

# BCS 100: Introduction to the Circumpolar North

## University of the Arctic

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### MODULE 2: Northern Perceptions

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#### Overview

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The vast region of the circumpolar North includes

- portions of three continents, North America, Europe and Asia, and the world's largest island, Greenland;
- the Arctic Ocean basin and its marginal seas;
- an abundance of natural resources; and
- a vast array of indigenous peoples.

Various classification schemes have been promoted to define the boundaries of the Circumpolar North. Several of these classification schemes will be examined in this module with a view to developing an appreciation of the various approaches adopted by researchers to define the boundaries of the Circumpolar North.

#### Learning Objectives

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Upon completion of this module you should be able to:

1. Locate features on a map or globe using the co-ordinate grid system consisting of parallels of latitude and meridians of longitude.
2. Explain the concept of nordicity using the following criteria: astronomical, physical, biological, and cultural identity.
3. Compare the present biophysical and human socio-economic conditions in different parts of the North.
4. Map the boundaries of the subarctic zone and arctic zone as defined by the various concepts of nordicity.

#### Required Readings

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AMAP (Arctic Monitoring and Assessment Program). 1998. Chapter 2, Physical and Geographical Characteristics of the Arctic, p. 9-17. <http://www.amap.no/AAR-Ch02.pdf>

## Key Terms and Concepts

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- Air masses
- Arctic Circle
- Biome
- Ecosystem
- Isolines/Isotherms
- Meridian of longitude
- Nordic Index
- Nordicity
- Obliquity of the ecliptic
- Parallel of latitude
- Permafrost
- Prime meridian
- Treeline
- VAPO (Polar units)
- Water masses

## Learning Material

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### 2.1 Latitude and Longitude

Earth scientists examine phenomena that occur over a wide range of spatial scales above, on and beneath the Earth's surface. In order to describe these phenomena it is important to know where they occur in relation to the Earth's surface; a coordinate grid system is needed. Earth scientists use a co-ordinate grid system consisting of **parallels of latitude** and **meridians of longitude** to identify a position on the surface of the Earth. This coordinate grid system uses two fundamental reference lines for measuring the position of points on the Earth's surface: the **Equator** (a parallel of latitude) and the **Prime Meridian** (a meridian of longitude).

Lines of latitude circle the globe parallel to the Equator (Figure 1), which is called 0° North and South. Latitude measures the position of a given point north or south of the Equator. The North and South Poles are 90° North and South, respectively. There are 180 parallels of latitude, then, between the North and South poles. The spaces between parallels of latitude are measured in minutes (') and seconds ("). There are 60 minutes in a degree, just as with time, and 60 seconds in a minute. The format for writing positions of latitude is this: for example, 71° 17' 26" N (i.e. 71 degrees, 17 minutes, and 26 seconds north of the Equator.) With regards to latitude, the coordinate grid system is divided into broad latitude zones:

- *Equatorial zone* (10° North to 10° South)
- *Tropical zones* (10° to 25° North and South)
- *Subtropical zones* (25° to 35° North and South)

- *Mid-latitude zones* ( $35^{\circ}$  to  $55^{\circ}$  North and South)
- *Subarctic and Subantarctic zones* ( $55^{\circ}$  to  $66.5^{\circ}$  North and South)
- *Arctic and Antarctic zones* ( $66.5^{\circ}$  to  $90^{\circ}$  North and South)

Using this information we can define the circumpolar North as that portion of the Northern Hemisphere lying north of the  $55^{\text{th}}$  parallel of latitude. We will be making frequent reference to physical phenomena that occur within the latter two zones, the Subarctic and Arctic zones, throughout the module.

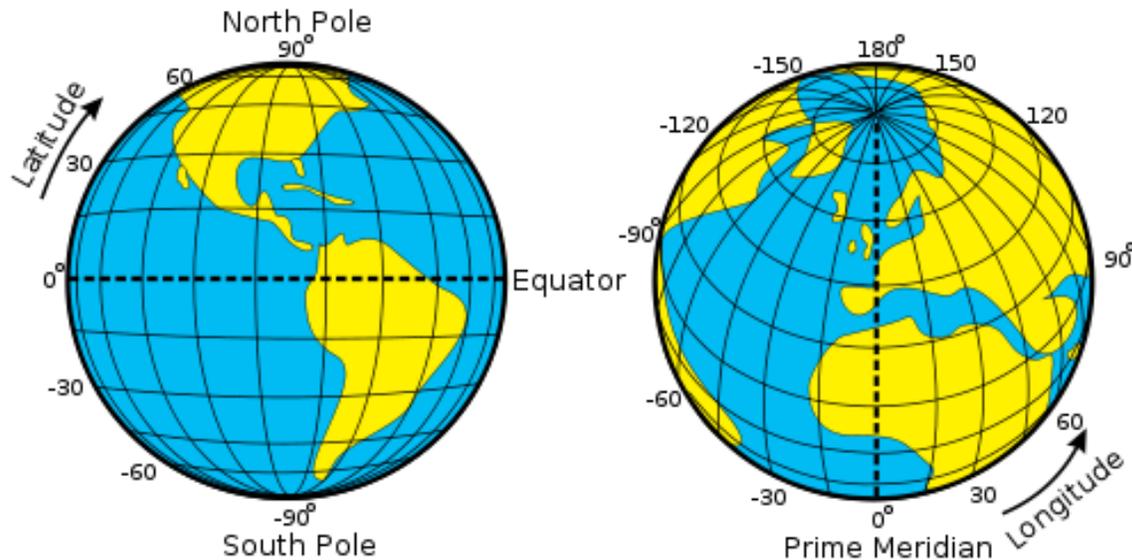


Figure 1: Illustration of the geographic grid consisting of parallels of latitude and meridians of longitude.

Source: [http://en.wikipedia.org/wiki/File:Latitude\\_and\\_Longitude\\_of\\_the\\_Earth.svg](http://en.wikipedia.org/wiki/File:Latitude_and_Longitude_of_the_Earth.svg) Public Domain.  
 Author: djexplo

Longitude measures the position of a point east or west of the Prime Meridian. This reference point is recognized internationally as that line extending from the North Pole to the South Pole that passes through the Royal Observatory at Greenwich, England. Meridians of longitude, unlike parallels of latitude, are not parallel to one another and converge at the poles. The meridians are labelled from  $0^{\circ}$  to  $180^{\circ}$  East of the Prime Meridian and  $0^{\circ}$  to  $180^{\circ}$  West of the Prime Meridian. The *International Date Line* lies on the  $180^{\circ}$  meridian and makes up the other half of the prime meridian. There are 360 meridians of longitude, all of which converge at the North and South Poles (Figure 1). The spaces between meridians of longitude are also measured in

#### Learning Activity 1: Location

1. Locate your community on a map and describe its location in degrees North and degrees East or West.
2. Locate on a map the place situated at  $71^{\circ} 17' 26''$  N.,  $156^{\circ} 47' 19''$  W. Where would you be at this location?

minutes and seconds. The format for writing positions of longitude is the same as for latitude: for example, 156° 47' 19" W (i.e. 156 degrees, 47 minutes, and 19 seconds west from the Prime Meridian).

To specify the location of a particular place on the globe, the position north or south of the Equator is given first, and the location east or west of the Prime Meridian is given second, in the form, 71° 17' 26" N., 156° 47' 19" W.

## 2.2 Earth-Sun Relations

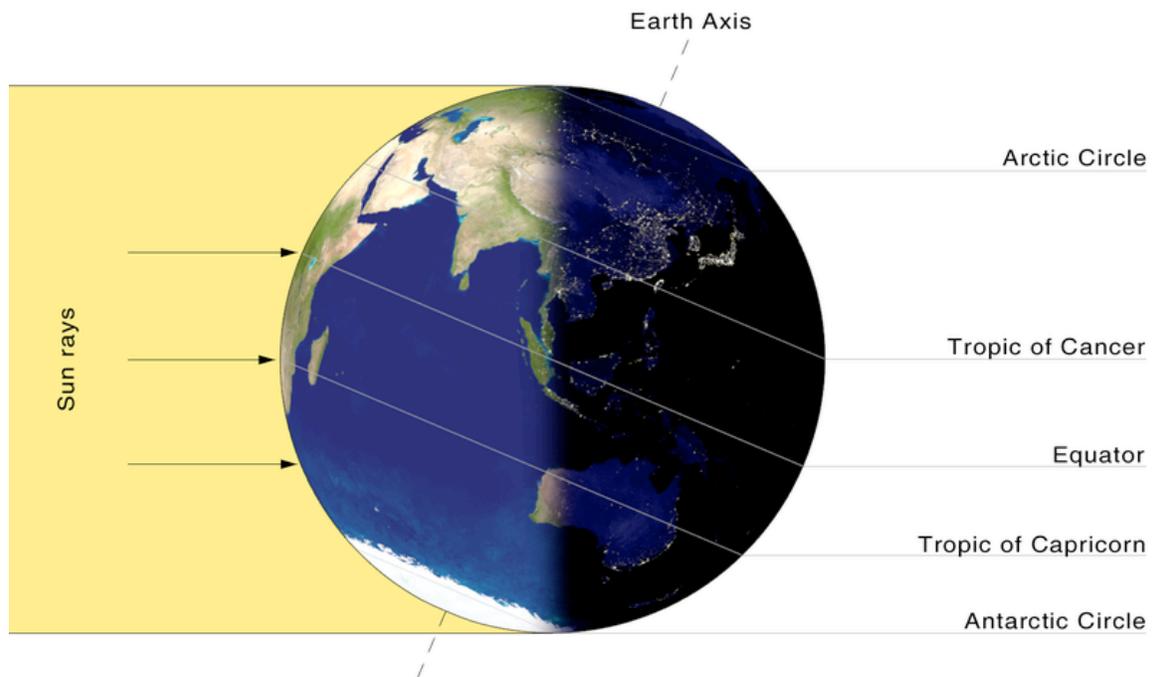


Figure 2: Solar illumination of the Earth's surface at the winter solstice (December 21). The arrows at the side of the figure indicate that the Sun's rays are tangent to the Earth's surface at the Arctic Circle at the time of the winter solstice.

Source: [http://es.wikipedia.org/wiki/Archivo:Earth-lighting-equinox\\_EN.png](http://es.wikipedia.org/wiki/Archivo:Earth-lighting-equinox_EN.png) Public Domain. Author: Przemyslaw "Blueshade" Idzkiewicz.

From the perspective of an astronomer or climatologist, it is the orientation of the Earth relative to the Sun and its influence on the input of energy from the Sun (**solar radiation** or **insolation**) to the Earth's atmosphere that is of greatest interest. Northern environments share these important characteristics:

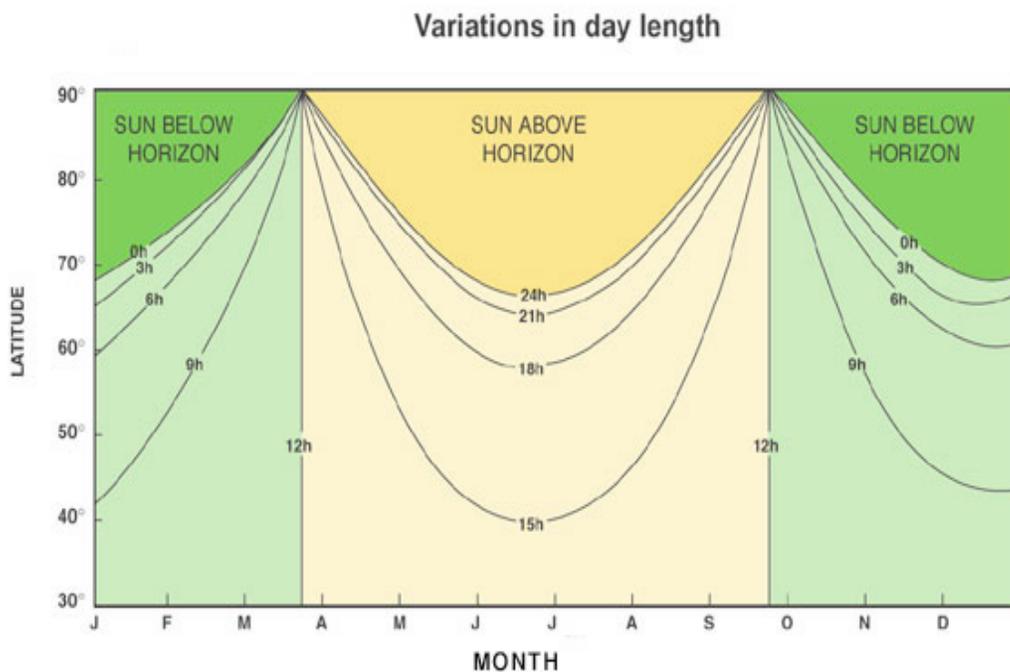
- They experience extreme seasonal variations in the receipt of solar radiation, and
- Only small quantities of energy are available at the surface of the Earth to do the work of melting snow and ice, thawing **permafrost**, warming the atmosphere in contact with the ground surface, evaporating water, and facilitating the processes of photosynthesis and transpiration within plants.

The tilt of the Earth's rotational axis, known as **obliquity**, together with the Earth's spherical shape causes the seasonal variations in day length and in the quantity of solar radiation that reaches the Earth's atmosphere. The obliquity of the ecliptic also provides the basis for the location of the **Arctic Circle** at  $66^{\circ} 33'$  North (Figure 2). The Arctic Circle is defined as:

- The point where the Sun's rays just touch (are tangent to) the Earth's surface at midnight at the summer solstice—the longest day of the year (June 21).
- The point where the Sun's rays just touch (are tangent to) the Earth's surface at noon at the winter solstice—the shortest day of the year (December 21).

In this context the Arctic Circle delineates a boundary separating arctic environments north of the Arctic Circle from subarctic environments south of the Arctic Circle.

In summer, the Northern Hemisphere is tilted towards the Sun, thus shortening the travel path for solar radiation to the Earth's atmosphere. This season also corresponds to the period of maximum day length: the period of the midnight sun above the Arctic Circle when the sun lies above the horizon throughout each and every day (see Figure 3). This combination of factors results in the maximum receipt of solar radiation in the subarctic and arctic zones during the Northern Hemisphere summer (see Figure 4).



**Figure 3: The influence of obliquity on the seasonal variation in day length, measured in hours, at various latitudes in the northern hemisphere.**

Source: Adapted from Hare, F.K. & Thomas, M.K. (1974). *Climate Canada*. Wiley Publishers of Canada, Toronto, p. 130. Posted with permission of the Copyright Clearance Centre for use in this course only. Resale or further copying or transmission of this material is strictly prohibited.

In winter, the Northern Hemisphere is tilted away from the sun, thus lengthening the travel path for solar radiation to the Earth's atmosphere. This season also corresponds to the period of minimum day length; the period of polar night above the Arctic Circle when the

sun lies below the horizon throughout each and every day (Figure 3). This combination of factors results in the minimum receipt of solar radiation in the subarctic and arctic zones during the Northern Hemisphere winter (Figure 4).

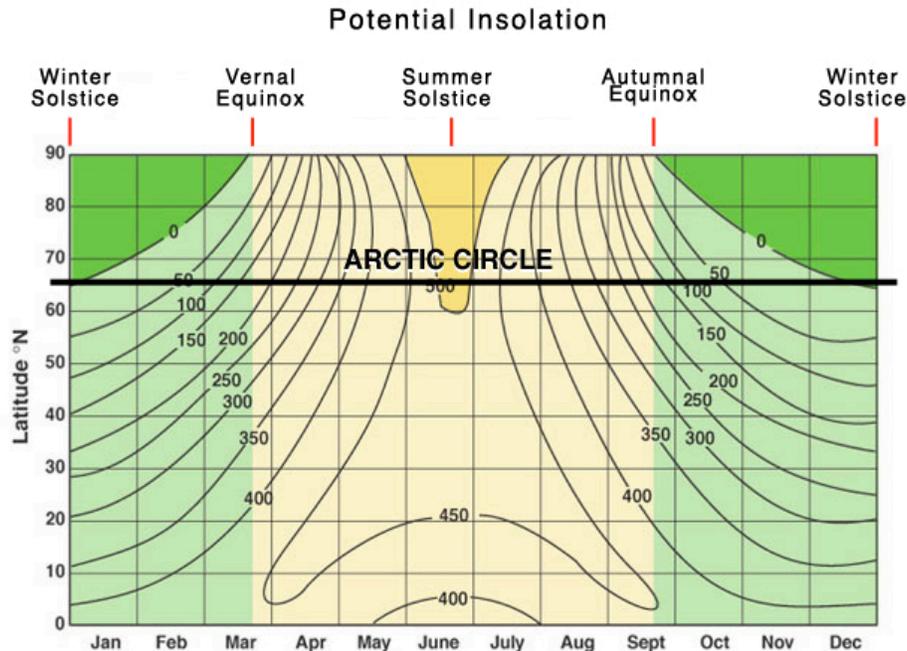


Figure 4: The influence of obliquity on the seasonal variation in the receipt of solar radiation at the outer surface of the atmosphere (potential insolation), measured in Watts per square meter ( $W/m^2$ ), at various latitudes in the northern hemisphere.

Source: Adapted from Rouse, W.R. (1993). "Chapter 3 Northern Climates." In H.M. French and O. Slaymaker (eds.) *Canada's Cold Environments*. After List, R.J. (1958). *Smithsonian Meteorological Tables*. Smithsonian Miscellaneous Collection, v114. Washington: Smithsonian Institution. E-journal at <http://www.silsi.edu/resources/> Creative Commons.

### Learning Activity: Seasonal Changes

Think about the place where you live and describe the changes in the environment that you observe during the transition from the autumnal equinox to the winter solstice, and the transition from the vernal equinox to the summer solstice.

The subarctic and arctic zones receive much less energy from the Sun on an annual basis than regions in the mid-latitudes and low latitudes. Several factors contribute to the low level of available energy at high latitudes. First, solar radiation must travel through a greater thickness of the Earth's atmosphere to reach the surface at high latitudes (Figure 5). This longer travel path for solar radiation results in the loss of energy via absorption and scattering within the atmosphere. Approximately 50 percent of the solar radiation that arrives at the surface of the Earth's atmosphere is actually received at the ground surface. Second, any given quantity of solar radiation received at the Earth's surface is dispersed over a greater surface area at high latitudes than at low latitudes due to the spherical shape of the Earth.

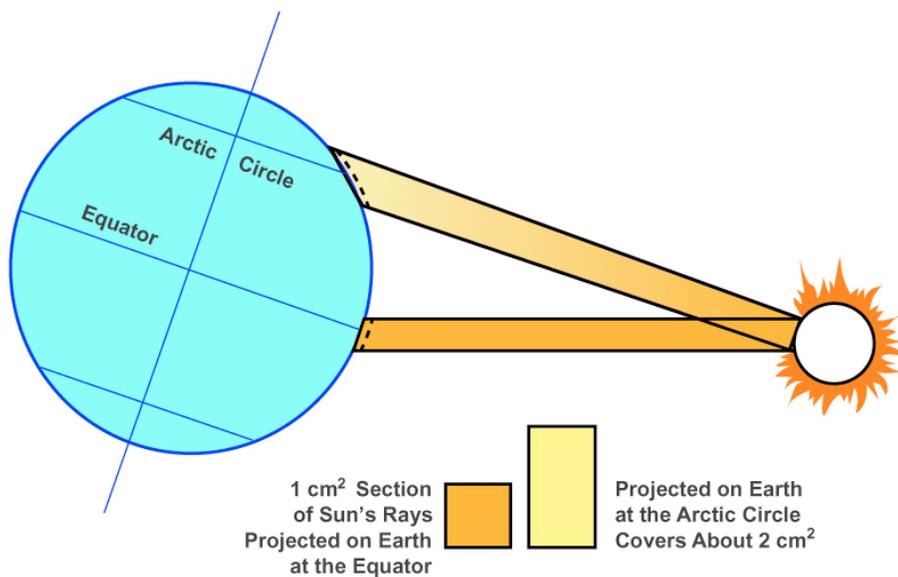


Figure 5: The influence of obliquity on the travel path of solar radiation through space and the intensity of solar radiation received at the equator and at the Arctic Circle.

Source: Young, S.B. (1989). *To the Arctic: An Introduction to the Far Northern World*. New York: John Wiley & Sons, Inc. Posted with permission of the author, Steven B. Young.

## Weather and Climate

From the perspective of geographers, variations in climate are of great interest in defining northern environments. Regional climates represent the average, long-term (i.e. greater than 30 years) weather patterns over the surface of the earth. Several environmental variables are employed to describe regional climates:

- variations in annual air temperature,
- variations in annual precipitation, and
- the winds in the atmosphere that affect the movement of **air masses** over land and sea.

Seasonal variations in air temperatures at high latitudes are influenced by changes in the input of solar radiation. The distribution of land and water influence the precipitation regime through their control of atmospheric humidity (i.e. water vapour content). The atmosphere over the oceans is moister than the atmosphere over the continents, reflecting the greater flux of water vapour from the ocean surface into the atmosphere. The precipitation regime is related to the humidity of various air masses in the atmosphere and their interaction under the influence of prevailing wind patterns near the earth's surface.

In this module, students should be familiar with the regional climates of the subarctic and arctic zones: the Boreal Forest climates of the subarctic zone, and the Tundra and Ice Sheet climates of the arctic zone. The seasonal variations in air temperatures associated with these regional climates are illustrated in Figure 6.

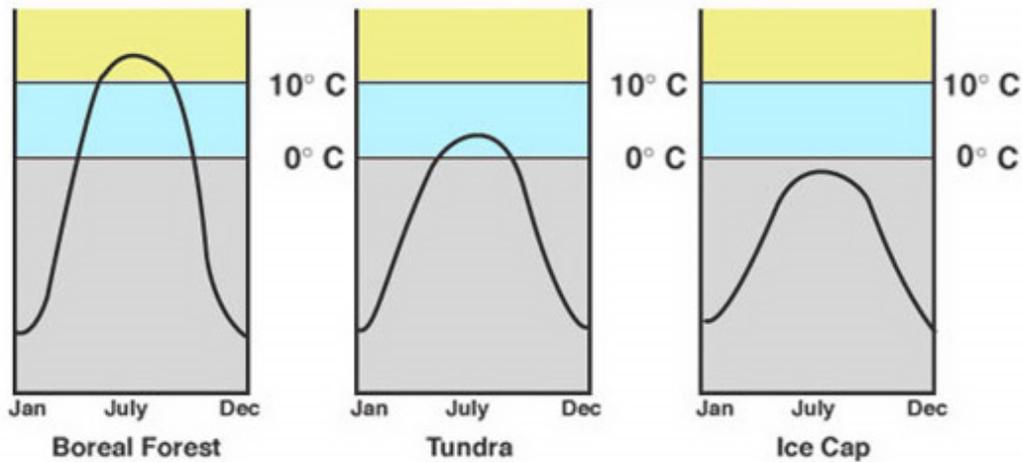


Figure 6: The seasonal variations in surface air temperatures for Boreal Forest (subarctic), Tundra (arctic), and Ice Cap (arctic) climate regions.

Source: Young, S.B. (1989). *To the Arctic: An Introduction to the Far Northern World*. New York: John Wiley & Sons, Inc. Posted with permission of the author, Steven B. Young.

The physical properties of air masses, specifically temperature and humidity, reflect the surfaces over which the air masses develop. Cold, continental air masses develop over land and the ice-covered surfaces of the Arctic Ocean. These air masses exhibit low humidity and have limited capacity to generate precipitation in the form of rain or snow. Arctic regions dominated by these air masses are characterized by low annual precipitation; for example, most of the Canadian Arctic Archipelago receives an annual mean precipitation less than 200 mm creating desert-like conditions (Figure 7). Cool, moist maritime air masses form over the Pacific and Atlantic Oceans north of 50° latitude. These air masses exhibit higher humidity and greater capacity to generate precipitation. The climate of the subarctic zone is more strongly influenced by these maritime air masses; annual mean precipitation varies from 300 mm to more than 700 mm across this region. Where mountains are situated adjacent to open water, large annual accumulations of snow occur and contribute to the development of glaciers at high altitudes.

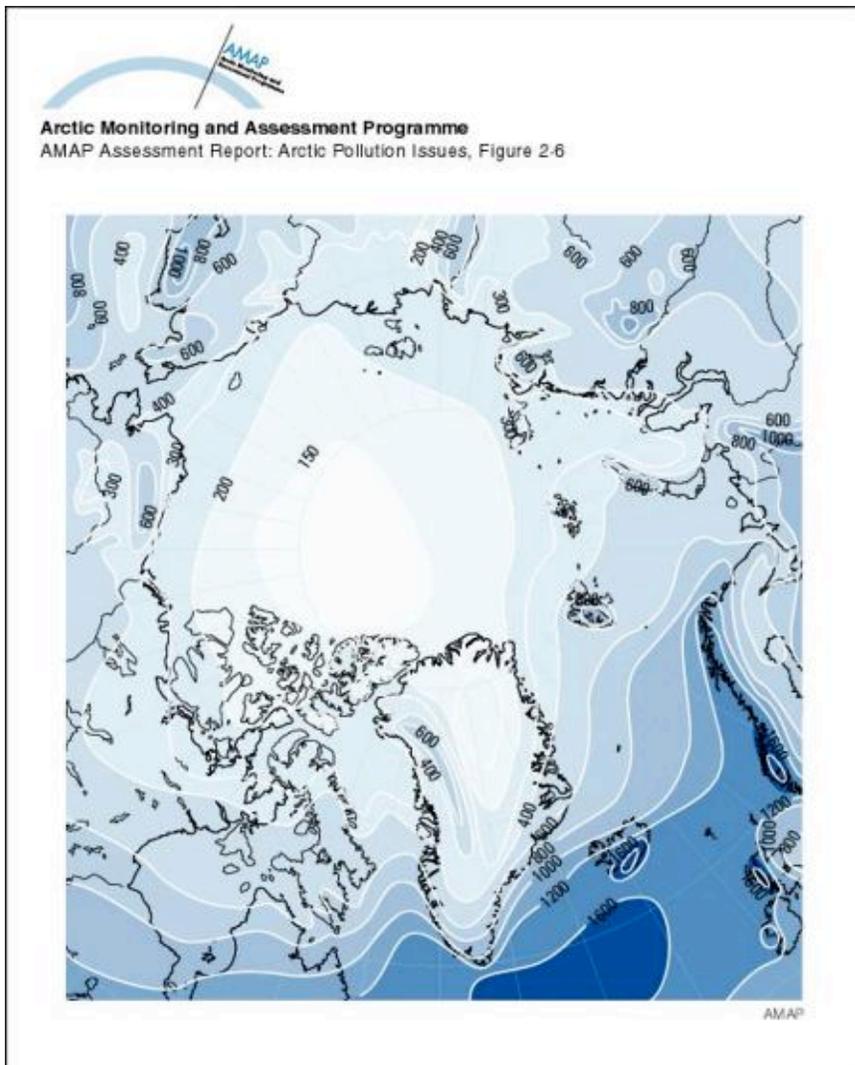


Figure 7: Annual mean precipitation (mm) in the circumpolar region.

Source: AMAP (1998). [www.amap.no](http://www.amap.no) Posted with permission.

## Biophysical Parameters

In addition to regional variations in weather and climate, geographers have also employed various biophysical parameters, such as the distribution of **permafrost** and **biomes**, to define the boundaries of the North.

### Permafrost

Permafrost refers to a thermal condition observed in soils, peat and rocks in which ground temperatures remain below 0°C for two or more consecutive years. The widespread occurrence of ice within frozen ground strongly influences landform development in northern landscapes. Geographers recognize several types of permafrost:

1. Continuous permafrost refers to an environment where more than 80% of the ground surface is underlain by permafrost. The southern limit of continuous permafrost corresponds closely to the  $-8^{\circ}\text{C}$  mean annual **isotherm** (which is derived from air temperatures). Landforms such as ice-wedge polygons (Figure 8) and pingos are associated with continuous permafrost.

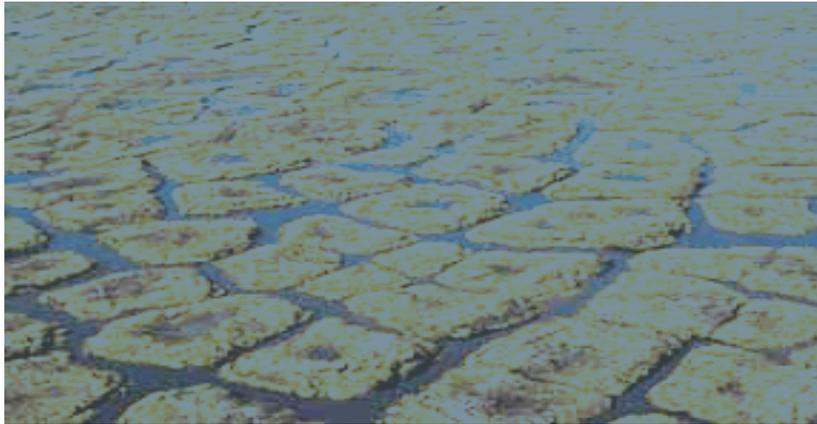


Figure 8: Ice-wedge polygons, Canadian Arctic Archipelago.

Source: *CAFF Status and Trends* (2001), p. 138. <http://arctic-council.org> Open Source.

2. Discontinuous permafrost refers to an environment where 30% to 80% of the ground surface is underlain by permafrost. The southern limit of discontinuous permafrost corresponds closely to the  $-1^{\circ}\text{C}$  mean annual isotherm. Landforms such as **palsas** and **peat plateaux** (Figure 9) are associated with discontinuous permafrost.



Figure 9: Palsas, Finland.

Source: *CAFF Status and Trends* (2001), p. 138. <http://arctic-council.org> Open Source.

3. Sporadic permafrost refers to an environment where less than 30% of the ground surface is underlain by permafrost. There is no commonly acknowledged thermal criterion for the southern boundary of sporadic permafrost. The presence of

sporadic permafrost is often dependent on the presence of organic soils that help preserve the permafrost under milder climates.

Continuous permafrost is associated with the arctic zone, while discontinuous permafrost is associated with the subarctic zone (Figure 10). The vast majority of permafrost is found in Russia, Canada and Alaska while Finland, Sweden, Norway (excluding Svalbard), and Iceland are largely devoid of permafrost.



Figure 10: Map of the circumpolar North illustrating the distribution of continuous and discontinuous permafrost.

Source: AMAP (1998). [www.amap.no](http://www.amap.no) Posted with permission.

### 2.3 Nordicity and Social Science

Louis-Edmond Hamelin, a Canadian geographer, coined the term “**nordicity**,” which means the state or quality of being northern. Although the word is most widely used in Canada and the United States, it is an appropriate term for use in this class because of its broad application across disciplinary boundaries including politics, society, the economy, astronomy, physical geography and biology. Up until now, we have defined the “North” in terms of geography. We now introduce the North from a social science perspective.

So, what does it mean to be “northern”? The label “northern” or nordicity are both very broad terms and despite being intuitively understood, they are imprecise and could be

interpreted in different ways. In terms of identity, one could say that nordicity is subjective. It is partly about self-identification; about feeling like or describing oneself as a northerner. Some components of this identification have to do with geographical settings including darkness and light, climate, and sparse populations. Additionally, identifying as northern has to do with culture and is affected by the use of nature and natural resources, traditional foods, language, and ethnicity.

Places, such as the United States and Canada, decide who northerners are by internal political boundaries. If you live in the state of Alaska or in one of the three northern territories in Canada (Yukon, the Northwest Territories, or Nunavut), you are considered a northerner. There is also an artificial line drawn across Canada, above which, is considered the North. It is interesting to note that the majority of Canada's population lives south of this line along the United States border.

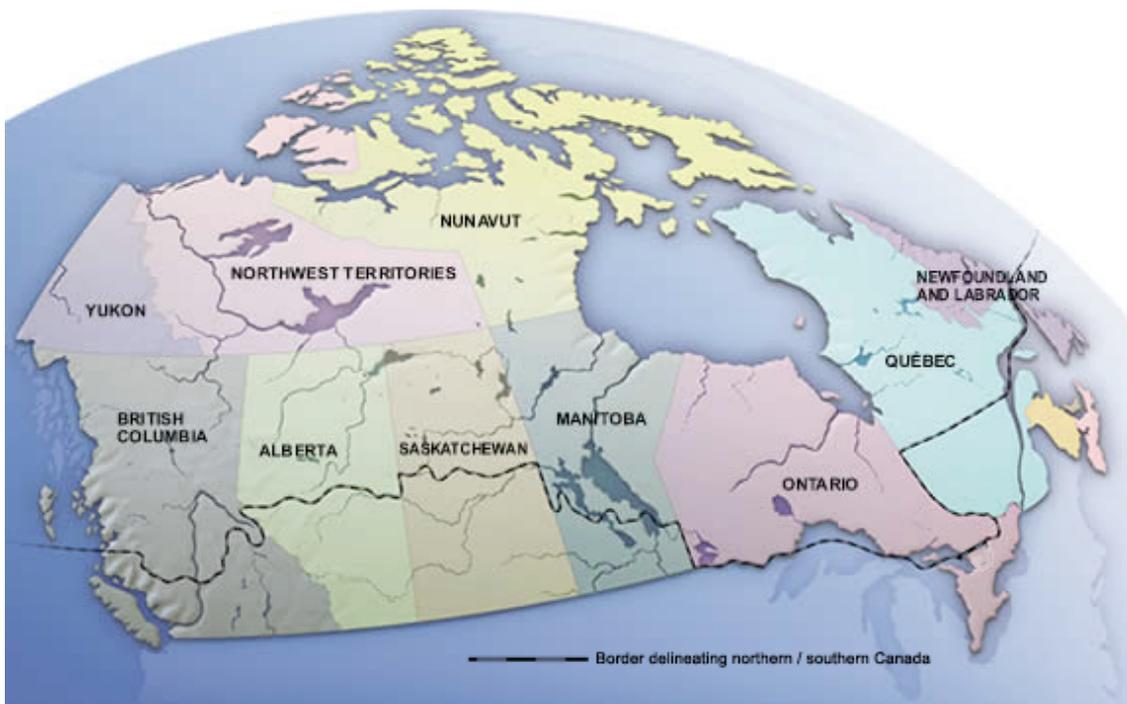


Figure 11: Map of Canada delineating the North from the South.

Source: Focus North [www.aandc-aadnc.gc.ca](http://www.aandc-aadnc.gc.ca) Public Domain.

Furthermore, what is especially interesting about this map is that much more than half of Canada's landmass is northern (See Figure 11). Indeed, according to this map about 90% of Ontario is considered "northern" including areas south of the 49th parallel.

In northern Europe, political boundaries are also used to delineate the north and in 1993 the Barents Euro-Arctic Region was created, which is made up of the thirteen northernmost districts of Norway (Finnmark, Nordland and Troms), Sweden, Finland (Kainuu, Lapland and Oulu Region), and northwest Russia (Arkhangelsk, Karelia, Komi, Murmansk and Nenets). Cooperation in the Barents Region is organized on two levels. At the government

level the Barents Euro-Arctic Council (BEAC) operates as a forum for the foreign ministers of the four nations and there is also a regional council with participation from the thirteen member districts and a representative from the Indigenous people in the region. (<http://www.beac.st>)



Figure 12: Barents region map of northern Scandinavia, Finland and Russia.

Source: <http://www.barentsinfo.org> Arctic Centre, University of Lapland. Posted with permission.

Consider Norway. Historically, only the three northernmost counties have been considered northern. However, compared to the Canadian North, the whole of Norway could be said to be northern in geographic terms. In this region, the dialects differ from those in the south; coastal life and the use of coastal resources are more dominant; industrial life and the economy of the region have been more based on natural resources; and the region has a greater degree of ethnicity than further south.

Examining northern Russia, we find more distinct features of a northern identity based on ethnicity and language. Important components of Russian nordicity include the vast diversity of indigenous peoples, their culture and customs, and similar economic conditions and resources to those in Canada and the Nordic-Barents region (see Figure 12).

The north is rich with natural resources that have, to a great degree, been exploited by the south. Industrial development has been driven from southern economic actors, state or private, having access to investment capital, technology and infrastructure. Many northern

cities grew in response to the need for labour in the natural resource sectors such as mining, whaling, fishing and forestry, and subsequently with the addition of military and administrative personnel.

The Circumpolar North today is a mixture of different and diverse economic adaptations, ranging from rural to city life. However, there is a strong north-south dimension in the northern economy, linked to its richness of natural resources, both renewable and non-renewable.

## 2.4 Terrestrial and Marine Biomes

Ecologists and biogeographers have examined the influence of air masses and **water masses** on the distribution of **biomes** to define the boundaries of the circumpolar North. Biomes are large, stable **ecosystems** characterized by specific plant and animal communities. The term ecosystem refers to any self-sustaining association of plants and animals and their physical environment.

The **boreal forest biome** occupies the subarctic zone (Figure 13a). This biome is characterized by closed canopy, mixed forest vegetation consisting largely of deciduous, broadleaf trees (e.g. aspen, birch and poplar) and evergreen, needle leaf trees (e.g. fir, pine and spruce). Shrubs, herbs and mosses dominate the understory vegetation. The vegetation cover within this biome is gradually replaced northwards by **open lichen woodland** as the climate becomes harsher. In open lichen woodlands trees are spaced widely apart from one another and mosses and lichens dominate the understory vegetation. The **tundra biome** occupies the arctic zone. Shrubs, grasses, sedges, mosses and lichen characterize this biome; trees are absent (Figure 13b).



Figure 13a. Boreal forest biome.

Source: <http://en.wikipedia.org> Public Domain. Photo by Ted Heuer.



Figure 13b. Tundra biome in Greenland. Sydkapp in Scoresby Sund, East Greenland; skull of Muskox in the foreground; vegetation is mostly *Salix glauca*.

Source: <http://en.wikipedia.org> Public Domain. Photo by Hannes Grobe, AWI.

The boundaries of biomes are commonly correlated with climatological phenomena. The boundary separating boreal forest and tundra biomes corresponds closely to the boundary separating continuous and discontinuous permafrost terrain (i.e.  $-8^{\circ}\text{C}$  mean annual isotherm). The northernmost extent of the boreal forest biome is represented by the **treeline** and corresponds closely to the  $10^{\circ}\text{C}$  mean July isotherm (Figure 14).

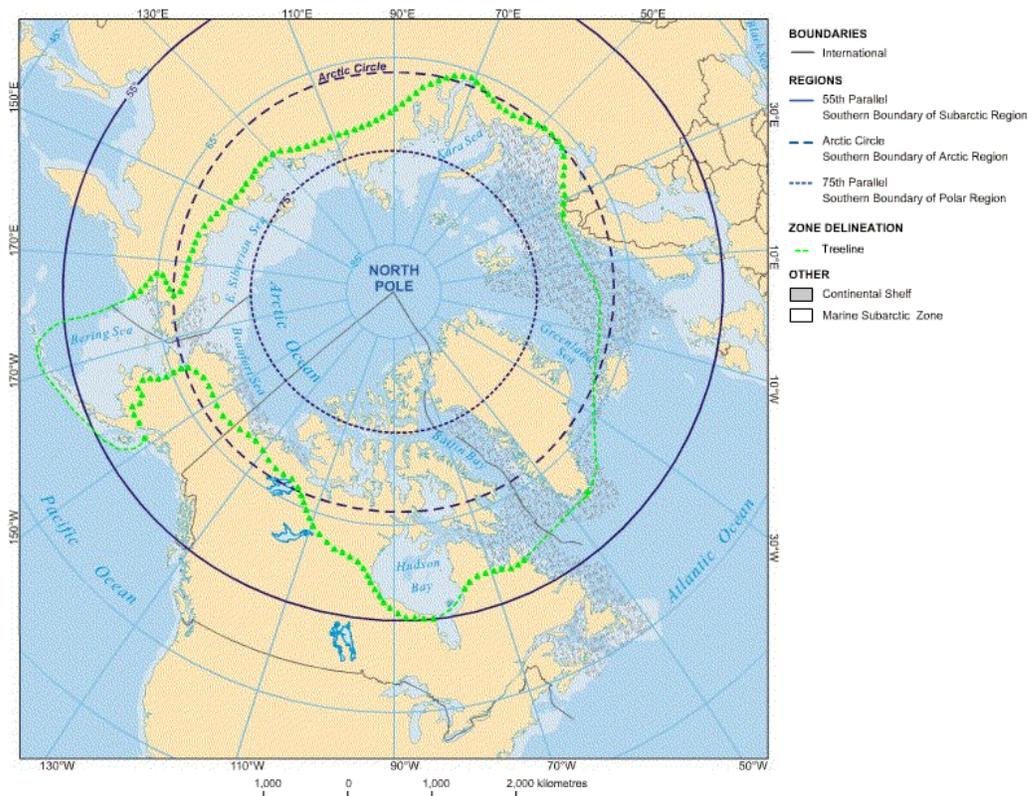


Figure 14. Map of the circumpolar North illustrating the treeline, marking the boundary.

Source: Elise Pietroniro, GIServices, University of Saskatchewan, Saskatoon, Canada.

The marine arctic zone is characterized by the permanent cover of multi-year sea ice (Figure 15) and surface waters exhibiting relatively low salinities and temperatures approaching the freezing point of seawater ( $\sim -2^{\circ}\text{C}$ ). The marine subarctic zone is characterized by the seasonal cover of annual sea ice and the mixing of cold, low salinity surface water derived from the Arctic Ocean with surface waters exhibiting relatively warm temperatures (i.e. above  $0^{\circ}\text{C}$ ) and high salinities derived from the North Pacific and North Atlantic oceans. Note that the boundary separating subarctic and arctic environments on land does not correspond with the boundary in the marine environment.

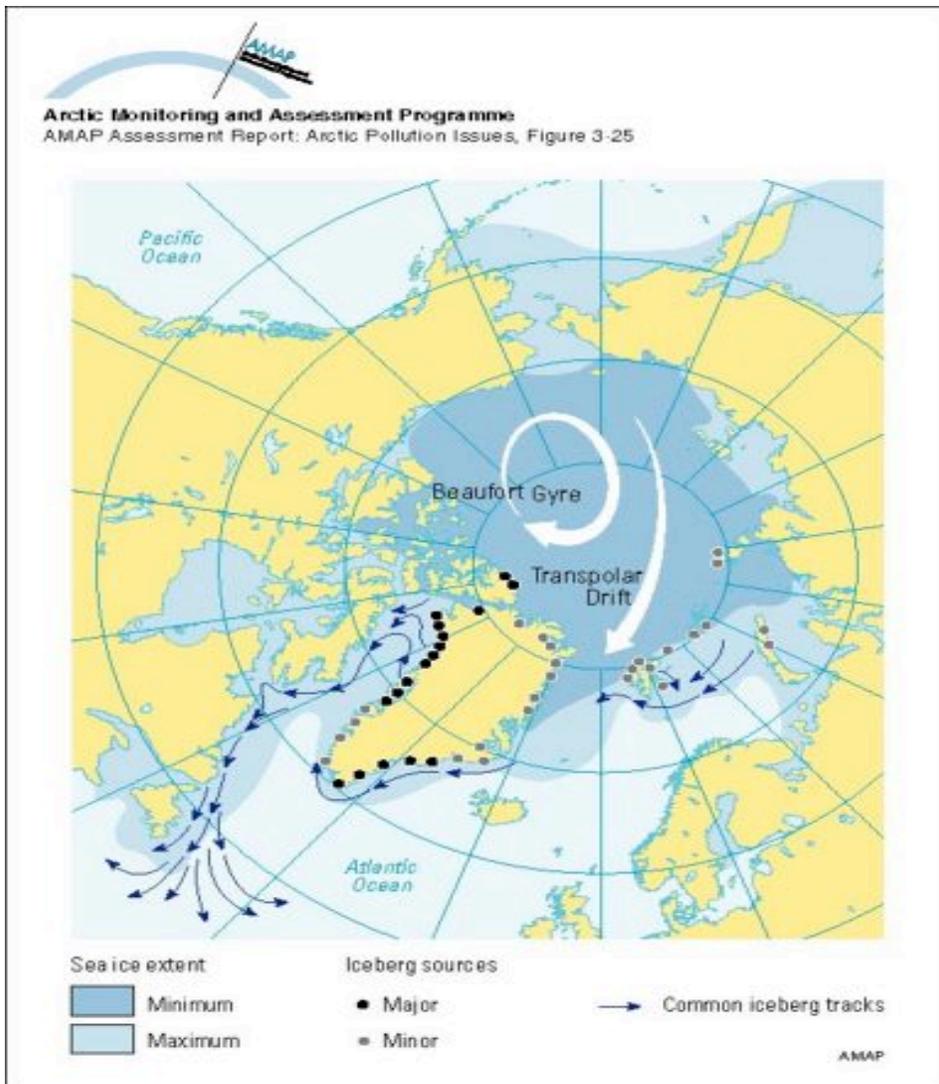


Figure 15. Map illustrating the maximum and minimum extent of sea ice, and the sources and trajectories for icebergs in the circumpolar North. The September ice edge (minimum ice extent) marks the distribution of multi-year sea ice and the boundary of the arctic marine zone. The March ice edge (maximum ice extent) marks the distribution of annual sea ice and the boundary of the subarctic marine zone.

Source: AMAP (1998). [www.amap.no](http://www.amap.no) Posted with permission.

## 2.5 Nordic Index

It is apparent, then, that using various criteria to delimit the boundary of the circumpolar North has yielded not a single comprehensive boundary but many different boundaries. Louis-Edmond Hamelin, the Canadian geographer mentioned earlier, recognized the complexity of the situation and proposed a comprehensive **Nordic index** based on a combination of biological, physical, demographic and economic development criteria; he did this to reflect the natural and human-modified characteristics of northern environments. The index is based on the calculation of **polar units (valeurs polaire: VAPO)** for each of ten criteria (Table 1). The range of values expressed in the Nordic index is illustrated in the following table.

Table 1. Summary table for the calculation of the northern index (after Hamelin, 1979).

Criteria	Minimum (VAPO = 0)	Maximum (VAPO = 100)
1. Latitude	45°N	90°N
2. Summer Heat	fewer than 150 days above 5.6°C	0 days above 5.6°C
3. Annual Cold	550 degree-days below 0°C	6650 degree-days below 0°C
4. Types of Ice		
4a. Frozen ground	Ground frozen for less than 1 month	Continuous permafrost more than 450 m thick
4b. Floating sea ice	Annual sea ice for less than 1 month	Permanent multi-year pack ice (Arctic Ocean)
4c. Glaciers and snow cover	Snow cover less than 2.5 cm thick	Ice sheet more than 1,500 m thick
5. Total precipitation	500 mm	100 mm
6. Natural vegetation cover	Rocky desert	Dense forest (needleleaf or broadleaf)
7. Accessibility other than by air (heavy transport, including water transport, pipeline and winter roads)	By more than two means of transport	No services
8. Air services (either private or government)	Regular daily service	Charter flights up to 1,600 km
9. Resident or wintering population		
9a. Inhabitants in settlement	More than 5,000	Fewer than 25
9b. Population density of an area of 250,000 km <sup>2</sup> (100,000 mi <sup>2</sup> )	4 persons per km <sup>2</sup>	Uninhabited
10. Degree of economic activity	Inter-regional centre with multiple services; significant monetary investment	No production

Each of the criteria is assigned a maximum value of 100 VAPO (polar units). The sum of the ten individual values gives the total degree of nordicity for the location under consideration. The maximum value of the Nordic index is 1000 VAPO and would correspond to the North Pole. Using the criteria for the Nordic index, Hamelin established regional subdivisions of the North: the Middle North bounded by **isolines** of 200 and 500 VAPO; the Far North bounded by isolines of 500 and 800 VAPO; and the Extreme North with a nordicity that exceeds 850 VAPO. The southern boundary of the Circumpolar North has an isoline of 200 VAPO.

## 2.6 Summary

No simple definition exists to define the North in a way that is relevant to all areas of scientific inquiry. Various disciplines in the natural and social sciences have posited criteria to define the concept of nordicity. Such criteria have been based on Earth-sun relationships, variations in climate parameters such as temperature and precipitation, the mixing of water masses in the oceans, and the nature of socio-economic development of regions and communities. Nordicity from a social perspective comprises features of a

northern identity built on history, natural resources, customs and cultures, and the effects of the north-south political and economic relationship. However, none of these criteria has proven entirely satisfactory. The Canadian geographer, Louis-Edmond Hamelin, has made a unique contribution to the study of the concept of nordicity through the development of a quantitative measure that he refers to as the Nordic index. This index is based on a combination of biological, physical, demographic and economic development criteria in order to reflect the natural and human-modified characteristics of northern environments. Using the criteria for the Nordic index, Hamelin established the southern boundary of the circumpolar North as an isoline of 200 VAPO (polar units).

## Study Questions

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*Answers to Study Questions 1 – 4 are at the end of this module.*

1. The quantity of energy received from the Sun at the Earth's surface depends upon . . .
  - a) The tilt of the Earth's rotational axis
  - b) The day length period
  - c) The latitude of the location on the surface
  - d) Only a) and c)
  - e) All of the above
2. The Arctic Circle is situated at \_\_\_\_\_ North \_\_\_\_\_.
  - a) 55°; latitude
  - b) 66°33'; longitude
  - c) 66°33'; latitude
  - d) 55°; longitude
  - e) 90°; latitude
3. The Arctic tundra environment is characterized by . . .
  - a) Summer temperatures less than 10°C
  - b) The absence of trees
  - c) The presence of continuous permafrost
  - d) a and b only
  - e) All of the above
4. The period of the midnight Sun above the Arctic Circle corresponds to the period between the \_\_\_\_\_ and the \_\_\_\_\_.
  - a) Winter solstice; summer solstice
  - b) Vernal equinox; autumnal equinox
  - c) Autumnal equinox; vernal equinox
  - d) Summer solstice; winter solstice
5. Examine Figure 7 that illustrates the distribution of annual precipitation in the circumpolar North. Some regions are characterized by high annual precipitation, notably the regions adjacent to the North Atlantic Ocean, the Norwegian Sea, and Barents Sea, while other regions are characterized by low annual precipitation, notably Greenland, the Canadian Arctic Archipelago, and the Arctic Ocean. Discuss

briefly the processes that contribute to these regional variations in annual precipitation.

6. Ice-wedge polygons are common landforms in regions underlain by continuous permafrost. Discuss briefly the processes that contribute to the development of these landforms. What types of plant communities are associated with these landforms?
7. Describe three key features of “nordicity” from a social science perspective. In your description, provide examples from the Circumpolar North.

## Glossary

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**Air masses:** Large volumes of air defined by temperature and water vapour content.

**Arctic Circle:** The parallel of latitude 66° 33' N., that forms an imaginary line around the Arctic region.

**Biome:** Climatically and geographically defined areas of similar climatic conditions such as communities of plants, animals, and soil organisms.

**Ecosystem:** a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the physical or abiotic factors of the environment.

**Isoline:** Any of several types of line on a map, chart or graph that links points having the same value.

**Isotherms:** A line of equal or constant temperature on a graph or chart, such as a weather map.

**Meridian of longitude:** The geographic coordinate most commonly used in cartography and global navigation for east-west measurement.

**Nordic Index:** A measure to define northern environments that uses a combination of biological, physical, demographic and economic development criteria.

**Nordicity:** The degree of northernness.

**Obliquity:** The element of the Earth's orbit that determines the amplitude of the seasonal variation of incident solar radiation.

**Palsa:** a peaty permafrost mound possessing a core of alternating layers of ice and peat or mineral soil material.

**Parallel of latitude:** The geographic coordinate most commonly used in cartography north-south measurement.

**Peat plateau:** a generally flat-topped expanse of peat, elevated above the general surface of a peatland, and containing ice lenses that may or may not extend downward into the underlying mineral soil.

**Permafrost:** Ground that is permanently frozen

**Treeline:** A Line that marks the upper limit of tree growth in mountains or northern latitudes.

**VAPO (Polar units):** A measurement based on ten criteria to measure the degree of nordicity of a location.

**Water masses:** large volumes of water defined by temperature and current.

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## Supplementary Readings

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## Answers to Study Questions

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*Answers to Study Questions 1 – 4 are as follows:*

1. e
2. c
3. e
4. b