30-40% shorter if ships went through the Arctic Ocean compared to the current route through the Suez Canal and the Mediterranean Sea.



A5 Yes. You can fly from Narita Airport to Norway and from there to Spitsbergen Island, where the Japanese research observatory is located.

Q6 Where is the world's northernmost automated teller machine (ATM)?



The answer is on the next page ▶

# Climate change in the Arctic is a crisis for the whole planet.

Oceanographic Research Vessel "*MIRAI*" (JAMSTEC)

Scientists around the world are starting to focus on the Arctic. They are conducting research in a wide range of areas on land, in the sea, and in the air.

Not only is the sea ice melting, but warming of the Arctic is speeding up. Ice sheet in Greenland and glaciers in Alaska are also shrinking.

Why are the effects of global warming so evident in the Arctic?

The ice floating on the Arctic Ocean is thin and it melts easily. Also, the Arctic Ocean is surrounded by areas where people live, so it is more easily affected by our activities.

We can't lose our home.

Warming in the Arctic might also be a major cause for the unusual weather that we are seeing around the world.

Scientists across the world have come together to investigate the effect of Arctic warming on global weather.

## Is there a utopia for scientists in the Arctic?

There is a village in the Arctic where scientists across the world have come together to do scientific research. The village is in Ny-Ålesund on Spitsbergen Island in the Svalbard Archipelago.
Norway has sovereignty over the Svalbard Archipelago, but it is not Norwegian territory. In 1920, after World War I, many countries signed the Svalbard Treaty which made the islands free for anyone to use. Later, Norway called for it to build an international station for Arctic scientific research. To control global warming, we need research and cooperation that crosses borders. Japan, of course, will play an important role in these research activities.

Ny-Ålesund



A6 It is in Longyearbyen on Spitsbergen Island. Longyearbyen is said to be the northernmost town where people live to spend their usual life.

Q7 What is the difference between sea ice and icebergs?



The answer is on the next page ▶

# What does Japan observe in the Arctic?

Are you from Japan?

Yes, I'm from the National Institute of Polar Research (NIPR) in Tokyo.

Why did you come all this way?

I want to know all about the Arctic. We cannot stop global warming if we do not understand all about how fast climate change has progressed in the Arctic and how it happens.

If your observations and research progress, will my friends and I in the Arctic be able to live peacefully forever?

We will do whatever we can to make sure all living things on the globe can live in peace.

I want to know more about your research.

Okay then, starting on the next page, I will tell you all about the research being conducted by Japan.

Atmospheric observation

## Watching the Arctic atmosphere over 25 years

Aerosols observatory on the summit

Japan has been observing the ozone layer in the Antarctic for decades and was the first country in the world to discover the ozone hole. So, we believe continuous observation is important for Japan's research in the Arctic as well. We opened an Arctic research observatory in 1991 and have been observing carbon dioxide, methane, and other greenhouse gases ever since. By continuing our observation, we can notice changes quickly and can then make better future predictions.

Another observation that Japan has been continuing are to measurements of aerosols and clouds in the atmosphere. Aerosols are things like small dust and smoke that are produced by burning petroleum oil or coal. Aerosols have the opposite effect of greenhouse gases – they block sunlight and may even cool the Earth over time. In fact, changes in Arctic atmosphere are closely related to unusual weather in Japan. Watching changes in the Arctic is also important for us to predict the weather in Japan.



A7 Frozen seawater is called sea ice. Broken pieces of ice sheet and glaciers pushed out to sea are called icebergs.

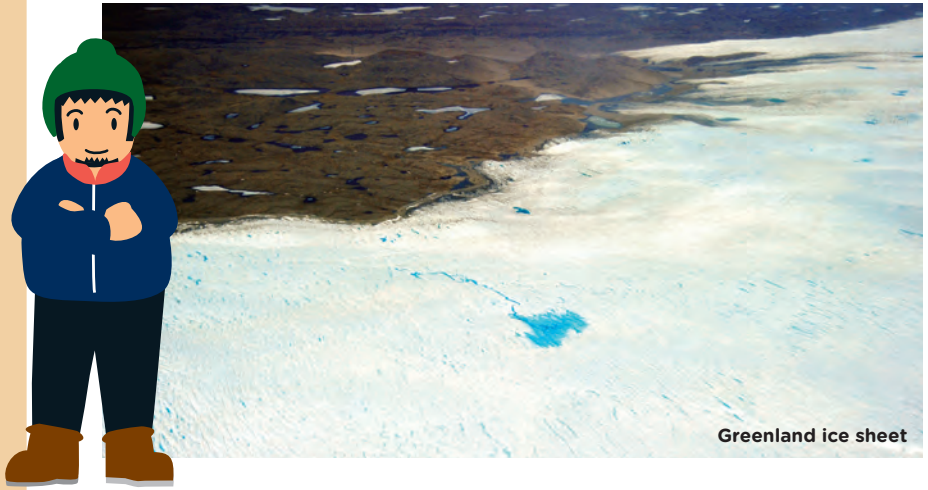
Q8 Is it true that there is no night in summer in the Arctic?



The answer is on the next page ▶

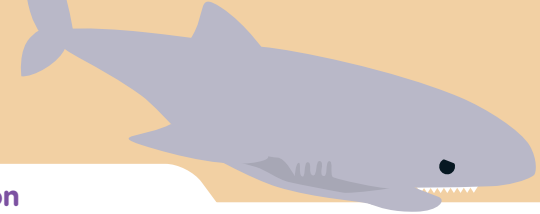
## Snow and ice observation

# Challenging to the frontline of global warming



Greenland ice sheet

The effects of warming in the Arctic are most visible in Greenland. Ice sheet – huge masses of ice rising several kilometers high that are made from snow accumulating over hundreds of thousands of years – have begun melting. The white area in the picture above is an ice sheet, and you can see pools of water here and there where the ice has melted. We are studying how the amount of ice in the ice sheet increased and decreased in the past. Ice columns called "ice cores" that are drilled out of ice sheet have become important research materials in such studies. By analyzing the ancient air, chemicals, and microorganisms trapped in the ice, we have discovered that there was a time long ago when the world was warmer than it is today and there much less ice. We have also obtained and studied ice cores from Antarctica, and by combining the findings from Antarctica and the Arctic we can understand further more about the mechanisms of climate change.



## Wildlife observation

# Discovering the secrets of wildlife

Young bearded seal with a data logger

Biologging is a method to study the hidden biology of wildlife by attaching video cameras and GPS systems to animals to collect their activity data. This observation technique has been refined in the Antarctic research. In the Arctic, data loggers have been used to tell us about the ecology of bearded seals and polar bears.
Through this research, we recently discovered that the Greenland shark swims surprisingly slowly. It swims as slow as a human baby crawls. However, this shark catches the seals to eat them. Maybe they hunt seals that are sleeping on the water surface.

©NRK/Armin Mück



A 8 Yes, it is. In the Arctic, the sun does not set in summer. In winter, the sun does not rise, and it is nighttime all the day. (See p. 9)

Q 9 How hot does it get in the Arctic in summer?



The answer is on the next page ▶

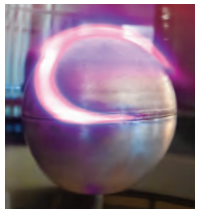
## Space observation

# What exists between space and the Earth?

EISCAT Svalbard Radar

In the region from about 60 km to 1,000 km above the ground, there expands an atmospheric region that forms the boundary between the Earth and space. This region is called the middle and upper atmosphere. The middle and upper atmosphere is an invisible shield that protects life on the Earth from strong solar radiations. It also plays an important role in the large-scale atmospheric circulation and in climate change. Together with research institutes both in Japan and overseas, researchers are working to observe and study the upper atmosphere. It's key facility is the EISCAT radar .

NIPR has joined the international consortium that operates this facility representing Japan's research community to precisely study the changes of the upper atmosphere.



Aurora appears in the ionosphere and thermosphere, ranging from 100 km to 500 km above the ground. We understand a lot about how aurora is formed from experiments using the aurora simulator. You can have a look at the aurora simulator at the occasion of Open house of NIPR.

## Ecosystem observation

# Does climate change also affect ecosystems?

Glacial retreat area occurring at Ny-Ålesund

How does global warming affect terrestrial ecosystems? Ever since we opened a research observatory in Ny-Ålesund, Japan has been monitoring these changes. For example, in places where glaciers have melted and the ground has been exposed, moss and flowering herbs appear, grow, and bloom. When this happens, animals come to these places to feed. How has this been affected by warming? We have understood many interesting facts over years of research.

In the ocean, we use satellites and ships to study changes in the amounts of phytoplankton. Phytoplankton are very tiny organisms, but they are very important for polar ecosystems. Since the ocean is a massive reservoir for carbon dioxide, we should pay close attention to the ocean continuously.



A9 In Alaska and Siberia, it is not unusual for the temperature to be above 30°C in summer.

Q10 What is the population of Greenland?



The answer is on the next page ►

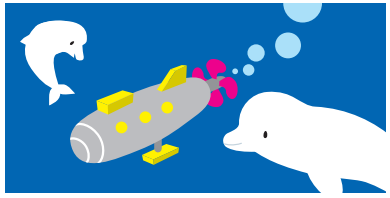
Geomorphological observation

## Mysteries of the Arctic landforms

Greenland geomorphological survey

At the bottom of the Arctic Ocean, there is an undersea mountain range called the Gakkel Ridge. The floor of the Arctic Ocean is made up of plates that created this ridge. These plates are still moving, but so slowly that we cannot see it's motion. Although only few people has studied this ridge, we know that hot water outbreaks and that creatures are active there. This place is very interesting because it teaches us about the interior of the Earth, and some groups have been studying it with unmanned underwater vehicles.

On land, we are studying coastal and glacial landforms in Greenland, where the ice has started melting so quickly that causes the change of sea level. We are looking at past changes in terrain to predict how the ice will melt in the future.





A10 It is about 56,000 people, even though the land is about six times larger than Japan.



# Central for Japan's Arctic research

Are you more interested in the Arctic now? You now understand that the Arctic is an invaluable natural environment and that it faces many problems. The truth is that we do not have a lot of time to fix these challenges. Scientists predict that almost all the Arctic sea ice will disappear in summer by 2040. To make sure this does not happen, Japan is promoting as a nation to advance polar research. At the center of this activity, the NIPR is working on collaborating with scientists from different fields to consider deeply the future of our globe and to take proper actions. We hope you will join us!

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