4.3 Climate (6.3.3)

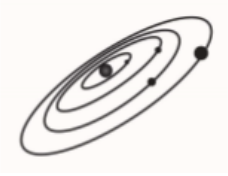
Explore this Phenomena

The same sun shines on the entire Earth.

Explain why these two areas have such different climates.

6.3.3 Climate

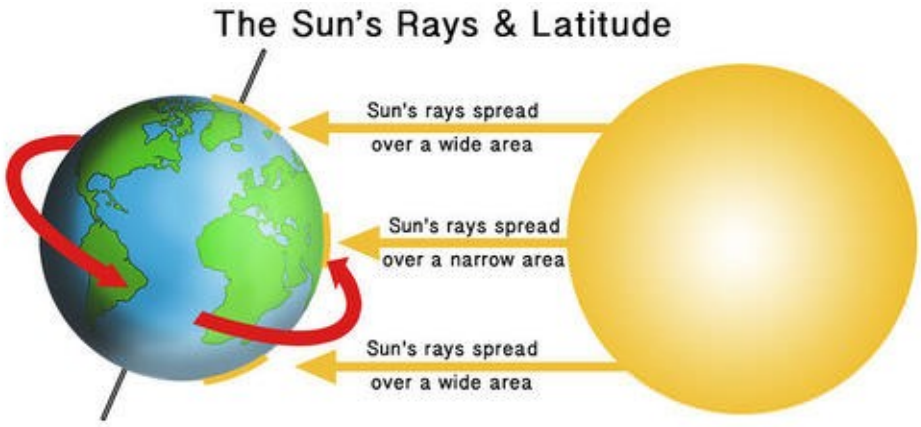
Develop and use a model to show how unequal heating of the Earth's systems causes patterns of atmospheric and oceanic circulation that determine regional climates. Emphasize how warm water and air move from the equator toward the poles. Examples of models could include Utah regional weather patterns such as lake-effect snow and wintertime temperature inversions.



As you read this section, focus on systems. Think about both the atmosphere and the ocean as systems as you learn about how heat energy is distributed around Earth by these two systems.

Energy and Latitude

Different parts of Earth's surface receive different amounts of sunlight (Figure below). The Sun's rays strike Earth's surface most directly at the Equator. Near the poles, the Sun's rays strike the surface less directly. This spreads the rays over a wide area. The more focused the rays are, the more energy an area receives, and the warmer it is.



The lowest latitudes get the most energy from the Sun. The highest latitudes get the least.

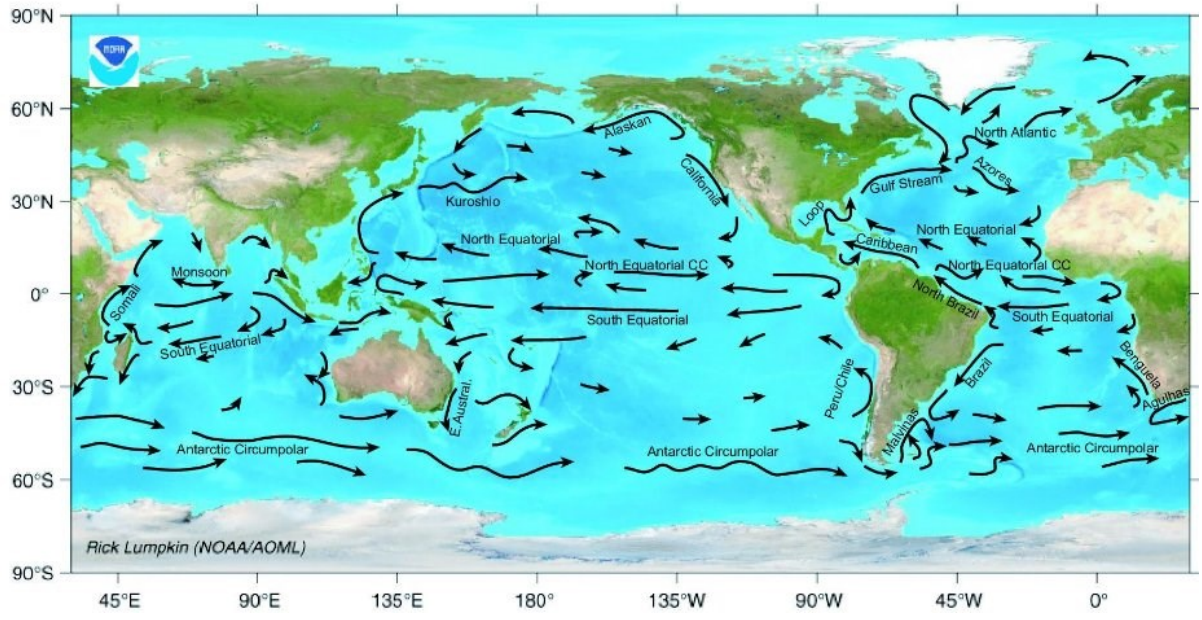
The difference in solar energy received at different latitudes caused unequal heating of Earth's surface. Places that get more solar energy will be warmer. Places that get less solar energy will be cooler. Warm air rises and cool air sinks. This principle means that air moves around the planet. The Earth's atmosphere carries heat, therefore the heat moves around the globe in ways that affect weather patterns.

Circulation of the Atmosphere and the Ocean

It may not look like it, but various processes work to moderate Earth's temperature across the globe. Atmospheric circulation brings warm air towards the poles and cold polar air towards the Equator. If the Earth's atmosphere didn't move the temperature differences would be much greater. In general, cold air masses tend to flow toward the Equator and warm air masses tend to flow toward the poles. This brings heat to cold areas and cools down areas that are warm. It is one of the many processes that act to balance out the planet's temperatures.

Ocean water moves in predictable ways along the ocean surface. Surface currents can flow for thousands of kilometers and can reach depths of hundreds of meters. These surface currents do not depend on the weather; they remain unchanged even in large storms because they depend on factors that do not change. Surface currents are created by global wind patterns and the rotation of the Earth. Surface currents are extremely important because they distribute heat around the planet and are a major factor influencing climate around the globe.

Winds on Earth are either global or local. Global winds blow in the same directions all the time and are related to the unequal heating of Earth by the Sun and the rotation of the Earth. These predictable wind patterns allowed early sailing ships to travel around the globe. Ocean currents created by these wind patterns move ocean water around the planet. Normally warm water at the Equator will be pushed to the polar areas and colder water will be pushed to the equator.



Major ocean surface currents

Surface currents play an enormous role in Earth's climate. Even though the Equator and poles have very different climates, these regions would have extremely different climates if ocean currents did not transfer heat from the equatorial regions to the higher latitudes.

An example of how ocean current effect an area's climate is the Gulf Stream. The Gulf Stream is a river of warm water in the Atlantic Ocean, about 160 kilometers wide and about a kilometer deep. Water that enters the Gulf Stream is heated as it travels along the Equator. The warm water then flows up the east coast of North America and across the Atlantic Ocean to Europe. The energy the Gulf Stream transfers is more than 100 times the world's energy demand.

The Gulf Stream's warm waters raise temperatures in the North Sea, which raises the air temperatures over land between 3 to 6°C (5 to 11°F). London is at about six degrees further south than Quebec. However, London's average January temperature is 3.8°C (38°F), while Quebec's is only -12°C (10°F). Because air traveling over the warm water in the Gulf Stream picks up a lot of water, London gets a lot of rain. In contrast, Quebec is much drier and receives its precipitation as snow.

Focus Questions

1. What causes Earth's poles to be much cooler than the Equator?
2. How do surface currents form?
3. Describe the Earth systems that are responsible for moving heat energy from the Equator to the poles.

Putting It Together

The same sun shines on the entire Earth.

Review what you wrote about the climates in these two pictures. Based on what you have learned, explain why these two areas have such different climates.