Revisit the Big Ideas in Climate Change

In this chapter, you examined climate change in the Earth system. Throughout geologic history, global climate has shifted between warmer and cooler phases. These shifts involved many cause and effect relationships between the oceans, the atmosphere, the geosphere, and the biosphere. Cycles of climate change have occurred over varying lengths of time. The impacts of climate change have varied across Earth’s surface as well.

Climate affects many parts of the Earth system. Climate also affects many processes in the Earth system. During glacial periods, sea level is lower. The margins of the continents extend across the continental shelf. As a result of global warming, sea level rises. The coastal margins are again submerged. The crust, once depressed by ice sheets, starts to rebound upward.

Different parts of the Earth system react in different ways to changes in climate. The plant and animal species in an area may change as a result of changes in temperature and precipitation.

Climate is dependent on the interactions of the Earth-Sun system. The amount of solar radiation received is controlled by Earth’s tilt and orbital characteristics. The tilt and the orbit of Earth change. The changes take place over long time scales. The shape of Earth’s orbit is affected by the locations of the other planets that orbit the Sun. Across the great distances of space, other planets that orbit the Sun exert a pull on Earth. Scientists have found a close relation between climate data and the change in Earth’s tilt and orbit.

The oceans and ocean currents are a major part of Earth’s climate system. The distribution of the oceans and the continents is controlled by tectonic processes. Surface currents and thermohaline circulation are parts of a gigantic system. This system redistributes heat across Earth’s surface. Individual ocean currents vary in scale in both time and space. Some currents take thousands of years to complete their journeys.

Carbon dioxide (CO₂) is a natural component of the atmosphere. It is one of several greenhouse gases. Earth’s greenhouse gases absorb radiation that is reflected from Earth’s surface. In this way, Earth is heated from below. This energy would otherwise be lost to space. Over geologic history, the amount of atmospheric carbon dioxide has varied. There is a correlation between higher levels of carbon dioxide and warmer climate periods. Carbon is constantly moving through the
Earth system in the carbon cycle. Carbon dioxide in the atmosphere is dissolved into the oceans. Sediments that contain carbon are precipitated from ocean water. This assists in the transfer of carbon dioxide from the atmosphere to storage in the geosphere.

Rising average global temperatures are a concern today. By thinking about climate change as a system, scientists are able to develop complex models. The system involves many parts and processes. Some processes cause changes in other parts of the system in the same direction. For example, think about sea ice and albedo. Other processes cause changes in the opposite direction. For example, think about ice sheets and sea level. Scientists look for connections between all the different parts and processes.

**Systems Thinking Questions**

1. **What are the major parts involved in climate change? Describe each part and its location.**

   *Thinking about the parts involved in climate change will help you to think about the structure of the system(s) you are examining. Describe the nature of the parts.*

2. **What are the major processes involved in climate change?**

   *Asking questions such as, “What causes Earth to get cooler?” or “How is carbon stored in the oceans?” helps you to figure out the operation of the system(s) you are studying. The same method can be applied to larger or smaller systems. You might also want to think about how one part of the system affects another.*

   a) **Describe major ways in which matter changes during climate change.**

   *Matter lies at the heart of systems. It often moves from one place to another. It also changes sometimes between states of matter or in other physical ways.*

   b) **Describe the role of energy in climate change.**

   *Energy drives systems. All systems require a source of energy for them to operate. As systems do work, energy from the source is transformed into different kinds of energy.*

3. **Over which spatial scales does climate change operate?**

   *Scientists like to look at different scales in the same system to seek patterns about how things work. Think about the distribution of the factors that affect and are affected by climate change. Consider how they interact on a local as well as global scale.*

4. **Across what time scales does climate change operate?**

   *Asking questions such as, “How long does a particular pattern of thermohaline circulation last?” or “How long does it take for carbon dioxide to be removed from the atmosphere?” helps you think more closely about the rates at which systems affect change.*

5. **How does climate change affect your community?**

   *Climate affects you both directly and indirectly in many different ways. The biosphere is closely interconnected with climate and vulnerable to changes in climate. Think about how climate change might affect the location of where you live. Also think about how climate change in another part of the country and the world might affect your life.*