



Be a Scientist!

Make a model to find out how melting ice and snow cover affect Earth's temperature. Use white paint to cover a round fruit such as an orange or grapefruit. The fruit represents Earth, while the white paint represents ice and snow cover. Paint a matching fruit dark brown and blue to represent exposed land and water. Carefully poke a hole into each fruit with a pencil or screwdriver. Gently push a thermometer into the hole in each fruit.

Place the fruits in a sunny spot and record their temperature every fifteen minutes for one hour. Which fruit warmed up more? Why? Think of ways to improve this experiment to better represent Earth's changing cryosphere, and then try it again.

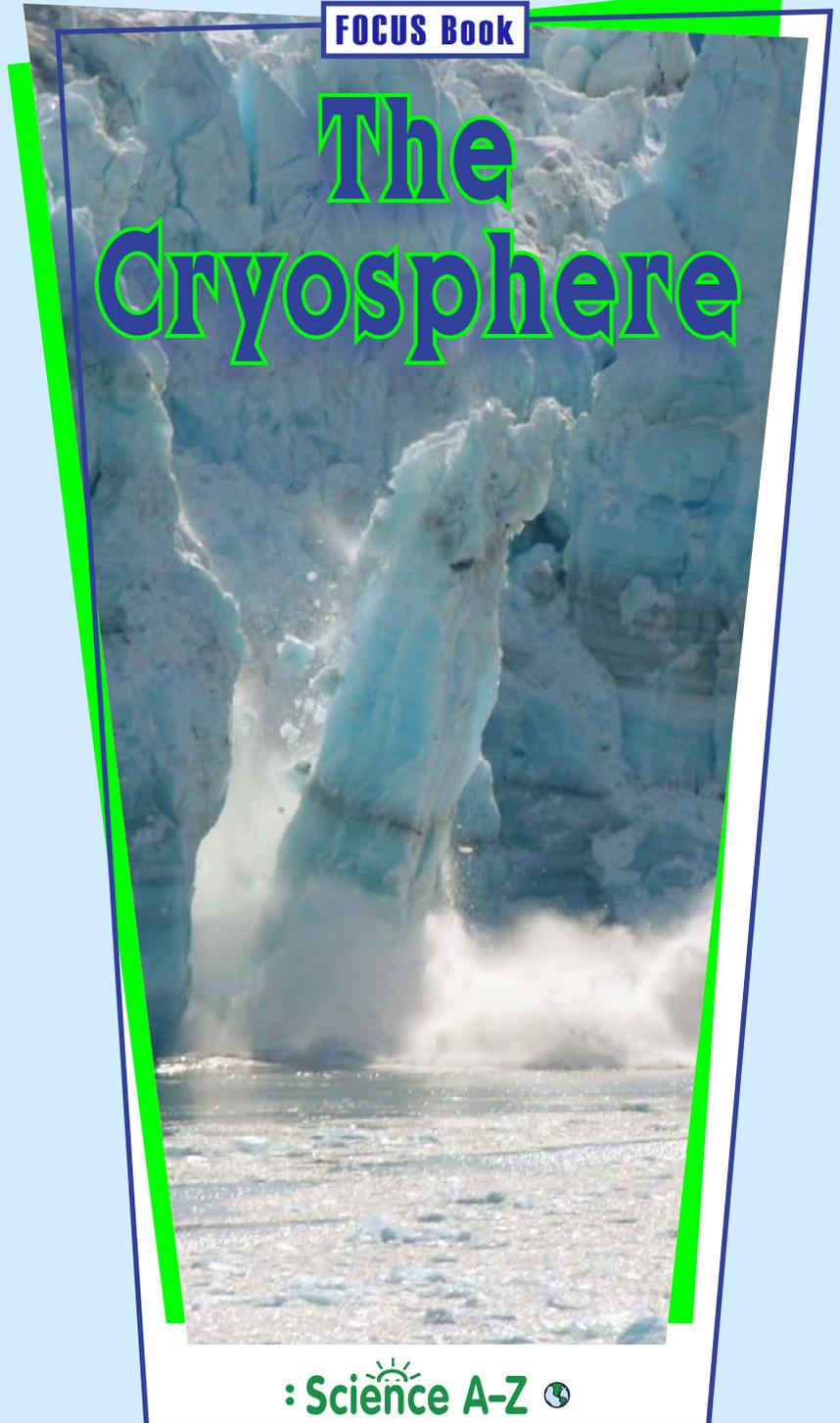


Beyond the Book

Use the Internet to find before-and-after images of glaciers. How have they been affected by climate change?

FOCUS Book

The Cryosphere



: Science A-Z 

The Cryosphere



FOCUS Question

What is the cryosphere, and why is it important to Earth?

Stability and Change

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Welcome to the Iceworld

The blue planet. The watery planet. The blue marble. Earth has earned these nicknames because it's covered by so much water, but most of it is salty ocean water. Only about 3 percent is fresh water. Surprisingly, most of that fresh water is locked up as solid ice.

Welcome to the icy *cryosphere* (KRY-oh-sfeer)—all the different types of frozen water on Earth. Its main components are glaciers, snow cover, floating ice, and permafrost. Bundle up and let's explore this iceworld.

Word Wise

The word cryosphere comes from the Greek language. *Kryos-* means "cold" and *-sphere* relates to Earth's round shape.



The cryosphere is part of the *geosphere*—the nonliving parts of Earth.

Glaciers

What rules the cryosphere? *Glaciers!* These icy giants are by far the main component of the cryosphere. Glaciers are slow-moving masses of ice and snow that occur in some of the coldest places on Earth. They are found in the Arctic region near the North Pole, in the Antarctic region near the South Pole, and high up in some mountains around the globe.

Ice sheets are a type of glacier that cover large areas of land near the poles. Another type of glacier is the *alpine glacier*. These glaciers form in low spots in and around mountains worldwide.



In the mountains of the western United States, you can find alpine glaciers such as Alaska's Worthington Glacier.



The largest glacier on Earth is the ice sheet covering eastern Antarctica. It is more than 4,200 meters (13,780 ft.) thick in some places.

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Ice can be ancient. Some glacial ice covering Antarctica has been there for almost a million years.

Snow Cover

Have you ever built a snowman or gone sledding? If so, you know snow—the softer side of the cryosphere. Snow is a form of frozen precipitation that covers the ground in polar and other cold regions during winter.

When the air cools to below freezing— 0°C (32°F)—water droplets in clouds form ice crystals called *snowflakes*. If the ground is also below freezing, falling snow can build up and cover the surface.

Unlike glaciers, snow cover is temporary, forming when it's cold and melting when it's warm. Snowmelt contributes to the flowing water in streams and rivers.



In Earth's middle latitudes, including most of the United States, snow cover usually occurs only in winter.



On some mountaintops and in places at high latitudes such as Northern Canada, snowfields occur year round.

Floating Ice

You can't ice-skate or play ice hockey without large areas of flat ice. In bodies of water, ice floats and stays at the surface because it is less dense than liquid water.

Most of Earth's floating ice is frozen ocean water called *sea ice*. Sea ice forms near the poles when salty ocean water freezes. Sea ice covers a vast area of Earth's surface—more than twice the size of Canada.



Sea ice occurs in both the Arctic and Antarctic regions all year. It grows larger in winter and shrinks in summer.

Icebergs are chunks of floating ice that form when pieces of glaciers near a coast break off and fall into the ocean. Unlike sea ice, icebergs are made of fresh water.

Floating ice also forms in lakes and rivers when the top layers of fresh water freeze in winter.



An iceberg floats in Glacier Bay National Park in Alaska.

Permafrost

Did you ever notice that the ground gets firmer when the temperature drops? When the weather is warm, liquid water fills up tiny spaces in the soil. When the temperature drops, the water freezes and so does the ground. The ground usually thaws in summer. But in places that don't have warm weather, the ground stays frozen all year long. Ground that is permanently frozen—or frozen for at least two years—is called *permafrost*.

Permafrost is only a small part of the cryosphere. Yet almost one-quarter of Earth's exposed ground contains permafrost. You can find it on high mountains, like the Rockies, and in the Arctic and Antarctic.



Interesting patterns and shapes can form in the ground when it freezes.



Living with the Cryosphere



The cryosphere matters to living things, including people!

❄️ It's a lifeline! Meltwater—liquid water from melting ice and snow—fills streams, rivers, and lakes. Plants and animals, including people, depend on this water. People use it for drinking, growing food, washing, and transportation.



❄️ It's powerful! Meltwater from glaciers is used to produce electricity in many countries around the world.



❄️ It cools the planet! The cryosphere helps make our planet a comfortable place to live.

❄️ It's home! For many organisms, ice, snow, or meltwater is their habitat.



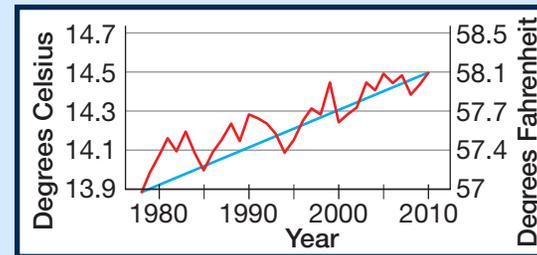
❄️ It's fun! We depend on ice and snow for sledding, ice skating, skiing, and snowball fights!

The Changing Cryosphere

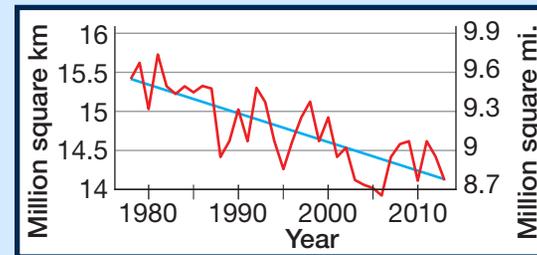
Newsflash: the cryosphere is melting! Scientists have evidence that climate change is to blame. As Earth gets warmer, more and more of the cryosphere melts. Melting glaciers add water and floating ice to oceans. Scientists predict that the sea level will rise up to 59 centimeters (23 in.) by the year 2100—enough to flood coastal lands and destroy numerous habitats.

Melting sea ice can also change ocean currents and coastal climates. When permafrost thaws, the frozen ground crumbles and habitats change. Thawing permafrost also releases gases that can cause more climate change.

AVERAGE GLOBAL TEMPERATURE



AVERAGE SEA ICE EXTENT



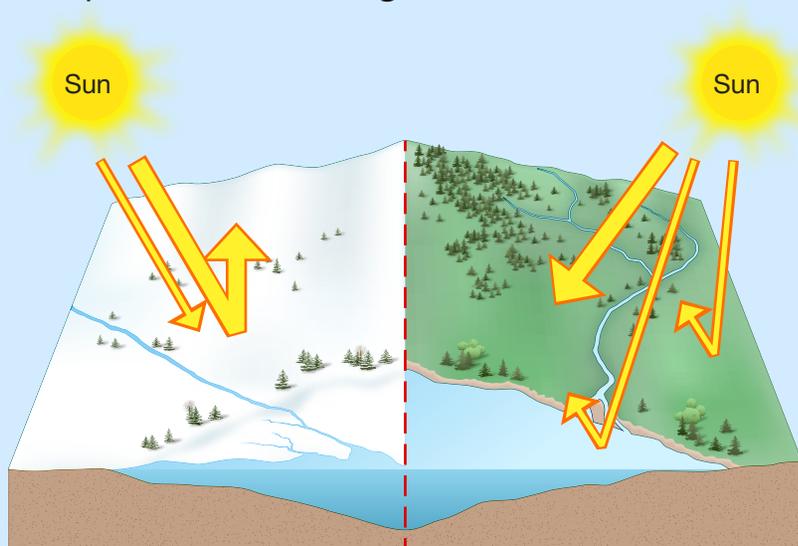
As the average global temperature increases, the amount of Arctic sea ice decreases.

Math Moment

Based on the first graph, would you expect the average global temperature in the year 2100 to be above or below 16°C? Why?

A melting cryosphere will also speed up climate change and cause even more melting. Light-colored ice and snow reflect much of the Sun's energy back to space. When ice and snow melt, more of Earth's darker-colored land and oceans are uncovered, thus absorbing more of the Sun's energy and heating up Earth.

The good news is you can help protect the cryosphere. When fuels such as coal and gasoline are burned, greenhouse gases are released into the air. This pollution adds to climate change by causing Earth to heat up. You can reduce pollution by turning down the heater in your home. You can walk or ride a bike instead of riding in a car. Small changes can help keep Earth a cool place to live for a long time.



Light-colored ice and snow reflect more and absorb less light energy. Darker land and water reflect less and absorb more energy.

Read-Think-Write

Write your answers on separate paper. Use details from the text as evidence.

- 1 About what percentage of Earth's water is fresh water?
 - A 3 percent
 - B 24 percent
 - C 75 percent
- 2 What are the four main components of the cryosphere discussed in this book?
- 3 How are glaciers and snow cover alike, and how are they different?
- 4 Look at the two satellite images of Arctic sea ice on page 5. Explain how the sea ice changes from the first image to the second and why.
- 5 California is thousands of miles south of the Arctic region. How can an ice sheet in the Arctic help keep a city in California cool?

FOCUS Question

What is the cryosphere, and why is it important to Earth? Choose two components of the cryosphere from the book. Explain the importance of each one to people and other living things.

