Chapter I

presented by Hydro Québec

The Far North and its Environment

GOALS

Locating the Arctic

Understanding the northern climate

Introducing the Arctic landscape

Chapter I

GEOGRAPHY

What is the Far North?

Good question! The Far North, which is often used as a synonym for the Arctic, is difficult to define. Usually, it's described as the portion of the Earth located north of the Arctic Circle (latitude 66° 33' North) — but that arbitrary limit includes regions of Scandinavia where, thanks to the Gulf Stream, the climate is warm enough for cold-blooded creatures like lizards, snakes and frogs to survive. On the other hand, it excludes Canada's James Bay, an important habitat for the polar bear. It also leaves out the Quebec-Labrador peninsula, where the tundra (a type of arctic vegetation) reaches its southernmost latitude (56° North).

A number of different boundaries have been suggested as ways of defining the North: the southern edge of permafrost (ground that stays frozen all year round); the tree line; the geographical distribution of certain animals; the isotherm[1] of 10° Celsius (50° Fahrenheit) in July. The scientific community has debated them all, and all have been found lacking in some way.

With an area of more than 14 000 000 square kilometres (5,405,400 square miles), the region above the Arctic Circle is so vast that it inevitably defies definition. Instead of thinking of the North in terms of a single criterion, we should understand it as a region defined by a complex set of characteristics. However, anybody standing on an ice floe in the company of Inuit or polar bears, can reasonably claim to be in the Far North!

What are the differences between the Arctic and Antarctica?

The main difference lies in the fact that Antarctica is a continent — an imposing mass of land (and ice). The Arctic, on the other hand, consists primarily of the Arctic Ocean, throughout which lie scattered a number of relatively small land masses. All that water has a moderating effect on the climate: it heats the atmosphere, allowing for greater plant and animal diversity and for the survival of human beings. The same kind of thermal exchange would never be possible in Antarctica, where the ice can be as thick as four kilometres.

Chapter I

Which countries are located in the Arctic?
No country lies completely within the Arctic Circle. However, the following countries have territory within the Circle: Canada, the United States (Alaska), Russia, Finland, Sweden, Norway and Denmark (Greenland). The northern tip of Iceland also brushes the Arctic Circle. So the Arctic extends over three continents: North America, Europe and Asia.

CLIMATE
What are seasons like in the Far North?
The North sees long winters (with winter defined as the period during which the average daily temperature is below freezing). In some places, winter starts in October and ends in June. Generally, the closer you get to the North Pole, the longer the winter.

On the other hand, summer (defined as the period during which the average daily temperature is above freezing) is rather short. In some places, it lasts only two weeks!

Snow, According to the Inuit

In northern regions, there are many different names for snow — depending on texture, thickness and density.

Choose the wrong kind of snow when you're building an igloo and it might collapse.

Aniu Snow that you melt for drinking water

Putak Granular snow

Apun Falling snow

Patuqun Crystalline snow

Pukaraq Powdery snow

Qanik A snowflake

Inuit words for snow seem to sound as soft as snow itself.

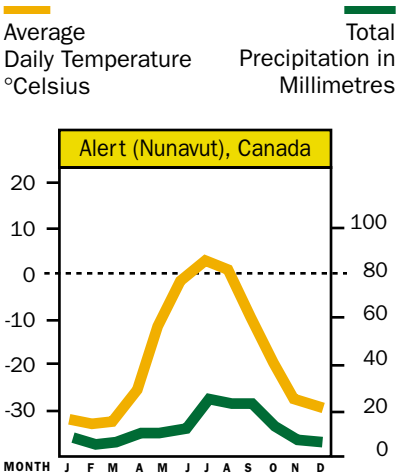
In summer, nature goes into overdrive, with an accelerated reproductive cycle and an explosion of life across the land. That kind of frenzied growth and activity is inevitable in an environment where the number of degree days[2] for plants to grow is under 300 (compared to 2,000 in Montreal, Canada).

As for spring and fall, they are little more than intermediate periods of heating up or cooling off, lasting only a few weeks. These two seasons are defined by maximum temperatures above freezing and minimum temperatures below the freezing mark.

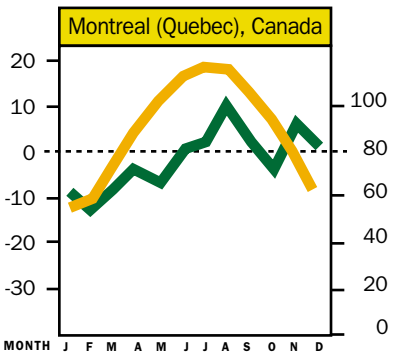
What is the Midnight Sun?
Because of the way the Earth is inclined, sunlight is not distributed evenly between the Equator and the poles. As a result, for six months the North Pole is sunlit 24 hours a day — so the sun shines at midnight.

During those six months, the sun's height in the sky varies every day. It gets higher until June 21 and then gets lower — but it never sets. After the six months, the sun dips below the horizon. It's the start of the long polar night, which also lasts six months.

The farther you get from the poles, the less marked these extremes become. At a certain distance from the pole, the



Total annual precipitation:
154.2 mm (6.08 inches)



Total annual precipitation:
939.7 mm (37.02 inches)

period of continuous light lasts only for one day (June 21, the summer solstice). And the period of continuous darkness also lasts only a day (December 21, the winter solstice). The point at which this happens is the Arctic Circle.

How low do Arctic temperatures go?
The sun's rays shine on the Arctic obliquely, instead of directly — so they pass through a thick layer of air before reaching the Earth's surface. As a result, there is less solar energy available to heat the ground. Add to this the fact that snow and ice reflect some of that heat straight back to the sky, and you've got a recipe for cold. But how cold?

The record is held by Verkhoyansk, a town in the Russian Arctic, where a temperature of -69.8° Celsius (-93.6° Fahrenheit) was once recorded. And that's without the wind chill factor[3]!

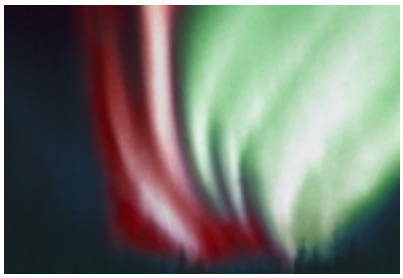
That's impressive, but annual average temperature is an even more significant measure of cold. In certain Arctic stations, annual average temperature is as low as -20° Celsius (-4° Fahrenheit). By comparison, Montreal, Canada, enjoys an average annual temperature of 7° Celsius (44.6° Fahrenheit). In July, the average Arctic temperature doesn't climb above 10° Celsius (50° Fahrenheit). Daytime temperatures can climb as high as 20° Celsius (68° Fahrenheit). The Inuit find this kind of heat uncomfortable.

Are there big snowstorms?
Yes and no. It's true that blizzards can rage for days, but the amount of snow that falls is relatively small.

The cold Arctic air is not conducive to the accumulation of humidity in the atmosphere, and that limits precipitation. In fact, in several Arctic locations, such as Alert, Canada, precipitation does not exceed 200 millimetres (7.9 inches) a year. By comparison, Moscow receives over 600 mm (23.6 inches) and Montreal gets over 1 000 mm (39.4 inches).

Most snow falls in October, after which the atmosphere becomes too cold to absorb humidity. As a result, snow storms consist mostly of fallen snow whipped up off the ground by high winds. Though not much new snow falls, the storms are still both spectacular and dangerous.

Does a climate like this lead to any unusual phenomena?
Yes, in particular mirages. Just as in the desert, there can be large variations in temperature among different air strata. For instance, the air is much colder closer to the ice on the ground and the frozen ocean than it is a few metres higher up. Sunlight hitting an object is deflected as it passes through different layers of air — so an observer sees a mirage. With warm air lying above the colder layer (as is the case in the Far North), the deflection of rays of light makes



Dancing Light

The Earth acts like a magnet that produces magnetic fields linking the two poles. The Sun continuously sends streams of electrically charged particles into space. These turbulent streams are known as **solar winds**.

Travelling at 500 km/hour (311 miles/hour), the solar winds slide around our planet, along the length of the magnetic fields.

Some of these particles eventually make their way into our atmosphere at the poles. As they enter the atmosphere, they release energy that becomes visible to us as shimmering, luminous colours. These are the northern lights, or **aurora borealis**.

The northern lights cross the land, performing a continuous enormous dance of light. Like astral aurorae, the aurora borealis is always there, but we only rarely see it because it is over the poles.

objects appear larger, straighter and taller. Thanks to this effect, it is sometimes possible to see objects below the horizon that would normally be invisible.

Another Arctic phenomenon is fog made up of tiny ice crystals suspended in the air. The fog reduces visibility, but the Sun is usually not completely obscured. Deflected in various directions by the crystals (depending on their shape and position), sunlight comes through as luminous haloes, which may be more or less colourful depending on the degree to which light is reflected or refracted[4].

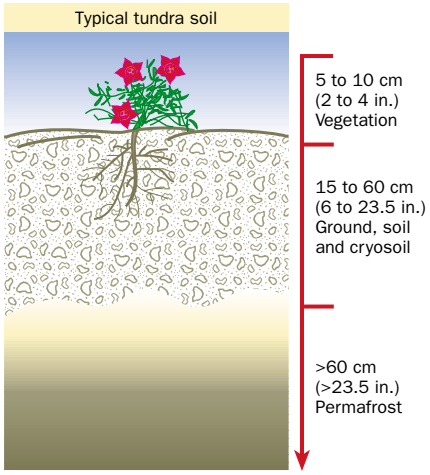
What is snow blindness?
One of the dangers humans face in the Arctic environment is snow blindness. This inability to see is caused by overexposure to the sun's ultraviolet rays, combined with light reflecting off the snow. As all this light floods the eye, it can cause a burning of the cornea, followed by a swelling of the eyelid. The combination makes seeing through the eye impossible. The blindness is accompanied by increasingly sharp pain.

To cure snow blindness, rest the eye by keeping it in darkness for a few days. If no steps are taken to rest the eye, the condition can lead to permanent damage — and even blindness. Inhabitants of Arctic regions have learned over time to shield their eyes by making sunglasses out of a wide range of materials. These glasses are not made of protective lenses; they allow a minimal amount of light to pass through small slits.

PHYSICAL FEATURES AND GEOLOGY
What does the Arctic look like?
Arctic land- and seascapes vary greatly. The land is generally flat, but can include impressive mountains and boulders. The few trees found here are stunted and scraggy, and grow scattered here and there. Moving north, trees give way to a rockier environment, with discontinuous low plant cover. In winter, the glacial icecap, which permanently covers most of the Arctic Ocean, stretches several hundred kilometres southward. In summer, the melting of the ice opens up channels so that ships and migratory sea mammals can venture forth.

What is the ground like in the Arctic?
In general, there is no soil in the North. The rocks in the landscape that do not lie bare on the land are covered by morainic deposits[5] of glacial or fluvio-glacial origin, and are concentrated in valleys and coastal areas. Rocks, gravel and sand lie scattered around.

Instead of soil, it would be more appropriate to refer to the substratum[6] of matter affected by the action of freezing and



thawing as cryosoil. However, in some areas, lichens can create a thin layer of soil that allows plants to take root. These roots trap the elements that can eventually lead to the creation of true soil.

One unique characteristic of Arctic ground is permafrost. Located at a depth of between 20 centimetres (7.9 inches) and 3.5 metres (11.5 feet), permafrost is a permanently frozen layer that can go as deep as 600 metres (1,969 feet). In some spots the permafrost has probably not thawed for tens of thousands of years. This is why perfectly preserved woolly mammoths have occasionally been found in these regions.

The sub-soil is often rich in minerals like nickel, copper and gold. However, these resources are only minimally exploited because they lie in such a remote and harsh environment. There is increased interest in pumping oil from the Arctic Ocean, but environmental problems remain an obstacle. Because the cold slows chemical and bacterial processes, pollutants in the North degrade much more slowly than in the South.

How are icebergs born?
Icebergs are majestic floating cathedrals of snow and ice — feared for the danger they present and, at the same time, admired for their stunning shapes and colours.

Where do icebergs come from? It all starts with glaciers. These mountains of snow get heavier and larger each year, as new layers of snow and ice are added to them. Slowly, over the years, they flow or slide towards the sea in a continuous process of melting and re-freezing. When they reach the water, huge chunks of ice — icebergs — break off, or calve, and drift with the ocean currents.

While icebergs may be beautiful, their danger to navigation is real (think of the Titanic, which sank after hitting one). Because of the difference between the density of water and that of ice, seven-eighths of any iceberg must lie below the surface of the ocean to let it float. It is this hidden, underwater mass that presents such a danger to sailors.

As icebergs melt, they slowly break into pieces that they leave in their wake. Before dissolving completely, an iceberg will travel thousands of kilometres (or miles). An iceberg that begins its journey at latitude 75° North near Baffin Bay could journey 4 000 km (2,486 miles) to a point 800 km (497 miles) south of St. John's, Newfoundland, in Canada. Occasionally, icebergs are spotted as far away as Bermuda and Ireland.

Glossary

[1] **Isotherm**:
A line connecting places that have the same average temperature.

[2] **Degree day:**
Difference, expressed in degrees, between the average daily temperature and the temperature at a particular reference point. This reference point has been set at 5° Celsius — the temperature at which most plants can function normally. So a day with an average temperature of 12° Celsius would have seven (12 minus 5) degree days.

[3] **Wind chill factor:**
Factor of perceived temperature adjustment based on the loss of heat caused by the outside temperature in conjunction with wind speed.

[4] **Refraction:**
The change of angle when light travels from one medium (such as air) to another medium (such as ice or snow) at an oblique angle.

[5] **Morainic deposit:**
A deposit of rocky matter torn from the earth by the grinding action of a glacier, and then deposited elsewhere — often several kilometres (or miles) away. This kind of deposit is called glacial when it has been left by a glacier alone, and fluvio-glacial when it is swept along by water flowing from a melting glacier.

[6] **Substratum:**
Rocky matter in the ground mostly covered by deposits.

Activity

Finding the North

Goal:
To become familiar with the location, geography and seasons of the North

Materials:

1 globe

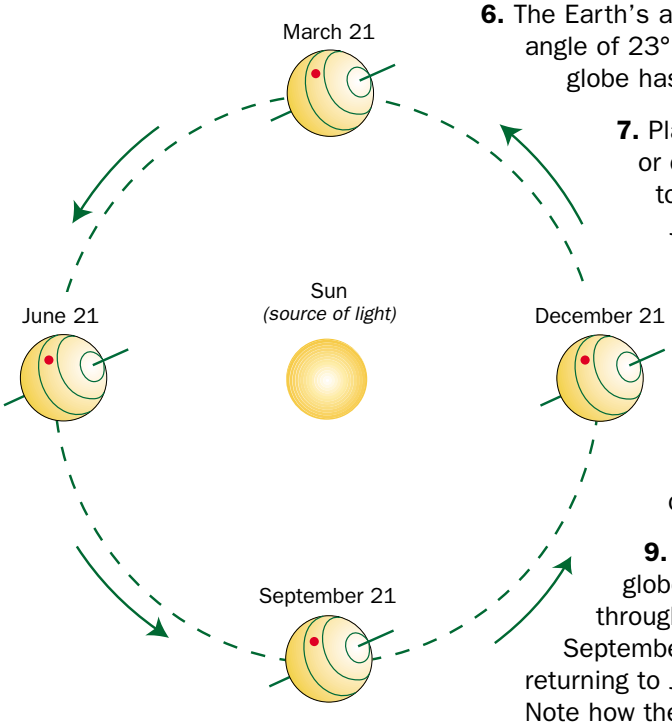
1 light source (light bulb or flashlight)

1 washable marker for drawing on the globe (optional)

1 map of the world or atlas (optional)

Directions:

1. On the globe, identify the rotational axis that passes through the poles. Then find the lines marking latitude and longitude. Latitude is shown by horizontal lines that divide the earth into slices and run perpendicular to the axis. Longitude is shown by lines that meet at the poles and divide the earth into pieces like the slices of an orange. For this activity, we are interested in latitude.
2. With your group, find latitude 0°, also known as the Equator. Everything above the Equator is calculated as degrees North; everything below it is calculated as degrees South. Degrees of latitude start at the Equator and the numbers get higher towards the poles. Find the lines that mark 30°, 60° and 90° North. The last one is just a point at the top of the globe. It is the North Pole.
3. Find the Arctic Circle, located at approximately 66° North. The line may not appear on your globe. If your globe does not show the Arctic Circle, use a felt pen to draw it in as a dotted line circling the globe at 66° North. The line should be parallel to the other lines of latitude and should brush the northern tip of Iceland (found between Europe and Greenland).
4. Find the following continents: North America, Europe and Asia.
5. Find the following countries, all of which include territory that lies within the Arctic Circle: Canada, the United States (Alaska), Denmark (Greenland), Iceland, Norway, Sweden, Finland and Russia.



Rotation of the Earth around the Sun

Let's Explore Some More:

6. The Earth's axis passes through the poles and leans at an angle of 23° relative to a vertical line. Make sure your globe has approximately the same angle.

7. Place your globe and a light source on a table or desk, so that they are in the same relation to each other as the Earth and the Sun on June 21 (see drawing at left). Turn off the lights in the room. If you are using a flashlight, point it at the globe to simulate the way the Earth is lit by the Sun.

8. Turn the globe slowly on its axis. You've just created day and night! Note how the light strikes one particular point on the globe (your region or country, for instance) during the course of one day.

9. It's time to explore the seasons! Move the globe around the source of light passing, in order, through the positions of the Earth and Sun on September 21, December 21 and March 21, before returning to June 21. You have just completed one year. Note how the light strikes one particular point on the globe throughout the year.

Questions:

What are the seasons like at the North Pole, at the Arctic Circle and where you live?

On June 21 and December 21, how long is the day at the North Pole, at the Arctic Circle and where you live?

What effect does the length of the days and nights have on the lives of people who live north of the Arctic Circle?

How would you fare in the Arctic days and seasons?

Resources

BOOKS

Lopez, B. 1986. **Arctic Dreams**. MacMillan. ISBN: 0333422449. 464 p.
Pielou, E.C. 1994. **A Naturalist's Guide to the Arctic**. U. of Chicago Press. ISBN: 0226668134. 327 p.
Taylor, B. 1995. **Arctic and Antarctic**. Eyewitness Books. ISBN: 0773728430. 64 p.

WEB SITES

Action des glaciers: www.ggl.ulaval.ca/personnel/bourque/s3/glaces.html
Arctic Circle: arcticcircle.uconn.edu
International Arctic Environment Data Directory: www.grida.no/add

