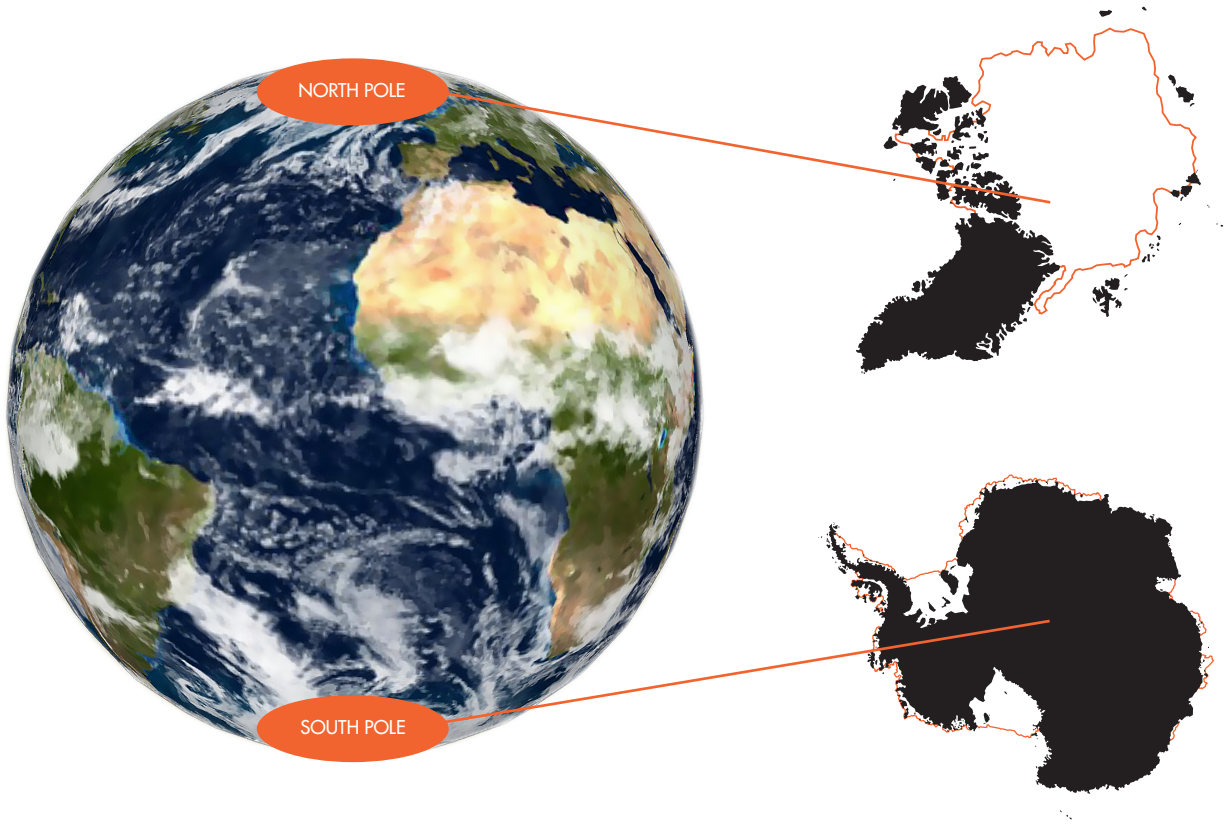
Class Zero Emission

TEACHING DOSSIER 1

ENGLISH, GEOGRAPHY, SCIENCE, ECONOMICS

THE POLAR REGIONS

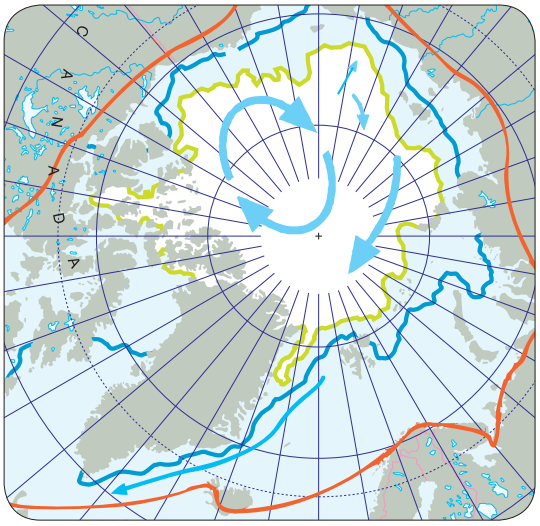
ANTARCTIC, ARCTIC, GEOGRAPHY, CLIMATE, FAUNA, FLORA, CLIMATE CHANGE, THREATS, CONSERVATION



THEORY SECTION

THE ARCTIC AND ANTARCTIC

The Arctic and the Antarctic have a number of points in common: low temperatures, darkness that lasts for several weeks or months in winter, and magnificent expanses of ice... There are several different types of ice[1], including sea ice, which is ice that contains salt, and ice caps and icebergs, which consist solely of freshwater ice. However, once we get past these initial similarities, it doesn't take long to realise that the Arctic and the Antarctic are two totally different regions.



THE ARCTIC

- Frozen ocean surrounded by land
- North Pole: located approximately in the centre of the Arctic Ocean
- Ocean covered to a large extent by permanent sea ice
- Holds almost 10% of all the Earth's continental ice (7% of the world's reserves of freshwater)
- Outer limit: place where the temperature never exceeds 10°C during the warmest month (July)
- Area: 21 million km^2 (14 million km^2 of which is the Arctic Ocean)

Ice drift
Maximum extent of the sea ice in summer
Maximum extent of the sea ice in winter
Outer limit of the Arctic

➥ Figure 1: Outer limit of the Arctic and seasonal variation of the sea ice

The Arctic Ocean is bordered by broad, shallow continental plates and consists of two main basins (4 km deep on average) separated by a range of underwater mountains: the Lomonosov Ridge, which joins the north of Greenland to the New Siberia Archipelago along a line that runs close to the North Pole. The Arctic Ocean is linked to the North Atlantic on one side and the North Pacific on the other.

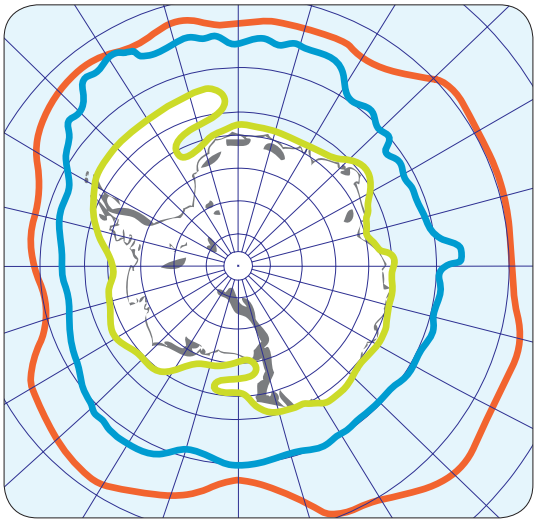
Until recently, approximately 75% of the Arctic Ocean was covered by permanent compacted sea ice, seawater that had been frozen for several years. Driven by the ocean currents and the wind, this sea ice drifts in a clockwise direction. The thickness of the ice is usually between 3 and 3.5 metres, however sheets of the ice can sometimes overlap and form ridges locally that are anywhere between 10 and 20 metres. But climate warming has had a dramatic effect on melting the sea ice in recent years: At the end of the 2007 boreal summer (usually only the permanent sea ice remains during summer), less than 35% of the ocean's surface was still covered with ice.

After the boreal summer (June to August), the ice freezes up again as the atmosphere cools down. The ice is at its maximum from November to April. However, the coastline of Scandinavia remains free of ice throughout the year because it benefits from the warming effect of the Gulf Stream.

When seawater freezes, only part of the salt is incorporated into the ice. The rest goes into the water which is just beneath the sea ice. When this happens, the water underneath the ice is very cold and extremely salty (the same thing also happens in Antarctica), which means it is very dense. This "heavy" water then sinks into the ocean depths, feeding a deep current of cold water that circulates through the oceans of the world. It re-surfaces in the Pacific and the Indian Oceans before continuing on its way to the North Atlantic.

1 See the corresponding teaching dossier and related animations at www.educapoles.org

This immense ocean conveyor belt driven by thermohaline circulation regulates the Earth's climate by allowing heat to be exchanged between the poles and the tropics[2]. As a result, the fact that there are ice fields in the Arctic and the Antarctic is essential for the balance of the planet's climate. The current process of climate warming may significantly reduce the amount of dense ocean water being generated and could even slow down thermohaline circulation.



THE ANTARCTIC

- A frozen continent surrounded by the Southern Ocean
- South Pole: located more or less in the centre of Antarctica at an altitude of 2,850 metres
- The continent is covered with a thick ice cap up to ~5 km thick
- Holds 90% of the Earth's continental ice (over 60% of the planet's freshwater reserves)
- Outer limit: the "Antarctic Convergence" (see elsewhere in the dossier)
- Area: 14 million km²

(with an additional 10 million km² of sea ice in winter)

= Maximum extent of the sea ice in summer
= Maximum extent of the sea ice in winter
= Outer Limit of the Antarctic

➥ Figure 2 : Antarctic convergence and seasonal variation of the sea ice

The continent of Antarctica can be divided into 3 sections: East (or Greater) Antarctica, which consists mainly of high land, is separated by a range of mountains (Trans-Antarctic Mountains) from the smaller West Antarctica, which is made up of a series of archipelagos bound together by the ice. The Antarctic Peninsula is often regarded as the third section of the continent. Apart from the continent itself, there are many small islands scattered throughout the Southern Ocean. These are known as the Sub-Antarctic Islands.

However, the Antarctic does not stop at the coastline of Antarctica. The region is bounded by a hydrological border that encircles the continent of Antarctica in an irregular line between 50° and 60° S. This is known as the "Antarctic Convergence," and is also sometimes called the "Antarctic Polar Front." When crossing this convergence from the north, there is an abrupt drop in the water surface temperature of approximately 4°C. This border separates the cold waters of the Southern Ocean (a total area of about 75 million km²) from the much warmer waters of the Pacific, Atlantic and Indian Oceans. The Southern Ocean is the only ocean defined as a mass of water surrounding a continent.

The winds that blow around the Antarctic without encountering any geographical obstacles (called the "Roaring Forties" and "Furious Fifties") generate a powerful ocean current that flows round the continent. This is called the "Antarctic Circumpolar Current." Varying in width between 200 and 1000 km, this current carries between 130 and 180 million m³ of water per second (which is approximately 1000 times the flow of the Amazon!). The Antarctic Circumpolar Current is the Earth's largest ocean current and moves at an average speed of 2 km/h.

During the winter, no ships can reach the Antarctic coast because the sea ice grows and completely isolates the continent for a number of months. The formation of sea-ice in the winter makes the Antarctic the world's other major producer of cold water that feeds the deep currents of the thermohaline circulation. In the austral summer (December to February), the warming process breaks up the sea ice, leaving just a narrow non-continuous belt of ice around the continent.

2 See the animation about "Impacts of climate change on oceans" at www.educapoles.org

THE CLIMATE IN THE POLAR REGIONS

The main features of the polar climate are the severity of the cold and the length of the winter. There are two basic seasons: a long, freezing winter and three months of a chilly summer. Depending on the latitude, the sun can shine for almost three months continuously (the "midnight sun"), whereas in winter, it is dark for three months[3].

There is usually a wind blowing in the polar regions. Katabatic winds can reach record speeds and dramatically intensify how cold it feels by increasing the wind-chill factor (fastest wind ever recorded in Antarctica: 320 km/h). In polar regions, most of the precipitation falls on the coast. There is very little precipitation on the centre of the polar ice sheets and the precipitation that does fall is mainly in the form of ice particles, which glisten in the sun. There is virtually no water vapour.

IN THE ARCTIC

You can't really talk about a single Arctic climate: in fact there are a number of different climates, depending on the latitude, altitude, distance from the coast (the weather is colder inland) or whether there are marine currents in the vicinity. For example, the average temperature in the middle of winter is minus 33°C on the Greenland Ice Sheet, whereas in the neighbouring coastal area, at the same time of year, the average temperature is usually minus 7°C. This wide variation in temperature is caused by relatively warm ocean currents.
This means that although it is very cold, the climate in the Arctic is less harsh than in the Antarctic as a result of the warmth carried there by currents in the ocean and atmosphere.

IN THE ANTARCTIC

The Antarctic is a very dry continent. In the heart of the ice sheet, there is only 2 to 5 cm of precipitation per year (in the form of snow) – which is less than the Sahara! Almost every part of the continent has an average annual temperature lower than minus 25°C. The lowest temperature ever recorded was minus 89.2°C at Russia's Vostok base, on 21st July 1983. Temperatures are a little milder at the coast and on the Antarctic Peninsula than they are inland. The climate on the Sub-Antarctic Islands is warmer still thanks to the marine currents – in fact the average annual temperature barely makes it above freezing!

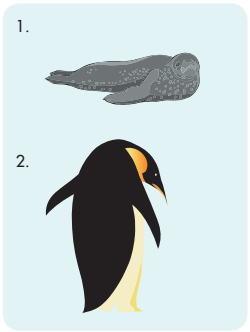
FLORA AND FAUNA IN THE POLAR REGIONS

All of the animals and plants that live in the Polar Regions have had to adapt to the extreme conditions that prevail there: very low temperatures, strong winds, poor soil that is often frozen solid, and long nights in winter alternating with long days in summer. This means that any plants that exist in these regions are small and grow in clumps to protect themselves from the cold. They tend to be covered in protective down or grow horizontally rather than vertically to keep out of the wind. This is the case with the Arctic willow, which does not grow higher than 25 cm and has branches that creep along the ground and some that are even grow underground. Polar animals are covered with fur, thick plumage or substantial layers of fat or blubber to insulate themselves from the cold. They have small ears and tails so that any loss of body heat is kept to a minimum.

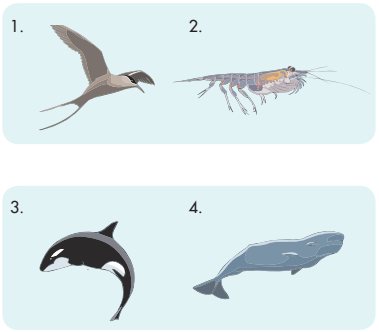
While some species may live at both poles (e.g. seals, killer whales, sperm whales), many only live only in either the Arctic or the Antarctic. So a penguin, which is often seen as the mascot of the Antarctic, will never meet a polar bear, which lives and hunts on the Arctic ice floes[4]. Just one species of bird (the Arctic tern) travels from one pole to the other each year.

3 See the animation about "Polar nights" at www.educapoles.org
4 See the animations about "Polar bears and penguins" and "polar flora and fauna at www.educapoles.org

➥ Figure 3 :



Antarctic Fauna
1 weddell seal, 2 penguins



Antarctic and Arctic Fauna
1 tern, 2 krill, 3 killer whale, 4 sperm whale

Arctic Fauna
1 greylag goose, 2 gull, 3 polar bear,
4 puffin, 5 walrus, 6 skua

IN THE ARCTIC

There are no plants at all on the sea ice, but there are several hundred species of plants on land in the Arctic. The isothermal limit that defines the Arctic is more or less where taiga (boreal forest of the high northern latitudes) ends and tundra begins. This is what is known as the "tree line." Going from south to north, the trees of the taiga gradually give way to tundra, a steppe-like region having very little and very short vegetation consisting of a few trees growing at ground level, herbaceous plants, moss and lichen. The tundra (as well as part of the taiga) is where you find permafrost, which exists in these extremely cold areas where the ground is usually frozen solid at a certain depth. Only the top 0.5 to 1.0 metres of the permafrost thaws during the summer, transforming the landscape into a vast, partly melted boggy area where plants are able to grow in just a few weeks.

A number of mammals live in the tundra (such as the wolf, Arctic fox, hare, musk ox, reindeer, lemming), as well as numerous types of birds and several hundred insects. Polar bears live mainly on the sea ice, where they hunt seals year-round.

In the sea, there is a vast array of marine fauna, including whales, seals, walruses and seabirds, as well as many fish and invertebrates. The short breeding season explains why there is not much biodiversity in the marine environment, although the total biomass produced is enormous: during the short window available to them, phytoplankton proliferate in incredible proportions and serve as food for the zooplankton, forming the basis of every Arctic food chain. Krill, a small crustacean ranging from 8 mm to 7 cm in length, is the most abundant species on the planet in terms of biomass and is considered zooplankton. To take full advantage of this short but very intensive period of animal and plant productivity, almost 200 types of birds come to nest in these high latitudes. During this period, the Arctic is home to the largest population of marine birds in the world, with several million individuals (terns, fulmars, gulls, auks, guillemots, razorbills, etc.).

IN THE ANTARCTIC

The interior of the frozen continent has virtually no life at all. The largest land animal found in the interior is the wingless midge, which is no more than 12 mm in length. As far as flora is concerned, there are just two flowering plants (on the Antarctic Peninsula, where the climate is less harsh), plus mosses and lichen that grow on rocks. This lack of plant life can be explained by the severity of the climate, as well as by the tiny surface area of the continent where there is no ice (less than 2% of the landmass).

Antarctic life is concentrated in the coastal regions and Sub-Antarctic Islands. In fact, flora and fauna in Antarctica are mainly found in marine environments: the cold waters are rich in nutrients carried from the great depths up towards the surface by powerful upwelling currents. These nutrients enable a large quantity of seaweed to develop, which in turn allows the zooplankton to multiply. There is far more krill in the Antarctic than in the Arctic. They sometimes drift along in gigantic swarms covering several thousand km^2, with billions of them serving as food for the rest of the marine fauna.

The surface waters are dominated by penguins, albatrosses, petrels, seals and whales. The marine biomass of the Southern Ocean is huge (although less than the Arctic Ocean), but generally speaking it is not very diverse. There are fewer than 300 species of fish; 43 types of birds nest to the south of the Antarctic Convergence (including seven species of penguin). Four types of seals are found on the coasts of the mainland and the peninsula. However, while it is true to say that there are not all that many different species, the populations of one particular species can run into the millions.

THREATS FACING THE POLAR REGIONS

Figure 4 a

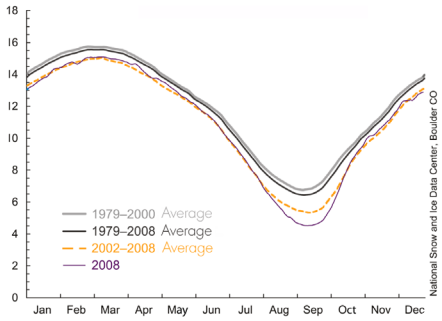
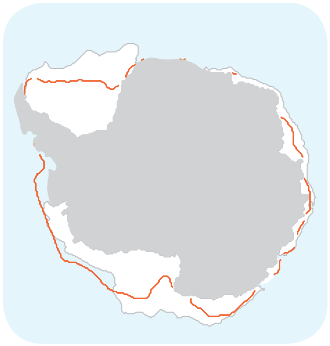


Figure 4 b

Figure 4 c



➥ Figure 4: 4a. Evolution of arctic sea -ice extent (millions km²) 4b. Arctic sea-ice in Septembre 2008 (end of summer) 4c. Antarctica sea-ice in March 2008 (end of summer) Note: In red,1979-200 average sea-ice extend for the given month (NSIDC)

IN THE ARCTIC

Climate warming is especially apparent in the Arctic. Temperatures there have increased twice as quickly as the world average. The speed at which the ice is melting is exceeding all expectations. Both the surface area and thickness of the sea ice are shrinking at an astonishing rate - so much so that scientists are predicting that we may see summer sea ice cover in the Arctic disappear completely by 2013 or 2040 (depending on the projections). According to the latest report from the IPCC[5], the likely average level of warming in the Arctic will be somewhere between 2 and 9 °C between now and the end of this century!

The polar flora and fauna are being affected badly by these dramatic changes to their environment. In fact, the various species will have no option but adapt or die out. As it is, polar bears already have to swim increasingly long distances to find food because their natural habitat – the sea ice – is disappearing. Man is also suffering from these changes. Roads and houses are collapsing as the permafrost thaws and traditional hunting practices are becoming impossible as the floating sea ice becomes dangerously fragile. And as the sea ice melts, this also brings other threats to the Arctic Ocean. New shipping routes are opening up. The Arctic subsoil is rich in deposits of oil, diamonds, gold, silver, copper, lead and other natural resources, and the inevitable pollution generated by exploiting these resources will only add to the already major problems facing the fragile Arctic environment, such as over-fishing and other forms of pollution.

In fact, the pollution created by mining or oil drilling in the tundra, as well as other industrial pollution from the Eurasian and North American land masses has already been gathering in the Arctic for almost a century now. This is because the Arctic acts as a depository for all sorts of pollutants from the northern hemisphere, brought in by atmospheric circulation, ocean currents or by rivers as they flow into the sea. Particles of soot, nitrogen oxides and sulphur oxides (acid rain), pesticides (PCB, DDT, etc.), heavy metals, radioactive isotopes and other pollutants are already being detected in measurable quantities in the Arctic air, snow, sediments and water. Some of these harmful molecules are being ingested at the bottom of the food chain, gradually rising up through the chain until they reach harmfully high concentrations in the great predators at the top of the chain, such as the polar bear, beluga, killer whales and even human beings (such as the Inuit, who live by hunting animals high on the food chain).

5 Intergovernmental Panel on Climate Change: http://www.ipcc.ch/

IN THE ANTARCTIC

Similarly, in the Antarctic, we can now measure many forms of industrial pollution in the ice, and animals there are being contaminated by pesticides and heavy metals as well. Climate change is also being felt in the Antarctic, albeit less severely than in the Arctic. However, the disintegration or break-up of some of the large ice shelves (such as Larsen B or Wilkins respectively) over the past ten years, or the arrival of species adapted to warmer climates also demonstrate that the western part of Antarctica is beginning to feel the effects of warming. Additionally, scientists are concerned about the future of Antarctic krill, which is sensitive to changes in temperature and whose biomass is beginning to reduce, due in part due to over-fishing. This is leading to a reduction in food reserves for all Antarctic fauna, since krill is at the bottom of the food chain.

Another threat is the hole in the ozone layer, which was first observed above the Antarctic in the 1980s. There is not actually a "hole" per se. What actually happens is that the protective layer of ozone thins during the springtime, due to various aerosols (Freon and other CFCs) that were widely used primarily in the industrial sector the 1960s and 70s. The same effect can also be seen in the Arctic, although to a lesser degree.

POLAR LEGISLATION : MANAGEMENT AND CONSERVATION

All of these threats (ozone layer, climate warming, industrial pollution, etc.) mean that genuinely global solutions are required if we are to protect the remote areas of our planet that are being endangered by harmful human activity in all parts of the globe. This protective action includes agreements such as the international treaties signed in 1985 and 1987 to halt the production of the various gases that harm the ozone layer. These measures have been successful, because recent analyses demonstrate that there is a clear-cut correlation between efforts to reduce harmful emissions and a partial reconstitution of the ozone layer. It will take some time, however, to restore the ozone layer to its original thickness, because CFCs last for a very long time in the atmosphere before breaking down. This is a good example of how grassroots campaigns in Europe, the United States and elsewhere on the planet can affect the future of the Polar Regions!

IN THE ARCTIC

Although there is a proper intergovernmental structure that promotes the protection of the Arctic (the Arctic Council6), there is no overarching treaty protecting the region. The Arctic's legal status is governed by the United Nations Convention on the Law of the Sea. The eight countries having territory in the Arctic (Canada, Norway, USA, Russia, Finland, Sweden, Denmark and Iceland) each have sovereignty over their territorial waters (from the coast to the edge of the continental shelf) and can exploit resources within their exclusive economic zone, which extends for 200 nautical miles from the coast. Beyond that, the "high seas" enjoy international status.

Until recently, there have been few claims made on the desert of ice that is the Arctic. The geopolitical context has changed radically in recent years because the melting ice promises unprecedented access to new mining and oil prospecting resources. If a country is able to demonstrate that the geological feature below the ocean seabed is a natural extension of the continental shelf of its own territory, it can file a claim to mine or drill it. This is why various nations have been conducting geological surveys in the Arctic since 2007.

IN THE ANTARCTIC

Unlike the Arctic, the Antarctic is protected by a treaty. The Antarctic Treaty System, which includes the Antarctic Treaty ratified in 1961 and the Madrid Protocol signed by 32 countries in 1991, creates a framework that puts the Antarctic outside the control of any particular state. The Treaty System defines Antarctica as a natural reserve dedicated to peace and science and forbids any mining, military activity, or the storage of any type of waste, including nuclear waste, until 2041.

GLOSSARY:

Sea ice : (or sea-ice) A layer of ice made up of permanent or seasonal frozen seawater, 1 to 4 metres thick. As a result, sea ice is salty, although its salt concentration diminishes as time goes by.

Biodiversity: The biological diversity of an environment, estimated by the number of animal or plant species populating that environment.

Biomass: (ecology, different meaning than in energy). The total quantity of living matter contained in a specific environment. It is also possible to calculate the biomass of a specific species: the biomass of plankton is said to be 500 million tons for the whole of the planet, which is double the biomass of human beings (World Watch Institute, 2005).

Ice cap: A mass of ice covering land over a large area. Up to several kilometres thick, ice caps are built up by the accumulation of snow over tens of thousands of years. Called an ice sheet when the surface area exceeds 50 000 km^2.

Katabatic winds: Powerful winds produced under the effect of gravity by the weight of a mass of cold air hurtling downwards across a descending slope of land. In the Antarctic, katabatic winds blow from the interior of the continent and down the slopes of the ice sheet to the low-lying coast (at up to 300 km/h).

Ozone layer: Layer of the stratosphere where the concentration of ozone (O_3) is higher than elsewhere in the atmosphere, with peak concentration of ozone at around 25 to 30 km. Ozone is produced naturally by the action of ultraviolet solar radiation on oxygen molecules. The ozone layer protects life on Earth against UV rays.

Permafrost: Layer of soil in cold regions on the planet that is permanently frozen. Permafrost can extend down to considerable depths (several hundred metres).

Plankton: Group of aquatic organisms that float in water, but do not swim. Plankton is generally microscopic or very small. Phytoplankton is plankton that makes its own food through photosynthesis like plants do, while the zooplankton (marine protozoa, larva, jellyfish, etc.) need to eat other organisms to get food like animals do.

Upwelling currents: Deep ocean currents that rise up to the surface, often close to the coast. In the section of water where the light is able to penetrate, this upwelling brings dissolved nutrients with it, leading to a proliferation of phytoplankton and the animal life that depends on it.

RESOURCES:

View the numerous animations we have produced on this topic ("What are the Arctic and the Antarctic?", "Icebergs", "Political situation", etc.), as well as our teaching files and many classroom activities. Or order the CD-ROM "Polar regions and climate change" from EDUCAPOLES, the educational website run by the International Polar Foundation (IPF):
http://www.educapoles.org (NL, FR, EN)

Other sources of information about the Polar Regions:
http://www.det.wa.edu.au/education/cmis/eval/curriculum/pathfinders/polar/index.htm (EN)
http://www.institut-polaire.fr/ipev/les_regions_polaires (FR)
http://www.hetonbekendecontinent.nl/
and http://www.natuurinformatie.nl/ndb.mcp/natuurdatabase.nl/i000980.html (for the Arctic) (NL)

A lavishly captioned map called "Melting Ice", produced by the United Nations Environment Programme (UNEP):
http://www.unep.org/wed/2007/downloads/documents/tunza%20meltdown_FR.pdf (FR)
http://www.unep.org/wed/2007/downloads/documents/TunzaMeltDownl_r.pdf (EN)

INTERNATIONAL POLAR FOUNDATION
Met steun van de Vlaamse overheid

PRACTICAL SECTION

LEARNING ISSUES

The main learning issues for this dossier consist of:

- Prompting the pupils to enrich the way they understand our planet, particularly the Polar Regions (geophysics).
- Making the pupils aware that a scientific approach to the world enables us to expand our knowledge base.

To do this, we need to give preference to investigative methods in our activities.

The polar world is a complex one and the parameters governing it constantly influence one another. As a result, we need to avoid looking at just one issue without looking at the big picture. For example, if we study Arctic animals, it is not just their physical characteristics that we need to examine, but also their place within the entire Arctic system.

ACTIVITIES FOR THIS DOSSIER

1. EXERCISE AND RESEARCH « ANIMALS AND THEIR ENVIRONMENT »

Target group	<12 years	Time required	30 minutes plus time needed for extra research
Aims	To associate animals with the environment in which they live, figure out where they live and do more focused research on one particular animal		

The teacher can also point out the way the animals have adapted to their environment (marine/land, cold/hot). Note that fauna in the Antarctic is mainly marine fauna. Once the children have done the research (it can be left out for younger pupils), the children can produce a diagram describing the way Arctic or Antarctic animals interact with one another and their relationship with their environment (pollution, climate warming, etc.) to give them a more general view and explain which species are threatened with extinction today.

Answers: Polar bear and walrus: Arctic sea ice / Reindeer: tundra / Penguins: Antarctic coast (sea ice) /Tern, Krill, Killer Whale and Sperm Whale: Arctic and Antarctic / Fennec: deserts of North Africa

2. « POLAR REGIONS » TOPOGRAPHICAL MAPS

Target group	12-15 years	Time required	15 minutes
Aims	Summary document that can be used to practise working with topographic maps.		

This document can also be used for an exercise in reading a topographic map. The teacher can ask questions such as: "What is the maximum depth of the Arctic Ocean?"; "In your opinion, is altitude in Antarctica measured from the surface of the ice or from the bedrock?"; "Compare the climate and the type of landscape that might be found at the same latitude (e.g. 65°) in the northern and southern hemisphere", "What makes it so difficult to explore the Arctic region or the Antarctic?", etc.

3. ROLE PLAY AND DISCUSSION ON IDEAS « WHAT FUTURE DOES THE ARCTIC HAVE ? »

Target group	15-18 years	Time required	45 minutes
Aims	To understand the complexity of the situation in the Arctic and the conflicts of interest between economic, environmental and social issues		

Allow the students to form four groups, with an equal number of students in each group. Each group will represent a particular position (see student sheet). In order to prepare for this activity, students will need to read over the recommended texts for their group. They can also do further research themselves, if they like. When the discussion takes place, the teacher leads the negotiations between the four groups, playing the role of an observer sent by the Arctic Council. After about 25 minutes of discussion, the teacher lets each group make its closing arguments. The students then vote based on their own personal opinion, not the official position of the group they represented in the activity. The teacher can then summarise the main points brought up during the discussion and ask the students whether any compromises might have been possible (such as taxes for the benefit of NGOs, the establishment of wildlife or marine protection areas, etc.).

IDEAS FOR OTHER ACTIVITIES

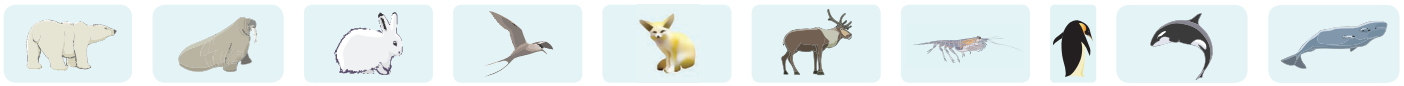
- Create an exhibition or multimedia document about the Polar Regions using for example the resources available from the Educapoles website (www.educapoles.org – photos, flash animations, teaching files, etc.);
- Examine the way polar animals have adapted to the cold. Devise an experiment that helps students learn about heat conservation. Some ideas to focus on: types of animals (penguins) and the protection they have against the cold such as down and fur, fat and blubber, skin colour, etc. The students can then look at the techniques animals use that human beings also use: wool, padded jackets, duvets, etc.
- Devise experiments to focusing on certain natural phenomena (states of matter, ice density, convection) making use of various measuring devices (scales, thermometer); you can find a number of sample experiments at the Educapoles website (www.educapoles.org) or at the following addresses:
  http://www.edunet.ch/activite/wall/enfants/experience/index.htm : expérience « les propriétés de la glace » (FR)
  http://www.lpi.usra.edu/education/explore/ice/activities/ice_action/expanding_ice/ (EN)
  http://www.educapoles.org/index.php?s=no&uid=449 : "coole experimenten" (NL)

ANIMALS AND THEIR ENVIRONMENT

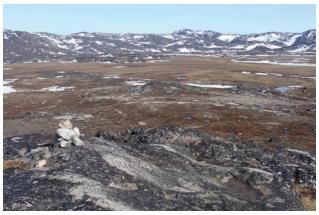
LINK EACH ANIMAL NAME

a) to the picture of that animal
b) to the picture representing the environment this animal lives in
c) to one or more places on Earth where the animal can be found (on the map of the Earth)

Penguin Krill Arctic hare Raindeer Walrus Killer whale Sperm whale Arctic tern Fennec Polar bear



Tundra



Sea and sea ice

Desert[1]

Ice cap

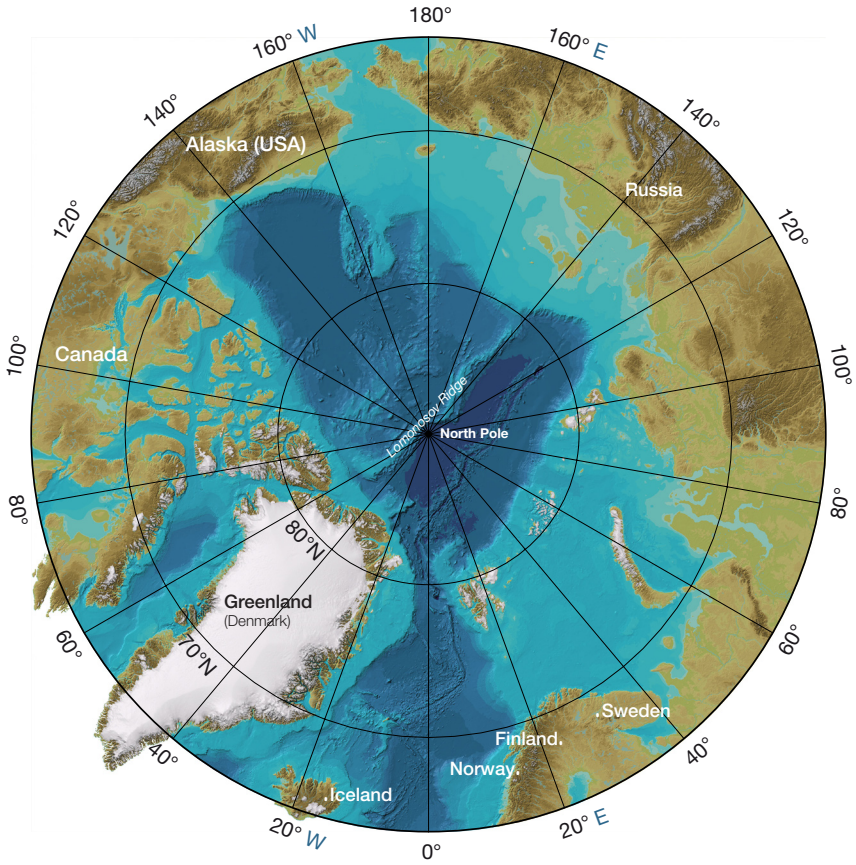
1. photo courtesy: http://PDPhoto.org

RESEARCH

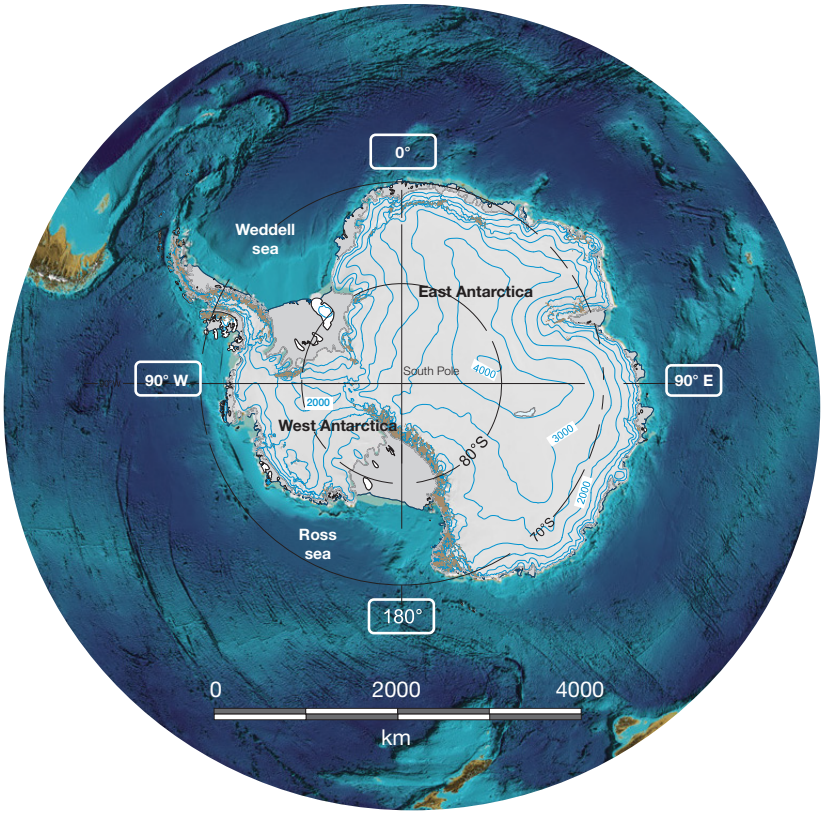
Choose one of these animals and create a fact sheet about it. Try to answer the following questions, using the dictionary, books, magazines or the Internet:

- What are the main physical traits of this animal?
- Does it need to protect itself against the cold or heat? If it does, how does it do so?
- What sound does the animal make?
- Where does the animal live? What does it eat?
- Does it have any predators or "enemies"? If so, which ones?
- What other animals are like the animal you chose?
- Draw a diagram that illustrates how this animal fits in and interacts with the other animals that live in the same environment.

THE POLAR REGIONS



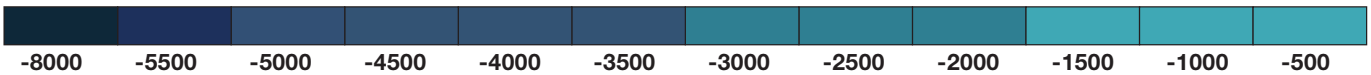
➥ Topographic and bathymetric map of the Arctic



key:
- Rock
- Ice Cap
- Ice shelf
- Altitude contours (every 500 m)

➥ Topographic and bathymetric map of the Antarctic

Visualization: Martin Jakobsson
Data source: ETOPO2, National Geophysical Data Center



WHAT WILL BE THE FUTURE OF THE ARCTIC ?

TOPIC FOR DEBATE

Imagine in the near future that the "Arctic Council" (a major intergovernmental structure that promotes the protection of the Arctic) has more power than it does at the present time and is on the point of taking a crucial decision on the future of the Arctic: either to give permission for the Arctic's resources to be exploited by private enterprise, or to make it a natural reserve. To help them make this decision, the Council members have appointed a small interdisciplinary committee of experts (that's you!) that has to report to the Council promoting one alternative or the other. The aim of your debate is to convince your opponents so that the conclusions made by the report favour your point of view.

DISTRIBUTION OF THE ROLES AND PREPARATION

Important: During this debate you will have to play a role and adopt the position set out below, even though it may not correspond to your personal opinion. A final vote will decide which alternative is chosen.

YOU ARE A POLITICIAN

You take a very serious view of the economic future of your region, which borders the Arctic Ocean. New drilling and mining operations would create significant income that would be very lucrative for your country: the taxes paid by the oil companies alone would provide stable revenue for your country for at least 10 years, and you believe that the effect of industrial pollution on the environment is just media hype.

Your opinion: in principle, you think it would be ridiculous to ban access to the Arctic for mining and drilling activities.

Your source of information for preparing your role: http://www.grida.no/_res/site/File/publications/environment-times/arctic_03.pdf

YOU ARE A SCIENTIST

From your research, you know that the environment in the Arctic is suffering enormously from the effects of climate change and pollution and that man is the main culprit. In Alaska for example, the permafrost (the upper part of the ground that stays frozen solid all year round) is the basis of the local ecosystem, and it is thawing not only as the result of climate change, but also because of the infrastructure humans have built in the region.

Your opinion: you believe that making the Arctic a natural reserve would be the only reasonable thing to do.

Your source of information for preparing your role: http://www.thearctic.is/articles/overviews/changing/enska/index.htm

YOU ARE THE REPRESENTATIVE OF AN NGO

Through your work in the field you have seen firsthand the devastating impact that climate change and industrial pollution are having on the life of local communities and the fauna. In addition, new human infrastructures (roads and pipelines) are harming the ecosystem and preventing local communities from continuing to live in their traditional ways (keeping herds of migrant livestock, hunting). Any new industrial operations are only going to make things worse.

Your opinion: in principle, you can see nothing but negative consequences for the fauna and the local communities if this region is opened up to the major multinational corporations.

Your source of information for preparing your role: http://www.thearctic.is/articles/overviews/homeland/enska/kafli_0501.htm

and http://www.thearctic.is/articles/overviews/homeland/enska/kafli_0405.htm

YOU ARE AN ECONOMIST

Through your job as a consultant in market economics, you have been able to see the initial effects of climate change in the country. For example, insurance companies have stopped providing coverage for houses in some areas with the permafrost thawing. However, you can also see the positive side of these changes: the more the ice melts, the more oil and mining companies can explore to find new places to drill or mine. Ships may soon be able to travel north of Alaska, which means that there will be ports to build, having a very positive effect on the local economy.

Your opinion: you are very much in favour of exploiting the Arctic's resources.

Your source of information for preparing your role: http://money.cnn.com/2006/09/27/news/economy/arctic_drilling/index.htm