Grade 10 NTI Day #10 Biology

Assignment: Please read the excerpt below as an independent reading assignment. Then read and answer the questions below the excerpt.

Climate, Weather, and Life

LESSON 3.2

KEY QUESTIONS

- *What is the difference between weather and climate?*
- *How are Earth's climate and average temperature determined?*
- *What causes ocean currents?*
- *What factors shape regional climate?*
- *What does climate change involve?*

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

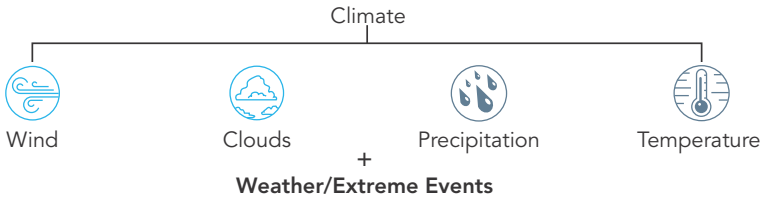
HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

People always talk about the weather. Storms like Hurricane Katrina or superstorm Sandy can cause widespread damage and loss of life. A summer may be uncomfortably hot, or a winter bitterly cold. Weather and climate are two terms we use to describe variations and averages in environmental factors that affect our lives.

Climate and Weather

Weather and climate are important parts of local and national conversations these days, so it is worth looking at them closely. ***Climate is defined by patterns and averages of temperature, precipitation, clouds, and wind over many years.*** **Climate** also includes the frequency of extreme weather events such as heat waves, droughts, and floods, as shown in **Figure 3-6**. ***Weather consists of short-term changes in temperature, precipitation, clouds, and wind from day to day, or minute to minute.*** **Weather** can change rapidly, and can be tough to predict. It may be sunny in the morning but rainy in the afternoon. Climate is usually more predictable, so you wouldn't be surprised if you heard that it is hot today in Miami, Florida, but cool in Seattle, Washington.

Either short-term weather changes (such as droughts) or long-term climate changes (such as the frequency of droughts) can make the difference between success and failure of crops. Weather and climate also shape natural populations, communities, and ecosystems.



VOCABULARY

climate
weather
greenhouse effect

READING TOOL

As you read, identify the cause and effect relationships that the text describes. Fill in the table in your **Biology Foundations Workbook.**

Figure 3-6
Climate

Climate includes long-term averages of wind, clouds, precipitation, temperature, and extreme weather events such as droughts, floods, and heat waves.

INTERACTIVITY

Learn how the greenhouse effect relates to the concept of solar energy.

ANIMATION

hhmi | BioInteractive

Visual Analogy

Figure 3-7

The Greenhouse Effect

Greenhouse gases in the atmosphere allow solar radiation to enter the biosphere but slow down the loss of reradiated heat to space.

The Global Climate System

Climate and weather are produced by a global climate system composed of winds and ocean currents. ***The global climate system is powered and shaped by the total amount of solar energy retained in the biosphere as heat, and by the unequal distribution of that heat between the equator and the poles.***

Solar Energy and the Greenhouse Effect

The main force that shapes climate is solar energy that arrives as sunlight striking Earth's surface. Some of that energy is reflected into space, and some is absorbed and converted into heat. Some heat, in turn, is re-radiated into space, and some is trapped within the atmosphere. ***Earth's average temperature is determined by the balance between the amount of heat that stays in the atmosphere and the amount of heat that is lost to space.***

This balance is largely controlled by the concentrations of three gases in the atmosphere—carbon dioxide, methane, and water vapor. These gases, called greenhouse gases, act like glass in a greenhouse. The gases allow visible light to enter but trap heat, as shown in **Figure 3-7**. This phenomenon is called the **greenhouse effect**. Without the greenhouse effect, Earth would be about 30 degrees Celsius cooler than it is today. Note that these three gases enter and leave the atmosphere as part of global cycles of matter. Their concentration in the atmosphere can therefore be affected by changes in those cycles driven by both nonhuman causes and by human activities. If changes in these cycles increase the greenhouse gas concentrations, the atmosphere retains more heat, and Earth warms. If changes decrease greenhouse gas concentrations, more heat escapes, and Earth cools.

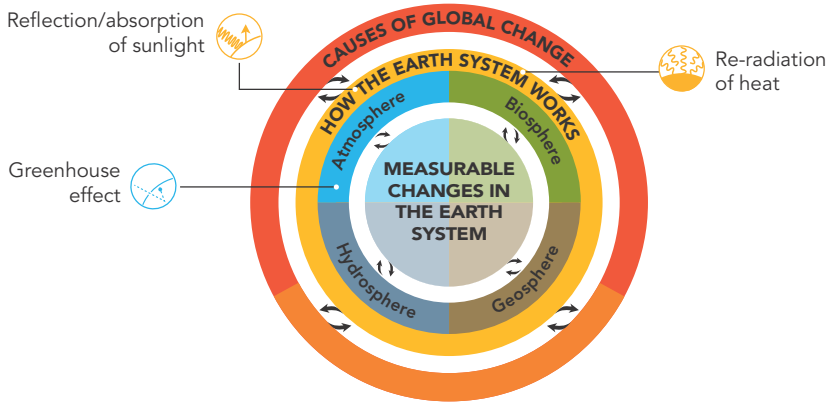


Figure 3-8

Global Change And The Greenhouse Effect

The amount of sunlight that is reflected or absorbed, the amount of heat that is re-radiated in the Earth system, and the intensity of the greenhouse effect influences Earth's energy balance.

Latitude and Solar Energy Because Earth is curved and tilted on its axis, solar radiation strikes the surface at angles that vary from place to place and at different times of the year. Earth's curvature causes the same amount of solar energy to spread out over a larger area near the poles than near the equator, as **Figure 3-9** shows. Near the equator, the sun is directly overhead at noon, and day length varies little over the year. North and south of the equator, the sun drops lower in the sky during winter as tilted Earth revolves in orbit, and days become shorter. For both these reasons, more solar energy per unit area, and therefore more heat, arrives each year near the equator than near the poles.

The difference in heat received at the poles compared to the equator creates three main climate zones: tropical, temperate, and polar. The tropical zone is located between 23.5° north and 23.5° south latitudes near the equator. Here temperatures near sea level are warm or hot all year. Two temperate zones are located between 23.5° and 66.5° north and south latitudes. Here, summers may be quite hot, and winters can be very cold. The polar zones lie beyond the temperate zones, between 66.5° and 90° north and south latitudes. Here, winters are bitterly cold, and summers barely get warm.

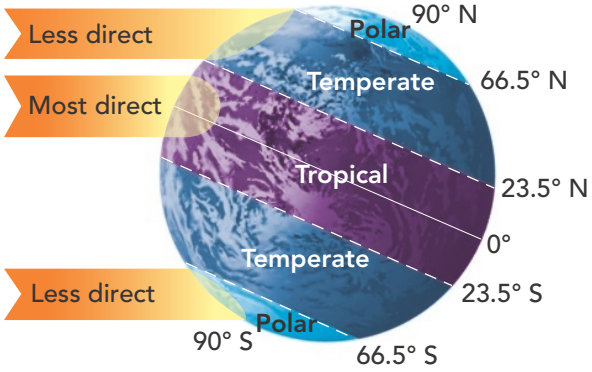


Figure 3-9

Climate Zones

Earth's climate zones are produced by unequal distribution of the solar energy across Earths' surface. The tilt of Earth's axis causes this distribution to change over the course of a year, resulting in seasons.

HS-ESS2-4

Quick Lab Guided Inquiry

Why Do Different Earth Surfaces Have Different Temperatures?

1. Review the procedure. Prepare a data table to record the temperature measurements.
2. Half fill each of three cups: one cup with gravel, a second cup with soil, and a third cup with water.
3. Place a thermometer inside each cup. Record the temperatures.
4. Place each cup under the heat lamp. Wait 30 minutes and then record the temperatures again.

ANALYZE AND CONCLUDE

1. **Use Models** How do the materials you used in the model represent Earth's surface?
2. **Draw Conclusions** Use the data in your data table as evidence to draw a conclusion about the way Earth's surface is heated by sunlight.
3. **Form a Hypothesis** What if you turned off the heat lamp, and then measured the temperatures of the three cups over time? Form a hypothesis, and then test it with your teacher's approval.

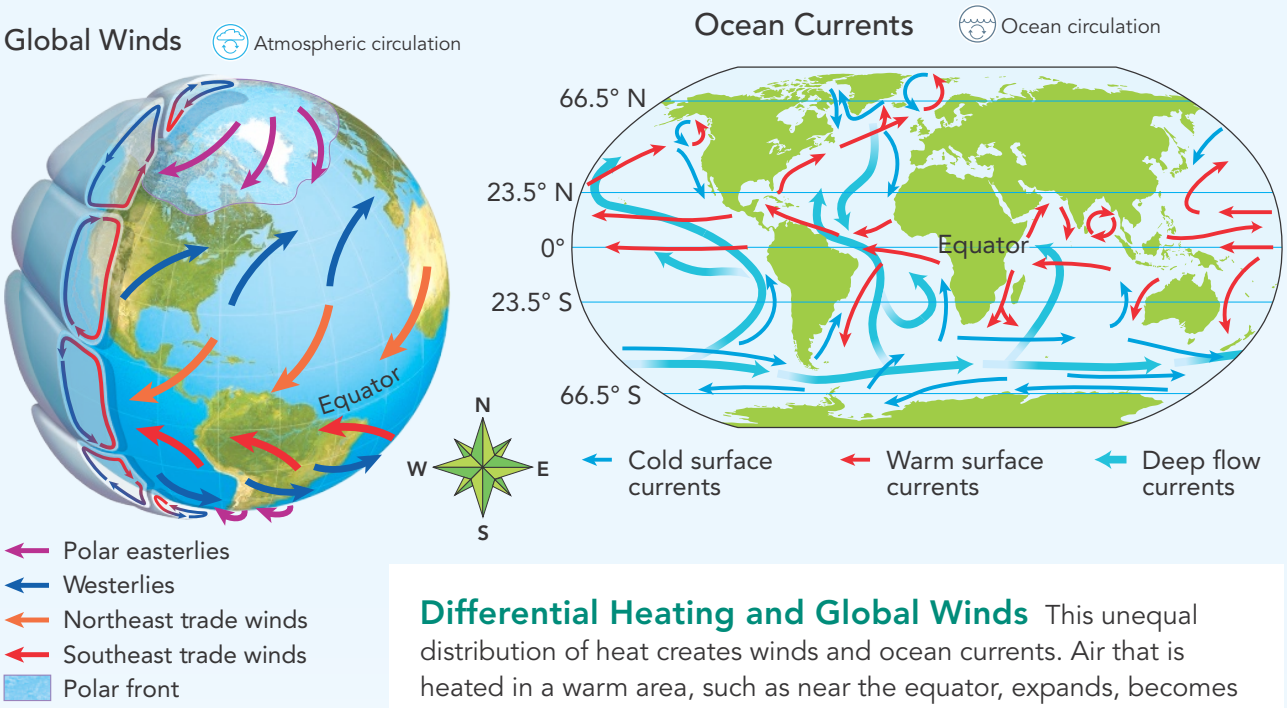


Figure 3-10

Global Winds and Ocean Currents

Earth's winds (left) and ocean currents (right) interact to help produce climate patterns. The paths of winds and currents are the result of heating and cooling, Earth's rotation, and geographic features.

Differential Heating and Global Winds This unequal distribution of heat creates winds and ocean currents. Air that is heated in a warm area, such as near the equator, expands, becomes less dense, and rises. As the air rises, it spreads north and south, losing heat along the way. As that air cools, it becomes more dense and sinks. Meanwhile, cold air over the poles also sinks. This pattern of rising and sinking air creates circulating cells of air that rise, travel north or south, sink towards Earth's surface, warm, and then rise again. As that air travels from places where it sinks to places where it rises, it creates winds, as shown in **Figure 3-10**. Earth's rotation causes winds to blow from west to east over both land and sea in the temperate zones, and from east to west over the tropics and the poles.

READING CHECK Synthesize Information How does wind form?

Ocean Currents

An oceanographer might say that ocean currents would flow around the world in much the way global winds do … but continents get in their way! ***Ocean currents are driven and shaped by patterns of warming and cooling, by winds, and by the locations of continents.***

Winds and Surface Currents Prevailing winds blowing over the ocean create surface currents that profoundly affect weather and climate in coastal areas. The warm Gulf Stream, for example, travels north along the east coast of North America, carrying heat from the Caribbean and Gulf of Mexico. Air passing over the Gulf Stream picks up moisture and heat, moderating winter temperatures in coastal areas. Along the West coast, the cool California Current carries cold water southwards, cooling the Pacific Northwest and the California coast. These interactions between atmosphere and hydrosphere shape weather and climate in coastal areas around the world. These interactions also influence water temperature and salinity that affect marine organisms and communities.

Deep Ocean Currents Cold ocean water near the poles sinks and flows along the ocean floor. This bottom water rises to the surface in some places, through a process called upwelling. Upwelling usually occurs where prevailing winds push surface water away from a continent. Cold water from the bottom rises to take the place of that surface water. One of the best-known upwellings in the Western Hemisphere occurs in the eastern Pacific Ocean off the coast of Peru. Increases and decreases in the strength of this upwelling are part of a phenomenon called El Niño. El Niño affects weather patterns from the southwestern United States all the way across the Pacific to Australia and Indonesia.

READING TOOL

Identify the effects of winds, ocean currents, and mountains on climate. Take notes in your notebook.

VIDEO

Learn about El Niño and its effects on weather and climate.

Regional Climate

Washington State and Montana are located at similar latitudes, and are affected by the same prevailing winds that blow from west to east. Yet Montana has a very different climate than coastal Washington. Why? Because of mountains. ***Regional climates are shaped by latitude, by the transport of heat and moisture by winds and ocean currents, and by geographic features such as mountain ranges, large bodies of water, and ocean currents.***

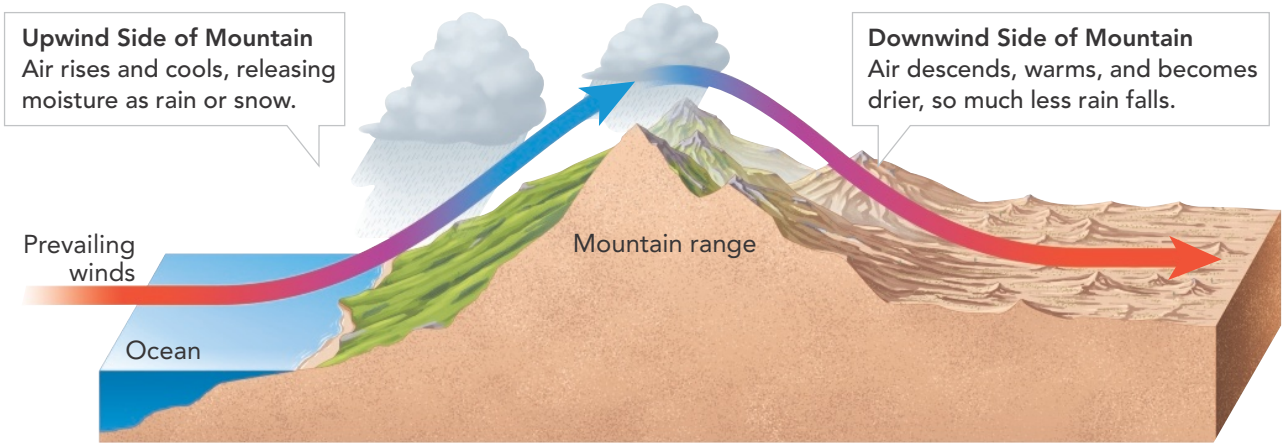
The states of Oregon and Washington border the northern Pacific Ocean, where cold surface currents cool and humidify the prevailing winds that blow over them from west to east. That moist air hits the Cascade Mountains, is pushed upwards, and cools, causing moisture to condense and form clouds. Those clouds drop rain or snow, mainly on the western side of the mountains that faces the winds, as seen in **Figure 3-11**. For that reason, coastal climate in these states is cool and wet, and it supports a temperate rain forest. East of the Cascades, that same air sinks to lower altitudes, warms, and dries out. As a result, eastern Washington and Montana are drier and much warmer in summer, and can get much colder in winter.

READING CHECK **Cause and Effect** What causes more rain to fall on one side of a mountain than the other side?

Figure 3-11

The Effect of Coastal Mountains

As moist ocean air rises over the upwind side of coastal mountains, it condenses, cools, and drops precipitation. With depleted moisture, the sinking air warms and becomes drier.



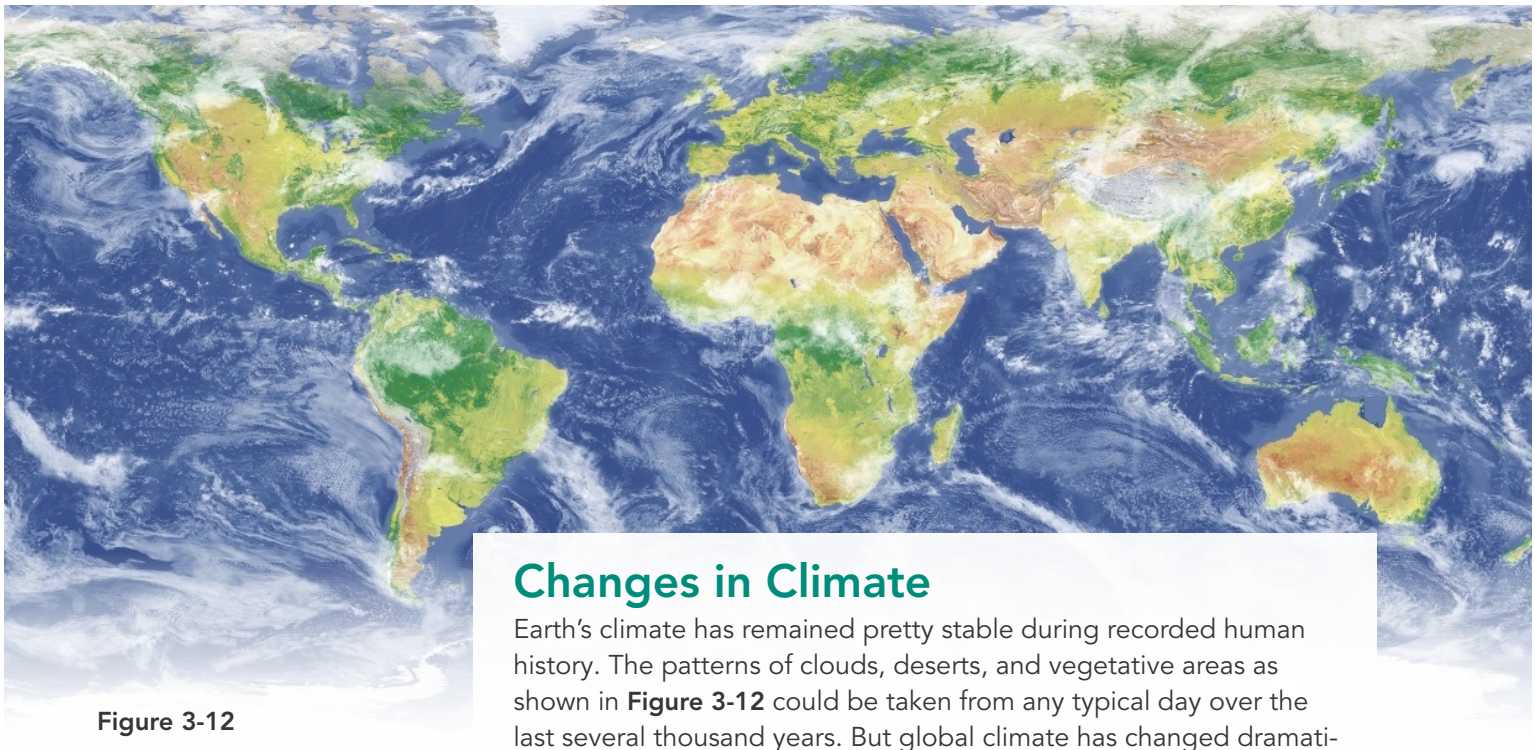


Figure 3-12

Global Climate

In this computer-generated map of Earth, the white regions show a typical example of cloud cover.
Predict How could changes to the global winds and ocean currents affect climate on land?

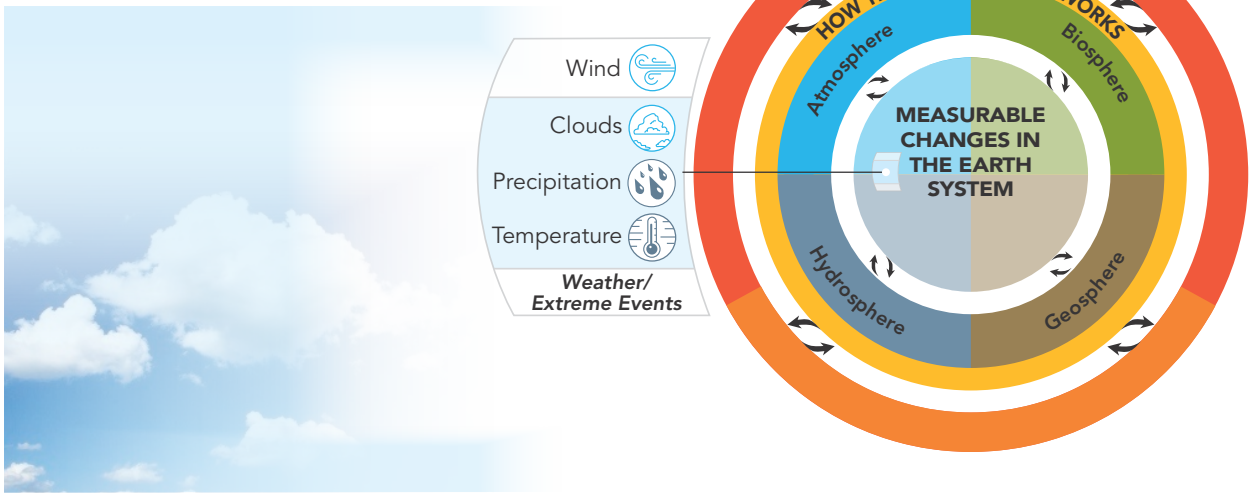
Changes in Climate

Earth's climate has remained pretty stable during recorded human history. The patterns of clouds, deserts, and vegetative areas as shown in **Figure 3-12** could be taken from any typical day over the last several thousand years. But global climate has changed dramatically over the far longer history of life. Earth's average temperature has increased and decreased over periods ranging from tens of thousands to millions of years. Those changes in temperature affected both the structure and the function of the global climate system. Recall that climate involves a lot more than just temperature. It also includes winds, precipitation, clouds, and extreme weather events. Climate change, therefore, involves more than global warming or cooling. ***Climate change involves changes in temperature, clouds, winds, patterns and amounts of precipitation, and the frequency and severity of extreme weather events.*** **Figure 3-13** shows climate change in the "Measurable changes" portion of our global change model.

Figure 3-13

Climate Change

Climate includes wind, clouds, precipitation, and temperature. Climate change involves changes in all of those factors and impacts both the atmosphere and hydrosphere.



Nonhuman Causes of Climate Change

Several factors have caused long-term changes in regional and global climate. As shown in **Figure 3-14**, these factors include: changes in solar energy, variations in Earth's orbit, meteorite impacts, changes in the distributions of continents and oceans, mountain building, volcanic activity, and meteorite impact.

The sun's output of solar energy varies over time. Changes in Earth's orbit and the tilt of its axis vary, in cycles of about 100,000 years. Once in a while, a giant meteorite hits Earth—like the one that led to the extinction of dinosaurs around 65 million years ago. The positions of Earth's continents change over millions of years, in ways that affect patterns of both winds and ocean currents. Episodes of mountain building can cause dramatic changes in regional climate, by affecting temperatures and patterns of precipitation. Major changes in the amount of volcanic activity worldwide can cause changes in the concentrations of greenhouse gases in the atmosphere.

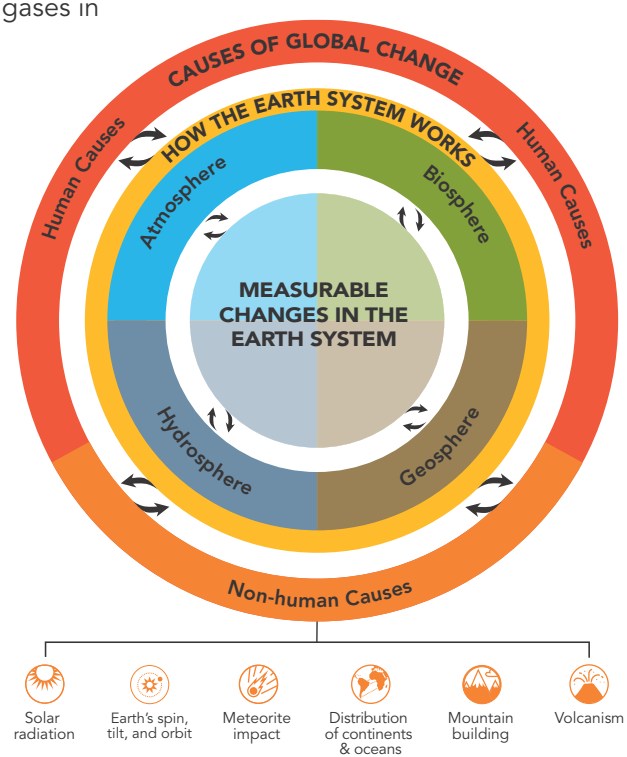
Results of Past Changes in Global Climate

These factors have caused both warm and cold periods over long periods of time. The most recent cold cycle caused the last major glacial period, which ended about 10,000 years ago. The global climate system creates regional climates that govern which plants, animals, and other organisms can survive in different places. Some changes in global climate have occurred slowly enough that most life on Earth could adapt and survive. But five times in Earth's history, climate change happened too fast for many organisms to survive, and vast numbers of species of all kinds died off. Those episodes are known as mass extinctions. In the Evolution unit, we will discuss mass extinctions driven by these nonhuman causes of global change. And in the last chapter of this unit, we will discuss whether human causes of global change are driving another mass extinction right now.

Figure 3-14

Nonhuman Causes of Climate Change

Geological and astronomical systems, processes, and events have caused major changes to global systems over the history of life on Earth. However, most of these nonhuman causes of global change act over extremely long time scales, ranging from thousands to millions of years.



HS-LS2-2, HS-ESS2-4

Lesson Quiz

3.2 Climate, Weather, and Life

Directions

For multiple choice questions, write the letter that best answers the question or completes the statement on the line provided. For other question types, follow the directions provided.

1. *For each missing word or phrase, circle the choice that correctly completes the sentence.*

The three main gases that trap heat in Earth's atmosphere are **(carbon dioxide / oxygen / nitrogen / hydrogen)**, methane, and water vapor. They contribute to the **(climate / ecosystem / greenhouse / biosphere)** effect, which makes Earth's temperatures warmer than they would be otherwise.

_____ **2.** Which is a description of climate, and not the weather?

a. Summer is wetter and warmer than winter.
b. A hurricane is likely to reach southeast Florida this afternoon.
c. The air today is more humid than it was yesterday.
d. No rain is likely to fall for the next week.

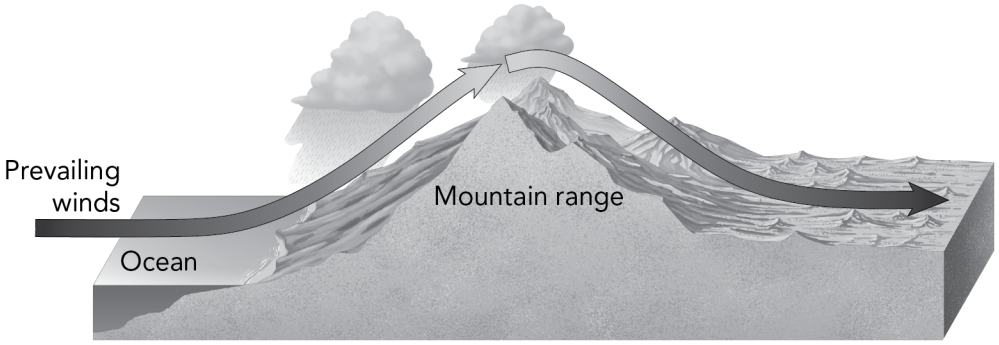
_____ **3.** An increase in the concentrations of greenhouse gases in Earth's atmosphere would have which of these effects on temperature?

a. a decrease in average temperatures on Earth's surface
b. an increase in average temperatures on Earth's surface
c. an increase in average temperature in the upper atmosphere
d. a decrease in average temperature within all Earth systems

_____ **4.** The Gulf Stream is a surface current in the Atlantic Ocean that flows northward from the Caribbean Sea and the Gulf of Mexico. It feeds another current that reaches northern Europe. Which of these events would cause the greatest permanent changes to the path and strength of the Gulf Stream?

a. a strong earthquake that occurs on the floor of the Atlantic Ocean
b. an increase in the volume of river water that flows into the Gulf of Mexico
c. a reversal of direction in the prevailing winds over the Atlantic Ocean
d. a slight increase in the salinity of the Atlantic Ocean

_____ **5.** The diagram shows that the upwind side of a mountain range tends to receive more precipitation than the downwind side of a mountain range.



Which statement is MOST useful for explaining this observation?

a. Prevailing winds flow from west to east.
b. Water vapor condenses to form droplets of liquid water.
c. Evaporation allows water vapor to rise through the air.
d. Cold air holds less moisture than warm air.

_____ **6.** Stuart is studying weather data for his region. The data was gathered from 1950 to 2016. Which observation would provide the strongest evidence that the climate of his region has changed during this time?

a. Average annual rainfall for 1985-2016 increased by 20 percent compared to the previous 30 years.
b. Total rainfall in 2014 was 30 percent greater compared to 1950.
c. The lowest recorded temperature occurred in 1954.
d. The highest recorded temperature occurred in 2016.

_____ **7.** Scientists cite evidence that Earth's climate has been changing significantly over the past 50 years. They also argue that changes to Earth's orbital path are NOT the cause of these significant changes to climate.

Which statement provides the strongest evidence in support of the scientists' argument?

a. Variations in Earth's orbital path are consistent with accepted laws of planetary motion.
b. Earth's orbital path does not affect the amount of solar energy that Earth receives.
c. Changes to Earth's orbital path occur in a cycle that repeats every 100,000 years.
d. Climate change cannot be demonstrated over a span of 50 years.