Video
MEDIA SPOTLIGHT

Ocean Currents and Climate

A roller coaster analogy to the ocean conveyor belt

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PARTNER

Mass flows of water, or currents, are essential to understanding how heat energy moves between the Earth's water bodies, landmasses, and atmosphere. The ocean covers 71 percent of the planet and holds 97 percent of its water, making the ocean a key factor in the storage and transfer of heat energy across the globe. The movement of this heat through local and global ocean currents affects the regulation of local weather conditions and temperature extremes, stabilization of global climate patterns, cycling of gases, and delivery of nutrients and larva to marine ecosystems.

Ocean currents are located at the ocean surface and in deep water below 300 meters (984 feet). They can move water horizontally and vertically and occur on both local and global scales. The ocean has an interconnected current, or circulation, system powered by wind, tides, the Earth's rotation (Coriolis effect), the sun (solar energy), and water density differences. The topography and shape of ocean basins and nearby landmasses also influence ocean currents. These forces and physical characteristics affect the size, shape, speed, and direction of ocean currents.

Surface ocean currents can occur on local and global scales and are typically wind-driven, resulting in both horizontal and vertical water movement. Horizontal surface currents that are local and typically short term include rip currents, longshore currents, and tidal currents. In upwelling currents, vertical water movement and mixing brings cold, nutrient-rich water toward the surface while pushing warmer, less dense water downward, where it condenses and sinks. This creates a cycle of upwelling and downwelling. Prevailing winds, ocean surface currents, and the associated mixing influence the physical, chemical, and biological characteristics of the ocean, as well as global climate.

Deep ocean currents are density-driven and differ from surface currents in scale, speed, and energy. Water density is affected by the temperature, salinity (saltiness), and depth of the water. The colder and saltier the ocean water, the denser it is. The greater the density differences between different layers in the water column, the greater the mixing and circulation. Density differences in ocean water contribute to a global-scale circulation system, also called the global conveyor belt.

The global conveyor belt includes both surface and deep ocean currents that circulate the globe in a 1,000-year

cycle. The global conveyor belt's circulation is the result of two simultaneous processes: warm surface currents carrying less dense water away from the Equator toward the poles, and cold deep ocean currents carrying denser water away from the poles toward the Equator. The ocean's global circulation system plays a key role in distributing heat energy, regulating weather and climate, and cycling vital nutrients and gases.

QUESTIONS

- Density differences in ocean water drive the global conveyor belt. This global circulation system is also called thermohaline circulation. When broken down into its root words, what does "thermohaline" mean?

  Thermo means temperature and **haline means salinity** (salt content).

- The global conveyor belt carries water and heat energy across the globe. What is the difference in how the conveyor belt moves water in the tropics compared to the Arctic?

In the Tropics, **water warms and becomes less dense**, so **it rises toward the surface**. **In the Arctic**, **water cools and becomes more dense**, so **it sinks toward the depths**.

- What forces are responsible for tidal currents and are they predictable?

Tidal currents are primarily driven by the **gravitational interaction of the sun**, **moon**, **and Earth**. They are also **influenced by coastal topography**. Tidal currents are the only type of currents that change regularly and can be easily predicted.

FAST FACTS

- Climate change leading to increases in ocean temperatures, evaporation of seawater, and glacial and sea ice melting could create an influx of warm freshwater onto the ocean surface. This would further block the formation of sea ice and disrupt the sinking of denser cold, salty water. These events could slow or even stop the ocean conveyor belt, which would result in global climate changes that could include drastic decreases in Europe's temperatures due to a disruption of the Gulf Stream.

- It would take a single water molecule approximately 1,000 years to complete one full cycle of the global conveyor belt. In that time, the water molecule would travel through the waters of all the major ocean basins: Pacific, Atlantic, Indian, Southern, and Arctic.

- The volume of water transported by the global conveyor belt is equal to 100 Amazon Rivers or 16 times the flow of all the world's rivers combined.

VOCABULARY

Term	Part of Speech	Definition
climate	*noun*	all weather conditions for a given location over a period of time.
Coriolis effect	*noun*	the result of Earth's rotation on weather patterns and ocean currents. The Coriolis effect makes storms swirl clockwise in the Southern hemisphere and counterclockwise in the Northern Hemisphere.
current	*noun*	steady, predictable flow of fluid within a larger body of that fluid.

density	*noun*	number of things of one kind in a given area.
ocean circulation	*noun*	worldwide movement of water (currents) in the ocean.
ocean conveyor belt	*noun*	system in which water moves between the cold depths and warm surface in oceans throughout the world. Also called thermohaline circulation.
rip current	*noun*	a strong flow of water running from the shore to the open ocean, sea, or lake.
salinity	*noun*	saltiness.
solar energy	*noun*	radiation from the sun.
thermohaline circulation	*noun*	ocean conveyor belt system in which water moves between the cold depths and warm surface in oceans throughout the world.
topography	*noun*	the shape of the surface features of an area.
upwelling	*noun*	process by which currents bring cold, nutrient-rich water to the ocean surface.
weather	*noun*	state of the atmosphere, including temperature, atmospheric pressure, wind, humidity, precipitation, and cloudiness.

For Further Exploration

Books

- National Geographic Environmental Literacy Teacher Guide Series: One Ocean, Chapter One—Ocean Currents

Instructional Content

- National Geographic Education: The Geography of Ocean Currents

Websites

- National Oceanic and Atmospheric Administration: Ocean Service Education—The Ocean's Role in Weather and Climate
- National Oceanic and Atmospheric Administration: Education Resources—Ocean Currents
- National Geographic: Ocean Conveyor Belt—Thermohaline Circulation
- National Geographic: Alien Deep

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This material is based in part upon work supported by the National Science Foundation under Grant No. DRL-1114251. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.