Revisit the Big Ideas in Oceans

In this chapter, you learned how the global ocean is a major component of the Earth system. Earth is different from the other planets. It has oceans of liquid water between the continents. Heat plays an essential role in the ocean system and highlights that system’s dependence within the Sun-Earth-Moon system. Despite its huge size, the global ocean contains a relatively small part of Earth’s biosphere.

It might seem like the scale of the global ocean operates independently of other parts of the Earth system. However, this is not the case. Tectonic processes control how the oceans and continents are distributed. The oceans are also closely related to the atmosphere.

Temperature and density are properties that affect how ocean water circulates. These properties in turn are affected by other parts of the Earth system. A large amount of solar radiation enters the Earth system near the equator. The surface waters there have the warmest temperatures and lowest densities. Surface waters near the poles are colder and denser. At high latitudes, cold, dry polar air causes the surface of the ocean to freeze. The ice that forms contains only fresh water. Therefore, the cold polar ocean water is also a bit saltier. These colder, saltier, denser bodies of water sink beneath neighboring less dense water masses.

The cold ocean water near the poles and the warm ocean water near the equator drive ocean circulation.

It is possible to predict the circulation pattern of the deep ocean system in both time and space. The movement and mixing together of different deep water masses causes their properties to change. Very dense water masses can rise slowly to the surface if they encounter an even denser mass. Deep ocean circulation is part of a gigantic system. It redistributes heat around Earth. It is like a giant conveyor belt. Some currents take thousands of years to travel across the floor of the oceans before rising to the surface.

The surfaces of the oceans are affected by global surface-wind systems. Global winds result from the uneven heating of Earth. They are also affected by Earth’s rotation. The rotation results in the winds being deflected in different directions in either hemisphere. This deflection is called the Coriolis force. Surface currents move in predictable patterns called gyres. Gyres play an important role in the redistribution of heat from the equator.

The global ocean system operates within ocean basins. The basins are formed by the margins of continents. Prevailing winds move ocean water away from coastlines. This allows deeper ocean currents to push toward the continents and rise to the surface. This process is known as upwelling. El Niño events highlight the interaction between the atmosphere, the oceans, and the biosphere. During El Niño years, drier conditions in the east Pacific become moister. As a result, the climate...
Systems Thinking Questions

1. What are the major parts involved in the global ocean system? Describe each part and its location.

Thinking about the parts of the ocean system will help you to think about the structure of the system(s) you are examining. Describe the nature of the parts. You might want to think about where the different parts are as well. This will help you to understand a system’s structure even more clearly.

2. What are the major processes involved in the global ocean system?

Asking questions such as, “How does water gain or lose heat?” or “How do water masses with different properties move?” or “What effects does the mixing of the ocean surface have?” helps you to figure out the operation of the system(s) you are studying. The same approach can be applied to larger or smaller systems. You might also want to think about how one part of the system affects another. This will help you to better understand interactions within the system.

   a) Describe major ways in which matter changes in the ocean system.

   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 the ocean system.

   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 the ocean system operate?

Scientists like to look at different scales in the same system to seek patterns about how things work. Think about the distribution and scale of major functions of the ocean system. Consider how the ocean system operates at local scales as well as a global scale. Bigger systems cover larger regions, typically have more parts, and process more matter. They require a large and continuous source of energy.

4. Across what time scales do major ocean system processes occur?

Asking questions such as, “How long does deep ocean circulation take?” or “How long does it take for El Niño conditions to develop?” helps you think more closely about the rates at which systems affect change.

5. How does the ocean system affect your community?

The oceans affect you both directly and indirectly in many different ways. The biosphere is closely interconnected with the oceans because of their effects on climate. Think about how the oceans, as part of the fluid spheres, affect your region. Also think about how a change in another part of the global ocean might affect your life.

of the western Pacific can become replaced by much drier conditions. The effects of El Niño events extend beyond the fluid spheres. The upwelling process that occurs during normal years provides a rich source of nutrients. During El Niño years, the anchovy population declines. As a result, larger fish are forced to migrate to seek food in other waters and many die as a result. This also has a strong negative impact on the Peruvian fishing industry.

Teleconnections are events that occur in one part of a system because of a change in a distant part of the same system. El Niño conditions have the greatest impacts in South America and the equatorial Pacific Oceans. However, they affect other parts of the Earth system as well. During El Niño events, the jet stream in the upper atmosphere also varies. This has an effect on weather conditions across the planet. El Niño affects weather over short time scales.