The Tools of Geography 1

1.1 Introduction

In the early 1800s, the United States was just beginning to expand west across North America. No American had ever crossed the territory that lay west of the Mississippi River. This vast area was mostly a mysterious blank space on the map.

To find out about this unknown territory, President Thomas Jefferson sent Meriwether Lewis and William Clark to explore the western frontier. Lewis and Clark led a team of explorers on a two-year expedition to the Pacific Ocean. The team mapped mountains and rivers as they crossed them. They collected samples of wildlife and plants that they had never seen before. The explorers also met the Native Americans of the West and learned how they lived.

In many ways, today's geographers are explorers like Lewis and Clark. They study the natural features of the land, the sea, and even the sky above. They try to understand the way people interact with the world around them. For example, they look at where people choose to live and why. They study the way people use Earth's resources, such as forests, water, and minerals. They explore the advantages that come with living in cities or in the country. Often geographers use maps as a basic tool for recording information and making new discoveries.

In this chapter, you will learn how to use different kinds of maps. You will see how maps can illustrate information about people and places on Earth. You will then put these tools to use in your own study of geography.

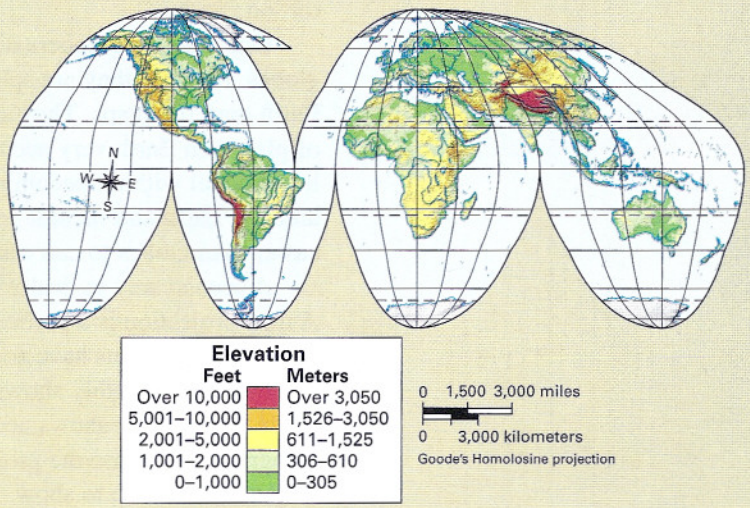
Essential Question

How do geographers show information on maps?

A geographer made this map to show information about the world. The words, lines, and symbols are clues from the geographer to help you make sense of the map. Keep this map and its clues in mind as you try to answer the Essential Question.

Graphic Organizer

Physical Features of the World



◀ Antique map and sundial compass

1.2 The Geographic Setting

In September 1805, the Lewis and Clark expedition crossed the Rocky Mountains on the way to the Pacific Ocean. Lewis and Clark wanted to explore the Columbia River, which could take them to the ocean, but they didn't know how to find it. A Native American chief named Twisted Hair came to the rescue. He drew a map on a white elk skin that showed the explorers how to reach the Columbia and indicated that the river was "five sleeps" away.

Today we still use maps to find the locations of places and determine how far apart they are. Like Twisted Hair's drawing, the most basic map is a diagram that shows what is where.

Locating Things on Earth: The Main Purpose of Maps For geographers, maps are tools that show where things are on Earth. With these tools, we can find the **absolute location** of any place in the world. Every feature is located at a precise, or absolute, point on Earth, and there are many ways to describe this precise point. Your street address, for example, indicates the absolute location of your home. Later in this chapter, you'll learn how a grid, or system of lines, can be used to show the absolute location of places on a map.

Maps also show the **relative location** of places on Earth. This is the location of one place compared to another. For instance, one place might be located east or west of another one. You probably use relative location when you give someone directions. Suppose you want to tell a friend how to locate the street where you live. You might tell her to proceed along a main street and then turn right one block past the park. With these directions, you would be telling her your street's location relative to a place she knows well.

Distortion: The Big Problem with Maps Maps are great tools, but they're not perfect pictures of Earth's surface. Maps are two-dimensional, or flat. In contrast, Earth is three-dimensional and shaped like a sphere, which is much like a basketball. The only way to show a spherical Earth on a flat map is by stretching some parts of it—a process that changes the shape, size, and position of Earth's features. These changes are called **distortion**. The photographs at the right show just how severe this distortion can be.

One way geographers deal with the problem of distortion is to use globes. Because they are spheres, globes are better models of the whole Earth than flat maps. They show the size, shape, distance, and direction of places on Earth very accurately. Unfortunately, globes cannot show a lot of detail without becoming huge. Maps, in contrast, can show smaller areas of Earth and include much more detail. In addition, maps are much easier than globes to carry around.

A second way to deal with distortion is to use **map projections**. A map projection is a particular way of showing Earth on a flat surface. All map projections have some kind of distortion. For example, one projection that accurately shows the sizes of places will distort their shapes, while another that shows accurate shapes will distort sizes and distances. Geographers choose the projection that best suits the kind of information they want the map to show.

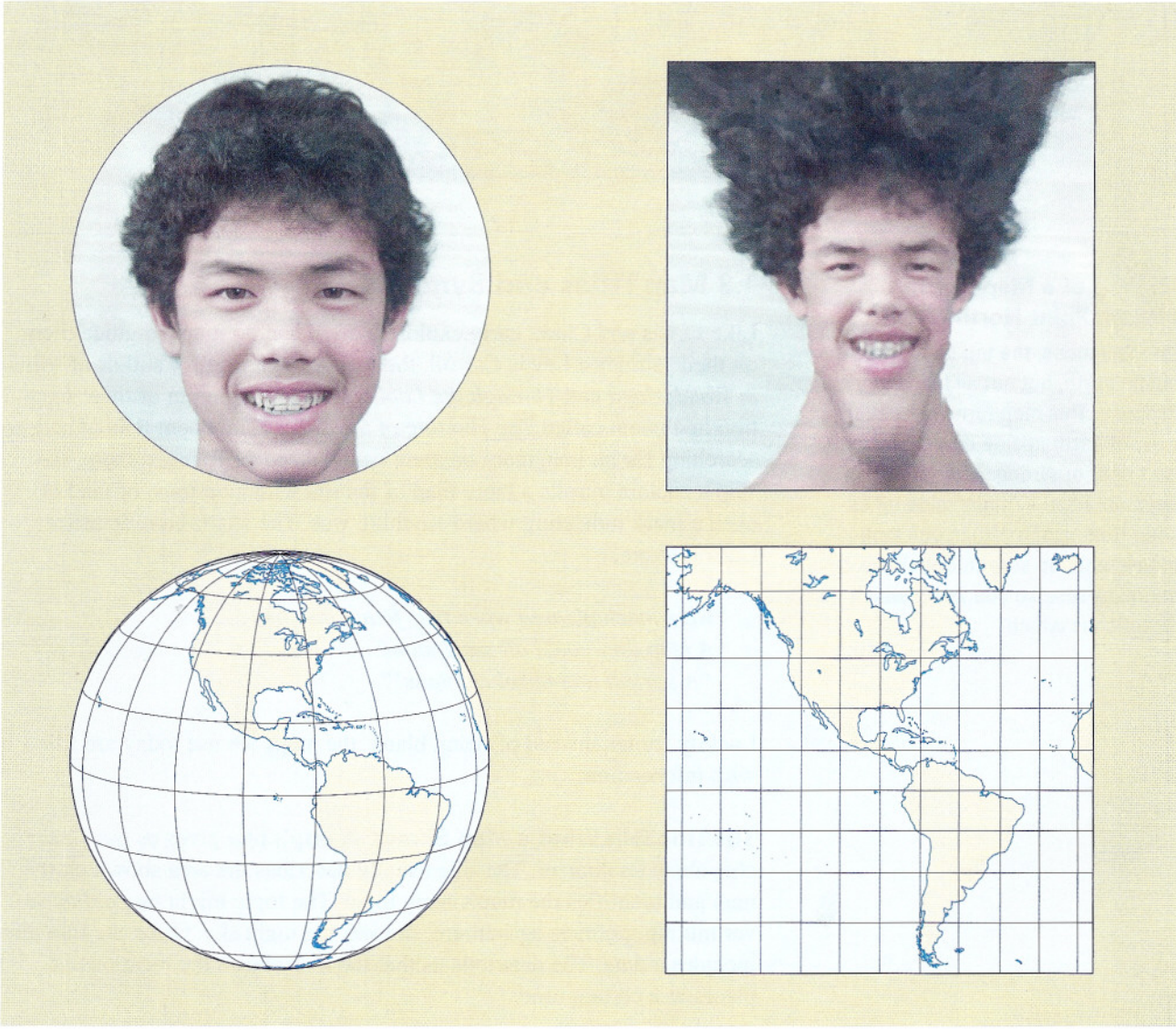
Geoterms

absolute location the precise point where a place is located on Earth

distortion a change in the shape, size, or position of a place when it is shown on a map

map projection a way of representing the spherical Earth on a flat surface

relative location where a place is located in relation to another place



Flattening a Sphere Distorts Features

A person's head is shaped almost like a sphere. If you try to flatten a head, its features stretch and change shape. As a result, the person becomes almost unrecognizable. In a similar way, flat maps can distort information about Earth's features.

Political Boundaries of the World

The Top of a Map Doesn't Always Point North

On most maps, the top of the map points north, but not all maps work this way. This map turns our usual view of Earth upside down. The map isn't right or wrong. After all, Earth does not have a "right" side up as seen from space. When you look at any map, be sure to check the compass rose so you know which direction is which.

1.3 Map Titles and Symbols

Like Lewis and Clark, early explorers often had no maps to guide them on their journeys. Lewis Carroll, the well-known English author of *Alice in Wonderland* and *Through the Looking Glass,* made fun of their situation in a poem called *The Hunting of the Snark*. The poem tells of sailors searching for an imaginary creature called a *snark*. To assist them, the ship's captain unrolls a large map of the sea without a trace of land or even a mark indicating where anything was. The snark-hunting sailors, Carroll wrote,

> *were much pleased when they found it to be*
> *A map they could all understand....*
> *"A perfect and absolute blank!"*

Luckily for us, instead of being blank, the maps we use today are filled with information.

The Title Tells What a Map Shows A map's title gives us our first clue about its content. The title usually describes the area shown on the map and identifies the map's main topic. The topic might be gold or silver mining, politics, agriculture, or even the night sky. Often the title also includes a date. The date tells us that the map shows the locations of places at a certain time.

A Compass Rose Shows Directions on a Map Have you ever used a magnetic compass to find your way when you were lost and in a strange place? If so, you know that the needle of a compass always points in a northward direction—toward the North Pole. Knowing where north is can help you determine which way to go.

Mapmakers use a small diagram called a **compass rose** to indicate directions on a map. Because these diagrams often resembled a flower on early maps, sailors called this direction-finding tool a compass rose. It gave them courage to sail out of sight of land.

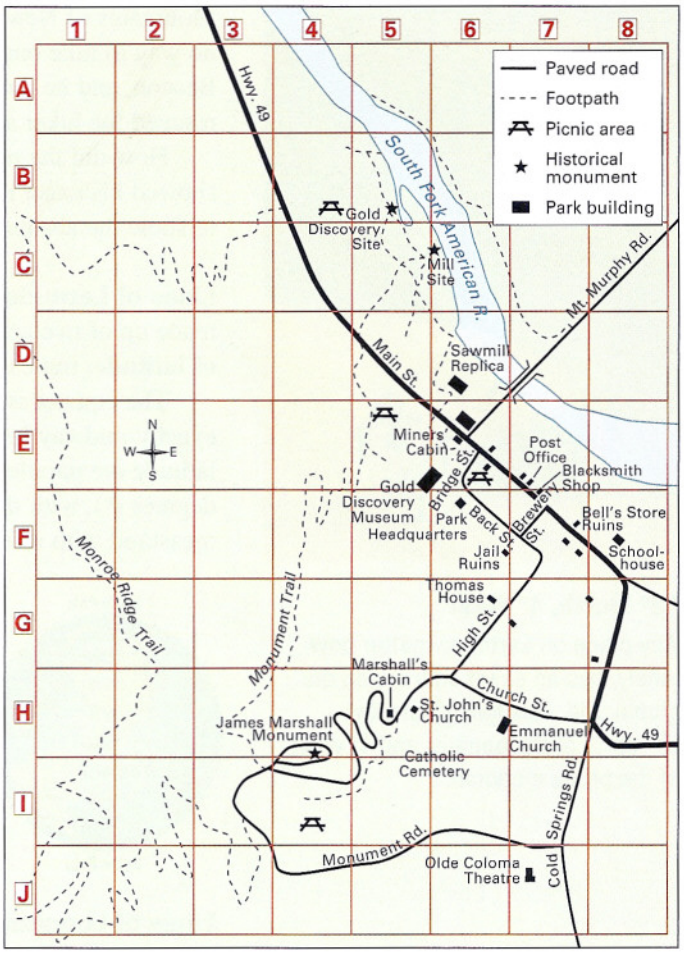
A simple compass rose has two short lines that cross at right angles. The points at the ends of the lines are labeled with the **cardinal directions**—north, south, east, and west. You can see such a compass rose on the map to the right. A more elaborate compass rose has lines between the cardinal points showing the **intermediate directions**—northeast, southeast, southwest, and northwest.

A Legend Identifies Symbols on a Map

A compass rose is one of many symbols used to show information on a map. Some symbols incorporate color to show features. Blue lines, for example, are symbols that indicate the locations of rivers; lakes and oceans are often colored blue as well. Other symbols use shapes to show information. A bold star is a common symbol for the capital of a state or country, while miniature airplanes are often used to show the locations of airports.

The symbols used on a map are usually identified in a box known as the **map legend,** or sometimes the **map key**. The map legend lists each symbol and explains what it shows on the map. The legend for the map on this page appears in the upper right corner.

Marshall Gold Discovery State Historic Park



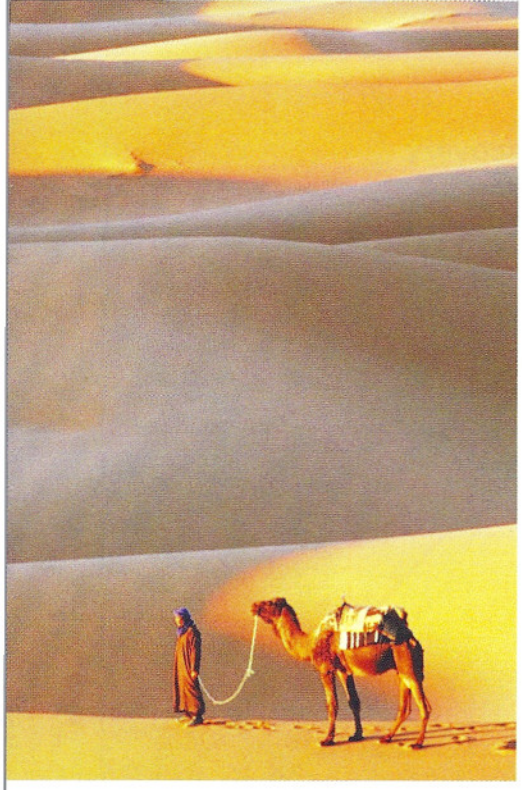
Using a Map's Title, Compass Rose, Legend, and Grid

You can use this map to tour a historic site. The map title tells which site you will be exploring. The compass rose shows which way north is on the map. The map legend tells you what the symbols on the map mean. Once you know what you want to visit, the map grid will help you locate it on the map.

A Grid Organizes Space on a Map Mapmakers often use a system of imaginary lines called a **map grid** to divide up space on their maps. You can see an example of a grid on the map above. To form this grid, the mapmaker drew a network of evenly spaced horizontal lines and vertical lines that meet at 90-degree angles. (Remember that horizontal lines go straight across, while vertical lines go up and down.)

Geographers make map grids useful by giving each line a label. For instance, on some maps the horizontal lines are labeled with letters and the vertical lines are labeled with numbers. Each number and letter identifies a particular section of the map. Once the grid has been labeled, a letter and number such as A9 or C3 can be used to specify the location of any place or feature on the map. The letter and number indicate the intersection of a horizontal and a vertical line on the map. Find the intersection of these two lines, and you will have found the place or feature you are looking for close by.

One very useful type of grid is the system of latitude and longitude. This **global grid** allows people to locate any point on Earth's surface with the use of a simple numeric code. You will learn more about the global grid in the next section.



32° North, 4° West

Any place on Earth, no matter how lonely, has an exact address on the global grid. This lonely spot lies 32° north of the equator and 4° west of the prime meridian.

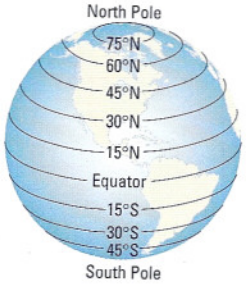
1.4 The Global Grid: Longitude and Latitude

In early November of 2003, a hiker set up camp high in the Adirondack Mountains of New York. Sudden, heavy snows trapped him there with no way to hike out. Luckily, the hiker had brought his Personal Locator Beacon, and he pressed a button to call for help. A helicopter crew soon rescued the hiker and flew him to safety.

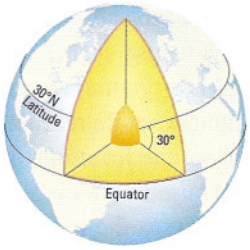
How did the rescuers find the stranded hiker? His locator beacon showed his exact location on the same global grid that geographers use to show the absolute location of every place on Earth.

Lines of Latitude Parallel the Equator The global grid system is made up of two sets of imaginary lines. The first set of lines, **parallels of latitude,** run east and west around the globe.

The equator is the most important parallel of latitude. It circles Earth exactly midway between the North and South poles. All other lines of latitude are parallel to the equator. Parallels of latitude are measured in degrees (°), with the equator marking 0° latitude. Other parallels are measured with reference to the equator.



Latitude Lines Run East to West



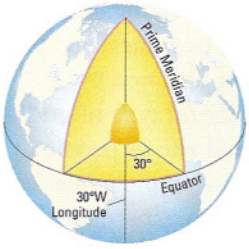
Latitude Is Measured from the Equator

Lines of Longitude Run from Pole to Pole The other set of lines in the global grid are half-circles, called **meridians of longitude,** that run from the North Pole to the South Pole. These lines are not parallel to each other, so the distance between them varies.

The most important of these north-south lines is the **prime meridian,** which runs through Greenwich, England. Like parallels of latitude, meridians are measured in degrees, with the prime meridian marking 0° longitude. The prime meridian is a reference for measuring other meridians.

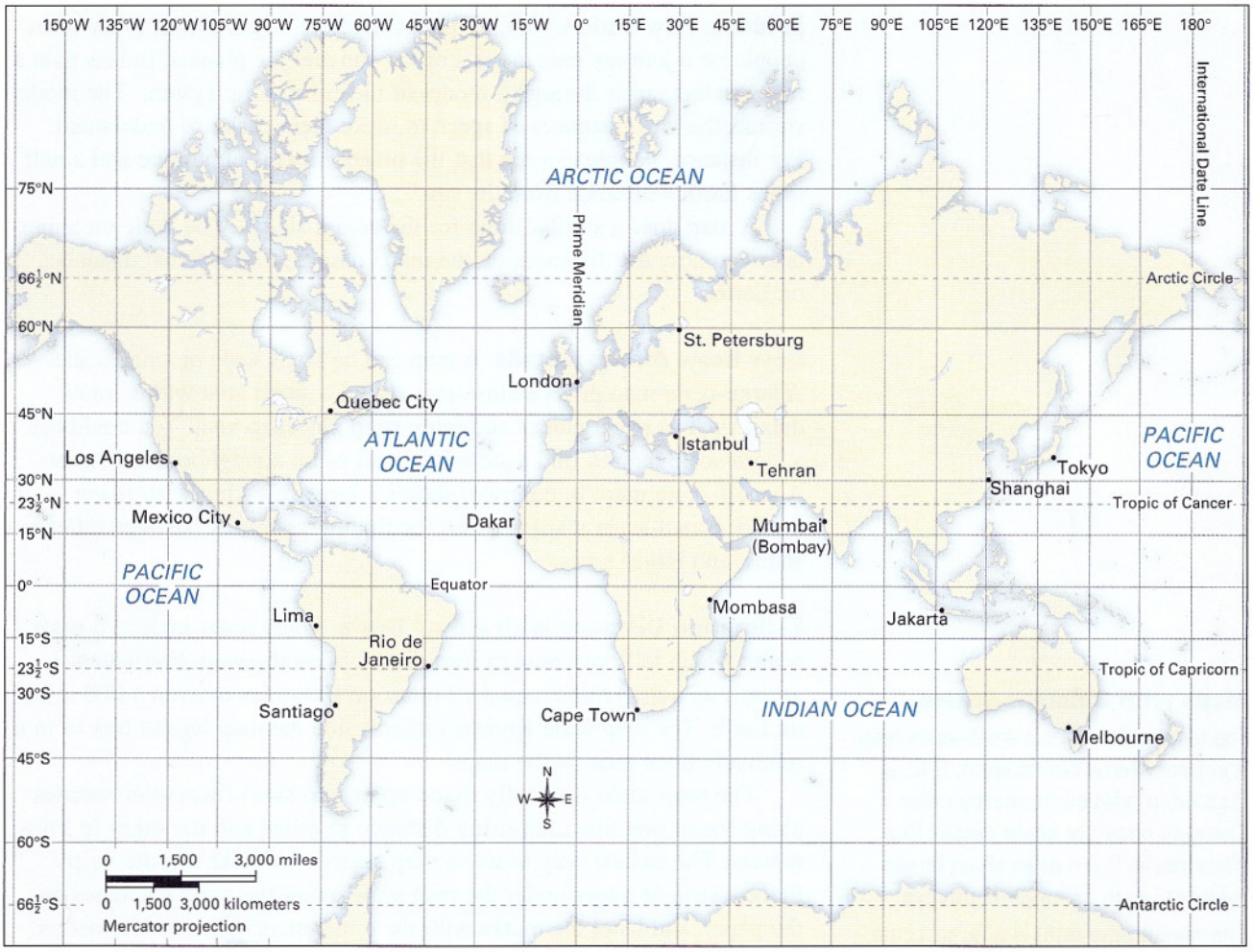
The next most important meridian is the **International Date Line.** This line runs though the Pacific Ocean exactly halfway around the world from the prime meridian. When travelers cross the International Date Line, they cross over to a different day. Travelers moving west across the line go forward a day, while those traveling east across the line go back a day.

Longitude Lines Run North to South



Longitude Is Measured from the Prime Meridian

Cities Around the World



Latitude and Longitude Mark Absolute Location The numbering system of the global grid helps make it easy for you to locate any place on Earth.

Moving north from the equator, the parallels of latitude increase in number from 0° up to 90°N (north) at the North Pole. A similar thing happens moving south of the equator, where the numbers of the parallels increase from 0° to 90°S (south) at the South Pole. One degree of latitude covers about 69 miles, or 111 kilometers.

Meridians of longitude start from 0° at the prime meridian. Traveling east from there, the numbers on lines of longitude increase until they reach 180° at the International Date Line. These numbers are labeled E (east). The same thing occurs going west from the prime meridian. The numbers increase until they reach 180° at the date line and are labeled W (west).

The absolute location of any place on Earth can be described as the meeting point of a parallel of latitude and a meridian of longitude. The numbers of these lines are the geographic **coordinates** of a place. These coordinates are like a street address for your house. They tell exactly where that place is located.

The Absolute Location of Cities

Latitude and longitude mark the absolute location of cities. The coordinates of Rio de Janeiro are 23°S, 43°W. To find this location, look for the parallel of latitude that is 23 degrees south of the equator. Move your finger along it until you come to the prime meridian. Now move west along the same line until you reach 43 degrees. You should be pointing to Rio de Janeiro.

1.5 Dealing with Distances: Map Scale

In Ithaca, New York, a winding path called the Sagan Planet Walk takes people on a journey past models of the sun and the planets. In less than a mile, walkers pass through a model of the entire solar system. The model shrinks the vast distances of space to make them easier to understand. For instance, people can see that the planet Mars is about one and a half times Earth's distance from the sun.

A map does a similar thing for the area it shows. The scale on a map tells you how the distances on the map compare to the actual distances on Earth.

How Scale Affects Details A map can be large scale or small scale. A large-scale map gives a close-up view of a small area with a lot of detail such as street names and interesting places to visit. You could use a large-scale map to find a store in a mall or on a neighborhood street. A small-scale map, in contrast, shows a larger area but with fewer details. Small-scale maps are best for finding your way between cities, states, and larger areas.

Estimating Distance with a Map Scale Many maps include a **map scale,** which tells you how to read distances on the map. For instance, an inch on a map might equal 10 miles or 100 miles or even 1,000 miles on Earth. The map scale appears either inside the map legend box or in a relatively open area on the map.

The map scale is usually made up of two short lines with notches along them, one line measuring distance in miles and the other in kilometers. The easiest way to use a map scale is to make a scale strip. Place a strip of paper under the map scale, mark the scale's notches on the paper, and label the marks with the numbers of miles or kilometers. Then place your strip with the "0" mark at one point on the map, and line up the strip with a second point. Now read the closest number on your strip to this second point. You've just figured out the distance between those two points.

Maps with Different Scales

The map on the left is a small-scale map. It shows where Washington, D.C., is located in relation to nearby cities. The map does not show details like city streets. But it does show larger features, such as major highways.

The map on the right is a large-scale map. It focuses on Washington, D.C. You could use it to find your way through the city's streets to the White House or other monuments.

Washington, D.C., and Surrounding Areas

Downtown Washington, D.C.

1.6 Hemispheres, Continents, and Oceans

"One of my favorite things to do when I have time off is to just watch the world go by," said astronaut Ed Lu about his experience in space. In 2003, Lu watched Earth go by while he was living aboard the International Space Station. "It isn't exactly seeing Earth like a big blue marble," he explained. "It's more like having your face up against a big blue beach ball." On the "big blue beach ball," he saw Earth's wide continents and blue oceans.

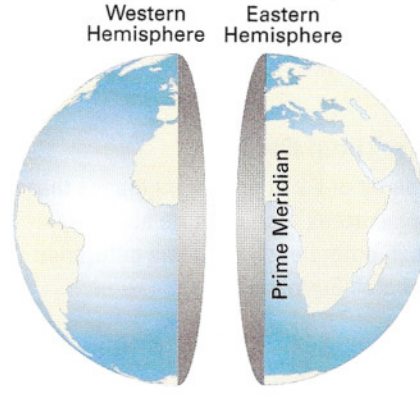
Few of us will ever see Earth from an astronaut's point of view, but we can use maps and globes to get a bird's-eye view of our planet's natural wonders. Geographers make these features easier to understand by dividing Earth into different areas.

A Hemisphere Is Half a World Geographers divide Earth into halves called **hemispheres**. The equator divides Earth into two hemispheres. The northern half is called the Northern Hemisphere, and the southern half is called the Southern Hemisphere.

Geographers also divide Earth in half by longitude. The Western Hemisphere lies west of the prime meridian, and the Eastern Hemisphere lies to the east of it. The two hemispheres divide again at the International Date Line.

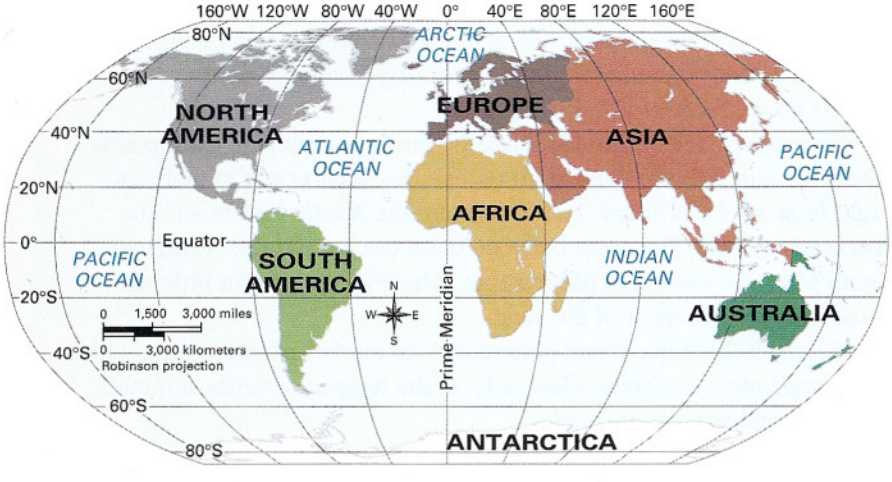
Continents and Oceans Cover Earth Geographers also divide Earth's lands and seas into areas. Ocean water covers more than 70 percent of Earth's surface. In fact, this ocean is really just one big body of water. But geographers usually divide it into four oceans—the Atlantic, Pacific, Indian, and Arctic oceans. Sometimes the Atlantic and Pacific oceans are divided at the equator into the North and South Atlantic and the North and South Pacific.

These oceans lap the shores of continents, the largest areas of land on our planet. The seven continents identified by geographers are, from largest to smallest, Asia, Africa, North America, South America, Antarctica, Europe, and Australia. Europe and Asia are actually parts of one huge **landmass,** but geographers usually think of them as two continents because they have different cultures and histories.

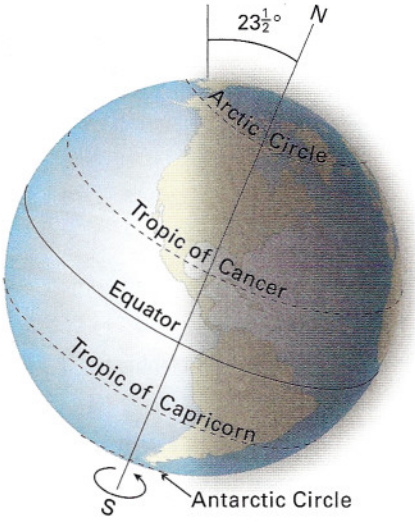


Hemispheres
The equator splits the globe into Northern and Southern hemispheres. The prime meridian and International Date Line split the globe into Eastern and Western hemispheres.

The World



Earth's Continents and Oceans
You can see from this map that oceans cover most of Earth. The four major oceans are actually a single body of water that surrounds the seven continents.



The Tilted Earth

The tilt of Earth on its axis means that some areas receive more sunshine than others each day. This difference creates Earth's seasons.

1.7 Earth and the Sun

For centuries, most people believed that Earth stood still in space. Today we know that our planet is in constant motion, moving at an average speed of about 67,000 miles per hour. That motion creates our years, months, and days and also helps to create our seasons.

The Moving Earth Earth moves around the sun in a nearly circular path called an *orbit*. One round trip, called a **revolution,** takes about $365\frac{1}{4}$ days, which makes an Earth year.

As Earth revolves around the sun, it spins like a giant top upon its **axis**. The axis is an imaginary line that runs from the North Pole to the South Pole through the center of Earth. The spinning motion of Earth is called **rotation**.

Earth makes one full rotation about every 24 hours. As Earth spins, it is daytime on the side facing the sun. Meanwhile, on the side facing away from the sun, it is night.

Earth's Tilt Creates the Seasons Earth's axis is tilted at an angle relative to the sun. Because of this tilt, the Northern and Southern hemispheres receive different amounts of sunlight as Earth moves around the sun. These differences create Earth's seasons.

Look at the diagram on the opposite page to see the changing seasons in the Northern Hemisphere. During the north's summer, this half of Earth is tilted toward the sun. At this time the Northern Hemisphere receives more sunlight and enjoys long, hot days. Winter, the colder part of the year, comes when this hemisphere tilts away from the sun and the days grow short and cool.

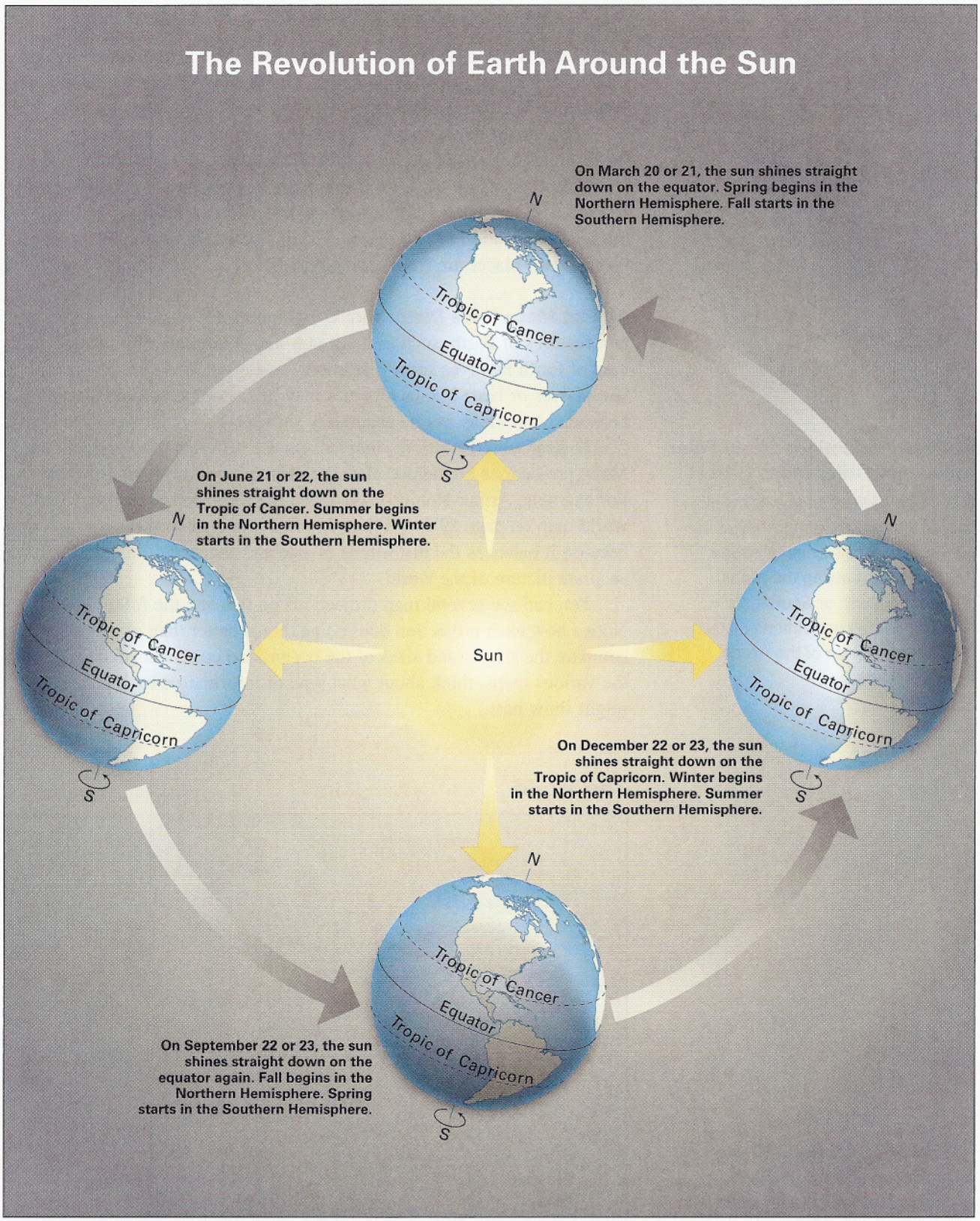
Of course, during these same months of winter, the Southern Hemisphere tilts toward the sun, so in the south it is summer. Similarly, when it is summer in the Northern Hemisphere, it is winter in Earth's southern half.

Tropics, Circles, and Zones Because of Earth's tilt, the sun never beats straight down on places in the far north and south. Two lines of latitude mark the northernmost and southernmost points where the sun's rays ever beat straight down. The northern line is called the **Tropic of Cancer,** and the southern line is called the **Tropic of Capricorn**. The Tropic of Cancer and the Tropic of Capricorn are equidistant from the equator.

The areas between these two lines and the equator are known as **tropical zones**. Tropical zones receive a lot of sunshine and are hot all year round. Considerable rain falls, especially in the hot rainy season, but there is no winter season.

Two other lines of latitude mark the farthest north and south points where the sun doesn't shine at all on one day each year. On that day, night lasts a full 24 hours. These lines are the **Arctic Circle** and the **Antarctic Circle**. The areas between these circles and the North and South poles are known as **polar zones**. These zones receive little sunshine and are cold most of the year.

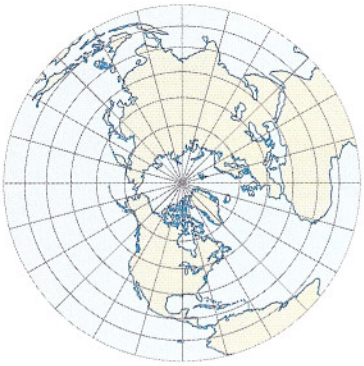
Between the tropical and polar zones lie the **temperate zones,** which lack temperature extremes. Generally, in the temperate zones summers are warm and winters are cool.



Earth's Revolution and the Seasons

This diagram shows how Earth's tilt creates the seasons during our planet's year-long trip around the sun. Notice that the seasons are reversed in the Northern and Southern hemispheres.

The World



Lambert Azimuthal Equal-Area projection

Lambert Projections Show Polar Areas that Other Maps Distort
A Lambert projection is a circular map. It shows size accurately at its center, but not distance or shape. It is good for showing the areas around the North or South pole. Most other map projections distort the shape and size of the Arctic and Antarctica.

1.8 Showing a Round World on a Flat Map

In this chapter, you learned how geographers show information on maps. Exploring a map's title, compass rose, legend, and symbols can help you understand what a map shows.

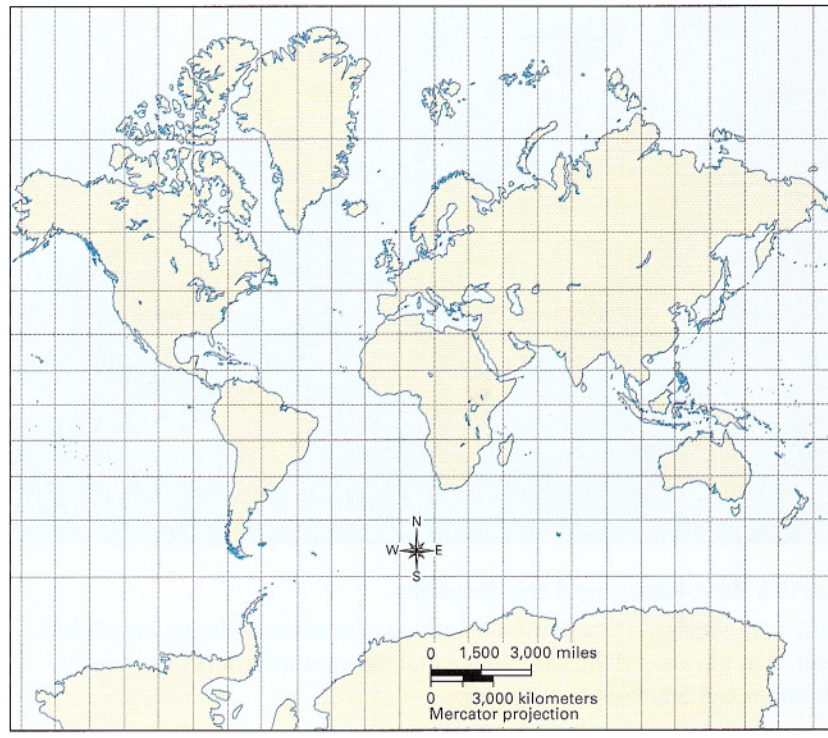
You learned how geographers describe where a place is in terms of its absolute location. The global grid allows mapmakers to indicate the exact location of any place on Earth using lines of latitude and longitude labeled with letters and numbers. Map scales are useful for describing the relative location of two places. Using a scale, you can estimate about how far two places are from each other.

All Flat Maps Have Distortion Geographers use maps to show important features of Earth, such as its oceans and continents. But every flat map of Earth involves some distortion. As a result, the size or shape of landmasses or large bodies of water may be distorted, and the distances between places may not be accurately shown.

To deal with distortions, mapmakers use different map projections. Many projections are named after the mapmakers who designed them. For example, Arthur Robinson designed the Robinson projection. The world map on page 19 is a Robinson projection. It is a popular projection because it balances the distortions of size and shape, resulting in a fairly accurate picture of the world.

You can see several map projections on this and the following page. Notice how each projection does some things better than others. As you compare the shapes and sizes of the oceans and continents displayed on the various maps, think about what type of information each projection might show best.

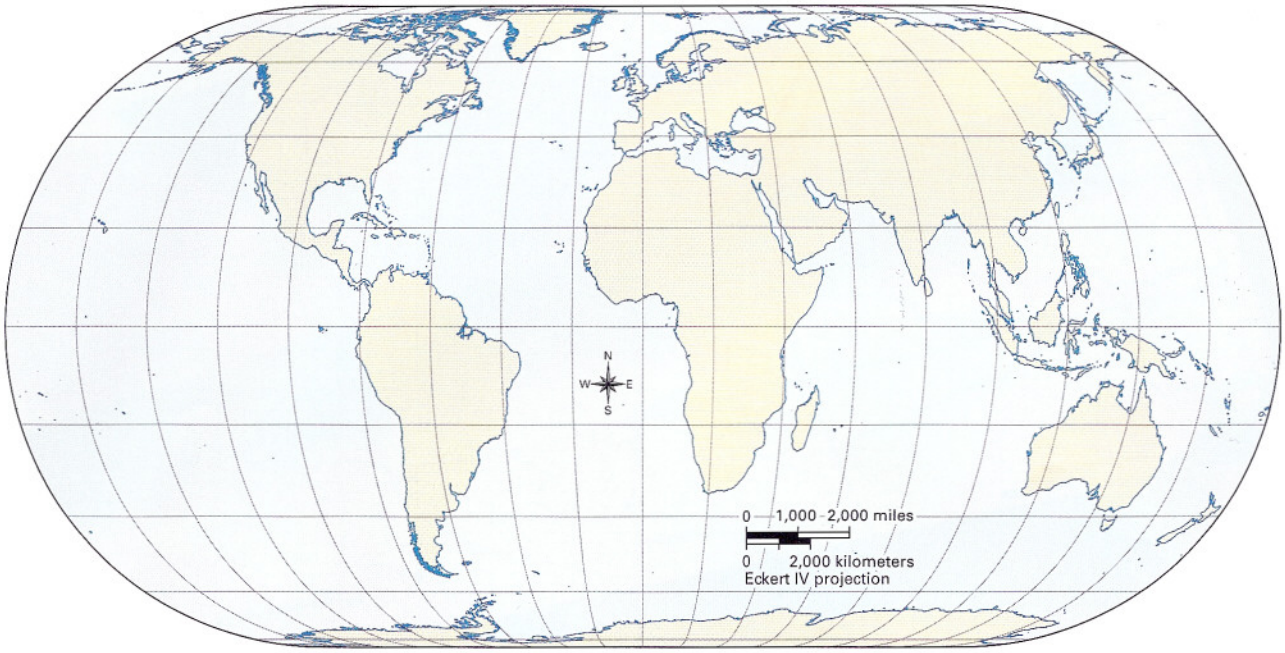
The World



Mercator projection

Mercator Projections Show Direction but Distort Size
Gerardus Mercator designed his map projection in 1569. It shows directions between places accurately near the equator. But it distorts the size of continents, especially near the North and South poles. This is called *area distortion*.

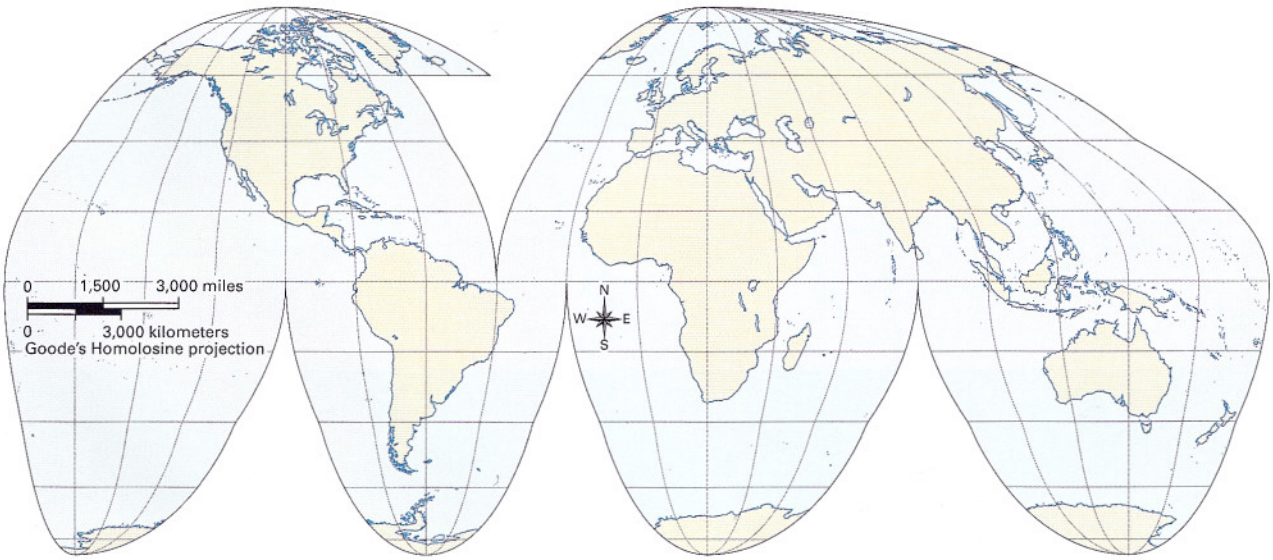
The World



Eckert IV Projections Show Size but Distort Shape

The Eckert IV projection is an equal-area map. Equal-area maps show the sizes of places accurately. However, they distort shape near the poles. This is called *shape distortion*. Geographers often use Eckert IV projections to show the number of people in different areas.

The World



Goode's Homolosine Projections Show Continents but Distort Oceans

Goode's Homolosine projection uses a trick to help us see how the continents compare in size. It snips bits out of the oceans. This trick allows the continents to stretch without distorting their shapes. But it distorts the shape and size of the oceans.