

ocean conveyor belt

thermohaline circulation

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The ocean is in constant motion. You can see this for yourself when you watch waves crash onto shore. If you go swimming, you may even feel an ocean current pulling you along. Surface currents, such as the Gulf Stream, move water across the globe like mighty rivers. Surface currents are powered by the Earth's various wind patterns.

The ocean also has deep underwater currents. These are more massive but move more slowly than surface currents. Underwater currents mix the ocean's waters on a global scale. A process known as thermohaline circulation, or the ocean conveyor belt, drives these deep underwater currents.

Thermohaline Circulation

Thermohaline circulation moves a massive current of water around the globe, from northern oceans to southern oceans, and back again. Currents slowly turn over water in the entire ocean, from top to bottom. It is somewhat like a giant conveyor belt, moving warm surface waters downward and forcing cold, nutrient-rich waters upward.

The term thermohaline combines the words *thermo* (heat) and *haline* (salt), both factors that influence the density of seawater. The ocean is constantly shifting and moving in reaction to changes in water density. To best understand ocean water dynamics, or how water moves, there are a few simple principles to keep in mind:

- Water always flows down toward the lowest point.
- Water's density is determined by the water's temperature and salinity (amount of salt).
- Cold water is denser than warm water.
- Water with high salinity is denser than water with low salinity.
- Ocean water always moves toward an equilibrium, or balance. For example, if surface water cools and becomes denser, it will sink. The warmer water below will rise to balance out the missing surface water.

Ocean Layers

The ocean can be divided into several layers. The top layer of the ocean collects the warmth and energy of sunlight, while the bottom layers collect the rich, nutrient-filled sediment of decayed plant and animal matter.

The top ocean layer is about 100 meters (330 feet) deep. Enough sunlight reaches that depth for organisms, such as phytoplankton, to carry out photosynthesis. Phytoplankton makes up the first part of the marine food chain and is essential to all ocean life.

The middle, or barrier, layer is called the thermocline. The ocean's temperature and density change very quickly at this layer. The barrier layer is about 500 to 1,000 meters (1,600 to 3,300 feet) deep.

Below the barrier layer is the bottom layer, referred to as the deep ocean. It averages about 3 kilometers (2 miles) in depth.

The Conveyor Belt

Scientists have long understood how nutrients move from the ocean's surface to its depths. As phytoplankton die, they sink and collect on the ocean floor. But if nutrients are continually sinking to the depths of the ocean, how are surface waters replenished with nutrients? Scientists discovered that in certain regions of the ocean, the nutrient-rich deep water was upwelling, or rising to the surface.

Scientists realized that the ocean was slowly turning over from top to bottom in a continuous global loop. Like a conveyor belt, thermohaline circulation moves nutrients from one part of the ocean to another.

Let's start in the northern Atlantic Ocean and follow the conveyor belt as it moves water around the Earth.

In the seas near Greenland and Norway, the water is cold. Some of it freezes, leaving salt behind. The cold, salty water becomes dense and sinks to the ocean floor. This water is known as the North Atlantic Deep Water, and it is one of the primary driving forces of the conveyor belt.

The force of the sinking cold water pushes the existing North Atlantic Deep Water south, toward Antarctica, in a slow-moving underwater current. When it reaches Antarctica, the water flows east with the Antarctic Circumpolar Current, a massive and powerful current that circles the continent.

Parts of the Antarctic Circumpolar Current flow northward and move into the Indian and Pacific Oceans. As the deep, cold water travels through the oceans, it mixes with warmer water. The water eventually becomes warm enough to rise, creating a slow upwelling that brings nutrients to the surface.

In the Pacific, the surface water flows through the Indonesian islands into the Indian Ocean, around southern Africa, and back into the Atlantic. The warm waters eventually travel back to the North Atlantic Deep Water, completing the global loop.

It takes about 500 years for the conveyor belt to turn over the ocean's waters and make one complete trip around the Earth.

The North Atlantic Deep Water

The deep water in the Greenland Sea flows along toward the lowest point on the floor of the North Atlantic Ocean. The water collects in a basin, the same way river water flows into a lake or pond. The basin is the North Atlantic Deep Water.

Other seas feed their cool ocean waters into the North Atlantic Deep Water. In the Labrador Sea, off the coast of northeastern Canada, the cold water sinks to depths of 3,000 meters (9,900 feet) at a rate of 10 centimeters (about 4 inches) per second.

Another source of the North Atlantic Deep Water is the Mediterranean Sea. As the warm surface water of the Mediterranean evaporates, the water grows saltier and denser. This water exits the Mediterranean through the Strait of Gibraltar, the narrow channel between Spain and Morocco that connects the sea to the Atlantic Ocean. The Mediterranean's deep water pours into the Atlantic at a rate of 2 meters (about 6.5 feet) per second and helps raise the overall salinity of the Atlantic Ocean.

The Antarctic Circumpolar Current

When the conveyor belt reaches the southern part of the globe, it is driven back to the northern oceans by the Antarctic Circumpolar Current.

Western winds are very strong in the Antarctic. They help create the intensely powerful Antarctic Circumpolar Current. The current moves a lot of water very quickly around the continent of Antarctica—about 140 million cubic meters (4.9 billion cubic feet) of water per second.

Overturning occurs in the waters around Antarctica. Overturning happens when the extremely frigid Antarctic surface water sinks. This forces the nutrient-rich deep water to rise. Overturning moves massive amounts of water. An estimated 35 to 45 million cubic meters (between 1.2 and 1.5 billion cubic feet) of water per second are continually moved from the ocean bottom to the surface in a massive tumbling rotation.

The Antarctic Circumpolar Current and overturning make the waters around Antarctica an ideal habitat for many marine mammals. Many types of whales, for instance, migrate to the waters around Antarctica every year to feed on phytoplankton and other tiny sea creatures churned up by overturning waters.

Climate Change

Ocean temperature plays a key role in the conveyor belt, so a change in the Earth's climate might have drastic effects on the system. If one part of the conveyor belt breaks down—if cold water is not lifted to the surface in upwelling, for instance—nutrients will not be distributed to start the food chain. Organisms, such as phytoplankton, need those nutrients to thrive. Severe climate change slows phytoplankton from forming the first link in the marine food chain. If the first link is threatened, all life in the oceans is threatened.

VOCABULARY

Term	Part of Speech	Definition
basin	<i>noun</i>	a dip or depression in the surface of the land or ocean floor.
channel	<i>noun</i>	waterway between two relatively close land masses.
climate	<i>noun</i>	all weather conditions for a given location over a period of time.
climate change	<i>noun</i>	gradual changes in all the interconnected weather elements on our planet.
continent	<i>noun</i>	one of the seven main land masses on Earth.
current	<i>noun</i>	steady, predictable flow of fluid within a larger body of that fluid.
decay	<i>verb</i>	to rot or decompose.
density	<i>noun</i>	number of things of one kind in a given area.
equilibrium	<i>noun</i>	point where pushing forces and pulling forces are in balance.
evaporate	<i>verb</i>	to change from a liquid to a gas or vapor.
food chain	<i>noun</i>	group of organisms linked in order of the food they eat, from producers to consumers, and from prey, predators, scavengers, and decomposers.
frigid	<i>adjective</i>	very cold.
Gulf Stream	<i>noun</i>	warm current that starts in the Gulf of Mexico and travels along the eastern coast of the U.S. and Canada before crossing the North Atlantic Ocean.

habitat	<i>noun</i>	environment where an organism lives throughout the year or for shorter periods of time.
marine	<i>adjective</i>	having to do with the ocean.
massive	<i>adjective</i>	very large or heavy.
migrate	<i>verb</i>	to move from one place or activity to another.
nutrient	<i>noun</i>	substance an organism needs for energy, growth, and life.
ocean	<i>noun</i>	large body of salt water that covers most of the Earth.
ocean conveyor belt	<i>noun</i>	system in which water moves between the cold depths and warm surface in oceans throughout the world. Also called thermohaline circulation.
ocean layer	<i>noun</i>	one of five marine depths: epipelagic, mesopelagic, bathypelagic, abyssopelagic and hadalpelagic.
photosynthesis	<i>noun</i>	process by which plants turn water, sunlight, and carbon dioxide into water, oxygen, and simple sugars.
phytoplankton	<i>noun</i>	microscopic organism that lives in the ocean and can produce its own food through photosynthesis.
polar	<i>adjective</i>	having to do with the North and/or South Pole.
primary	<i>adjective</i>	first or most important.
salinity	<i>noun</i>	saltiness.
sediment	<i>noun</i>	solid material transported and deposited by water, ice, and wind.
shore	<i>noun</i>	coast.
temperature	<i>noun</i>	degree of hotness or coldness measured by a thermometer with a numerical scale.
thermocline	<i>noun</i>	level or layer of a fluid depth where temperature changes more rapidly than the fluid either above or below it.
thermohaline circulation	<i>noun</i>	ocean conveyor belt system in which water moves between the cold depths and warm surface in oceans throughout the world.
upwelling	<i>noun</i>	process by which currents bring cold, nutrient-rich water to the ocean surface.
wave	<i>noun</i>	moving swell on the surface of water.
wind	<i>noun</i>	movement of air (from a high pressure zone to a low pressure zone) caused by the uneven heating of the Earth by the sun.

FOR FURTHER EXPLORATION

Articles & Profiles

- National Geographic News: Ocean "Conveyor Belt" Sustains Sea Life, Study Says



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