

Earth Science

Chapter 21

Section 1 - Ocean Currents

E.Q.: *How do wind patterns, the rotation of the Earth, and continental barriers affect surface ocean currents?*

STANDARDS:

SES5. Students will investigate the interaction of insolation and Earth systems to produce weather and climate.

- a. Explain how latitudinal variations in solar heating create atmospheric and ocean currents that redistribute heat globally.

Objectives

- **Describe how wind patterns, the rotation of Earth, and continental barriers affect surface currents in the ocean.**
- **Identify the major factor that determines the direction in which a surface current circulates.**
- **Explain how differences in the density of ocean water affect the flow of deep currents.**

Ocean Currents

***current in geology* - a horizontal movement of water in a well-defined pattern, such as a river or stream**

- **Oceanographers identify ocean currents by studying the physical and chemical characteristics of the ocean water.**
- **Scientists place ocean currents into two major categories: surface currents and deep currents.**



US scientists discovered two giant whirlpools in the Atlantic Ocean, off the coast of Guyana and Suriname. It became a sensational discovery because this part of the ocean has been studied thoroughly, and no one expected anything like that to appear in the area. More importantly, no one can understand where the whirlpools came from and what surprises they may bring to people.

According to Brazilian scientist Guilherme Castellane, the two funnels are approximately 400 kilometers in diameter. Until now, these were not known on Earth. The funnels reportedly exert a strong influence on climate changes that have been registered during the recent years.

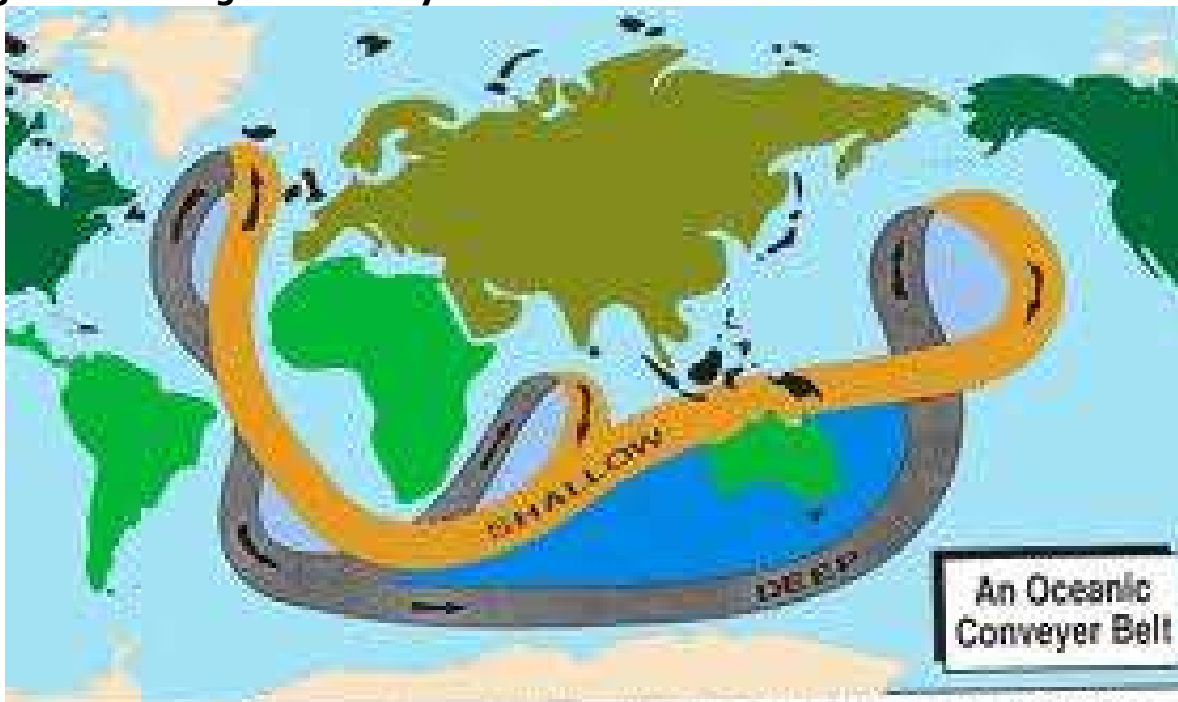


Figure 1. The long-term (millenar) circulation of water through the deep oceans, resulting in surface movements. (After Rooster et al., 1981)

Factors That Affect Surface Currents

surface current - a horizontal movement of ocean water that is caused by wind and that occurs at or near the ocean's surface

- **Surface currents are controlled by three factors: air currents, Earth's rotation, and the location of the continents.**
- **Because *wind* is moving air, wind has kinetic energy.**
- **As energy is transferred from the air to the ocean, the water at the ocean's surface begins to move.**

The website below shows ocean currents and wind belts.
http://www.classzone.com/books/earth_science/terc/content/visualizations/es2401/es2401page01.cfm?chapter_no=visualization

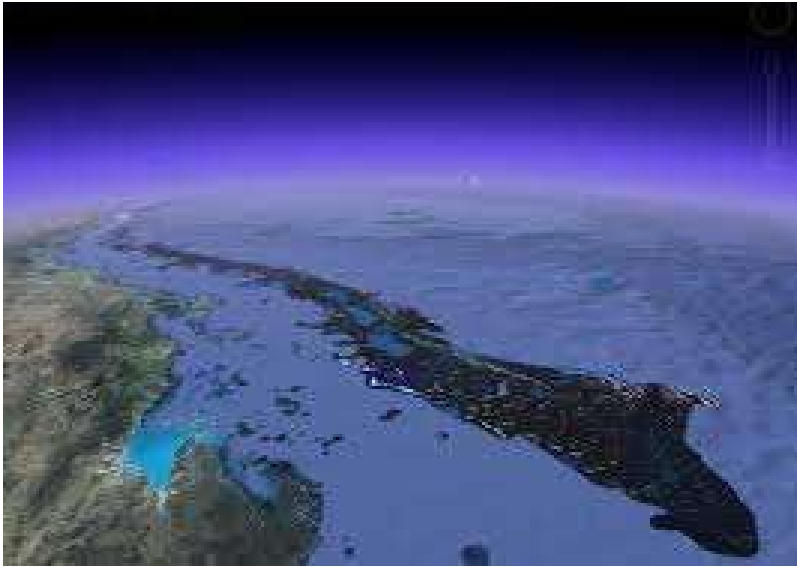
Global Wind Belts

- **Global wind belts, such as the trade winds and westerlies, are a major factor affecting the flow of ocean surface water.**
- **In both hemispheres, trade-wind belts push currents westward across the tropical latitudes of all three major oceans.**
- **Westerlies push ocean currents eastward in the higher latitudes of the Northern and Southern Hemispheres.**



Continental Barriers

- **The continents are another major influence on surface currents.**
- **The continents act as barriers to surface currents.**
- **When a surface current flows against a continent, the current is deflected and divided.**

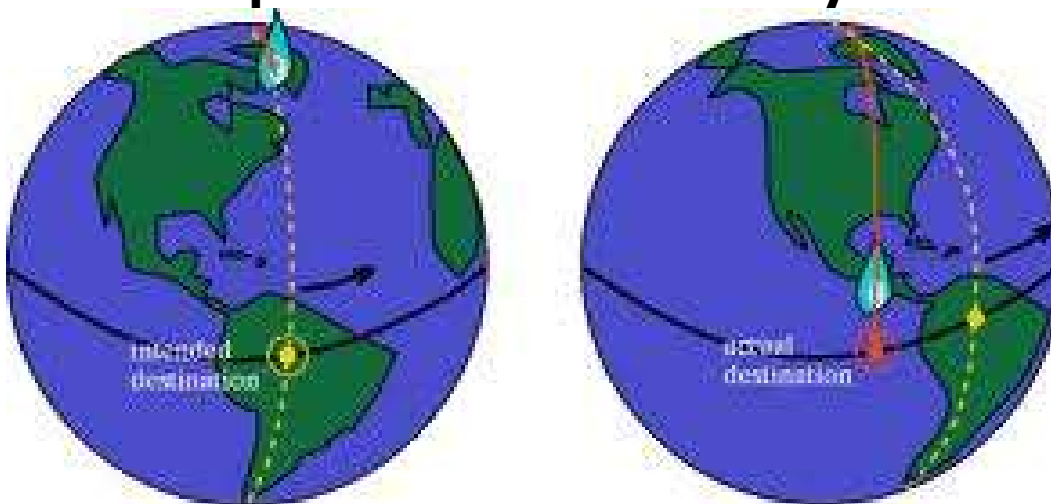


Great Barrier Reef

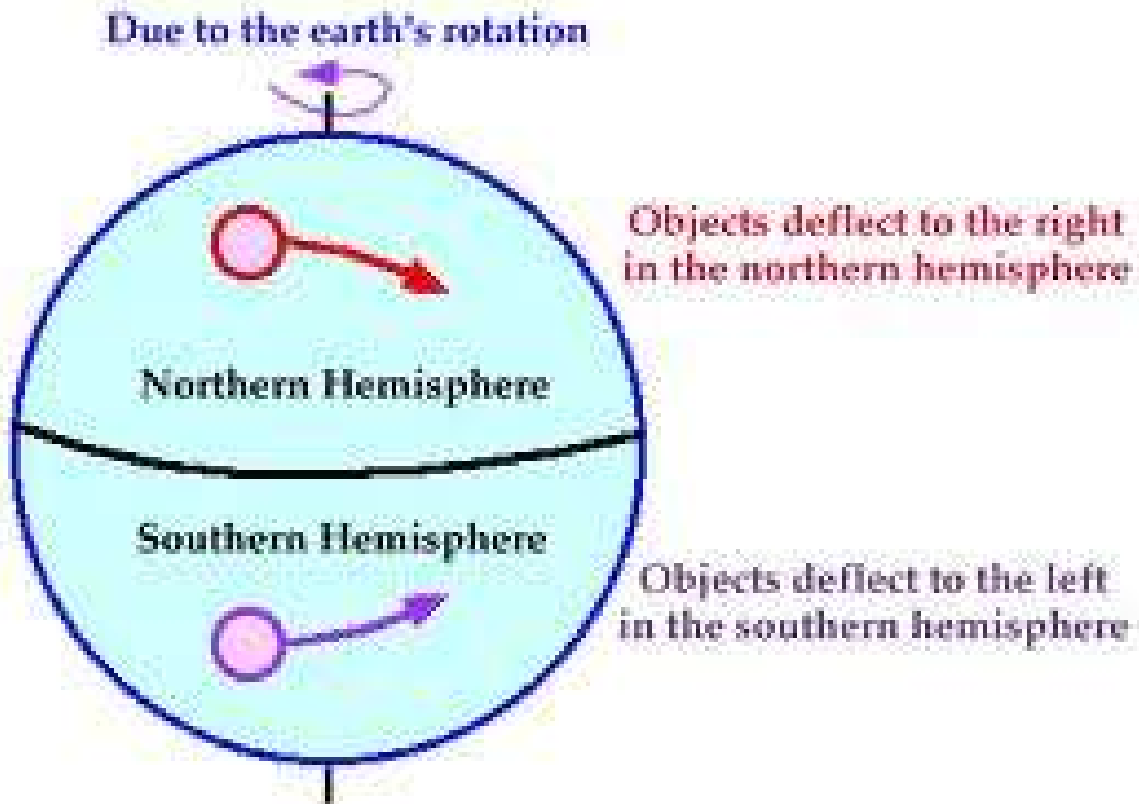
The Coriolis Effect

Coriolis effect - the apparent curving of the path of a moving object from an otherwise straight path due to Earth's rotation

- Wind belts and ocean currents follow a curved or circular pattern that is caused by Earth's rotation.



Coriolis effect: Original path of air is deflected westward by the rotation of the planet.



- ***gyre*** - a huge circle of moving ocean water found above and below the equator
- Wind belts and the Coriolis effect cause huge circles of moving water, called gyres, to form.
- In the Northern Hemisphere, water flow in gyres is to the right, or clockwise. In the Southern Hemisphere, the flow is to the left, or counterclockwise.



the Northern Gyre, in the Pacific Ocean

MAJOR SURFACE CURRENTS

Equatorial Currents

- Warm equatorial currents are located in the Atlantic, Pacific, and Indian Oceans.
- Each of these oceans has two warm-water equatorial currents that move in a westward direction.
- Between these westward-flowing currents lies a weaker, eastward-flowing current called the *Equatorial Countercurrent*.

Currents in the Southern Hemisphere

- In the most southerly regions of the oceans, constant westward winds produce the world's largest current, the *Antarctic Circumpolar Current*, also known as *West Wind Drift*.
- No continents interrupt the movement of this current that completely circles Antarctica and crosses all three major oceans.

READING CHECK

What is the world's largest ocean current?

Because no continents interrupt the flow of the Antarctic Circumpolar Current, also called the West Wind Drift, it completely encircles Antarctica and crosses three major oceans. All other surface currents are deflected and divided when they meet a continental barrier.

Currents in the North Atlantic

Gulf Stream - the swift, deep, and warm Atlantic current that flows along the eastern coast of the United States toward the north

- South of Greenland, the Gulf Stream widens and slows until it becomes a vast, slow-moving warm current known as the *North Atlantic Current*.
- Near western Europe, the North Atlantic Current splits.

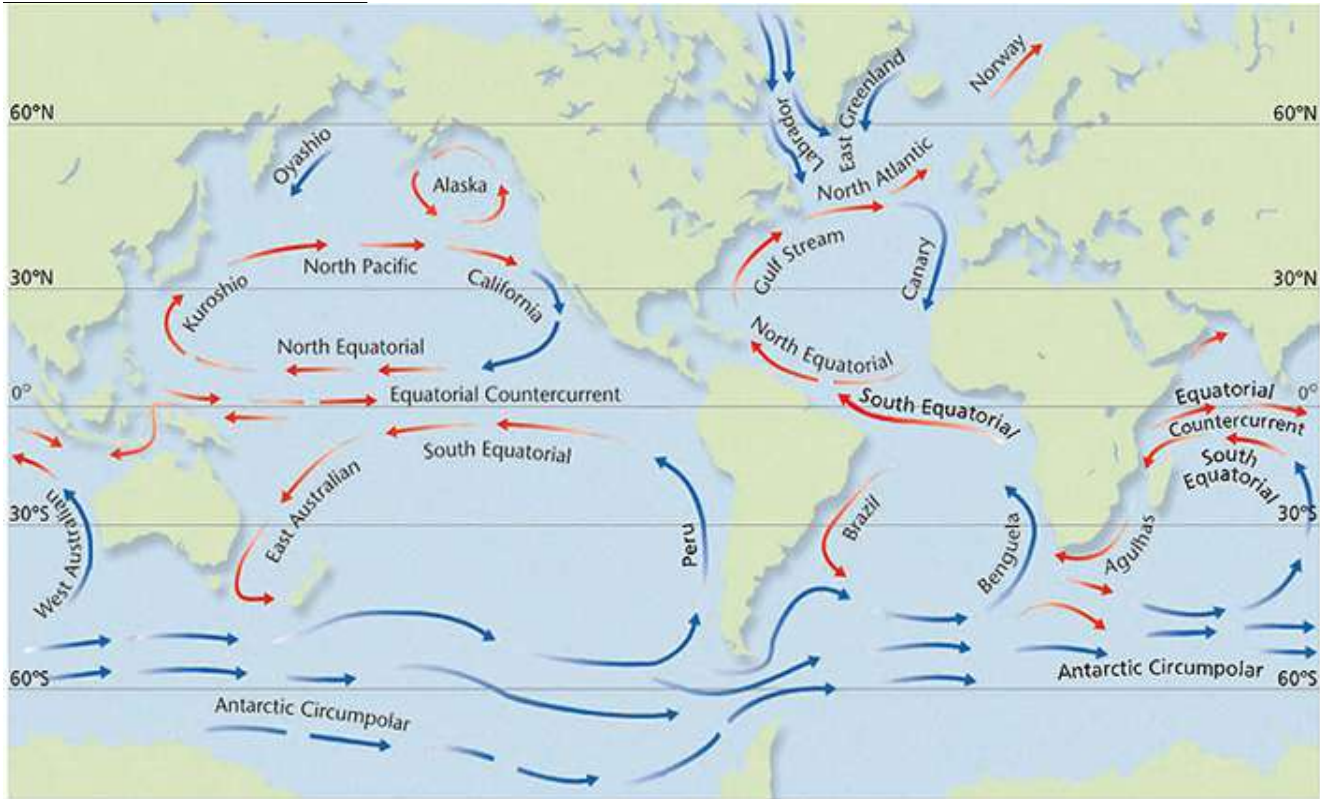
- The Gulf Stream, the North Atlantic Current, the Canary Current, and the North Equatorial Current form the North Atlantic Gyre.
- At the center of this gyre lies a vast area of calm, warm water called the *Sargasso Sea*.



Currents in the North Pacific

- The patterns of currents in the North Pacific is similar to that in the North Atlantic.
- The warm Kuroshio Current, the Pacific equivalent of the Gulf Stream, flows northward along the east coast of Asia. This current then flows toward North America as the North Pacific Drift.
- It eventually flows southward along the California coast as the cool California Current.

The diagram below shows the major surface currents of Earth's oceans.



Deep Currents

deep current a streamlike movement of ocean water far below the surface

- Deep currents form as cold, dense water of the polar regions sinks and flows beneath warmer ocean water.
- The movement of polar waters is a result of differences in density.
- Temperature determines density. Salinity, too, determines the density of water.

Antarctic Bottom Water

- The temperature of the water near Antarctica is very cold, -2°C . The water's salinity is high. These two factors make the water off the coast of Antarctica the densest and coldest ocean water in the world.
- This dense, cold water sinks to the ocean bottom and forms a deep current called the *Antarctic Bottom Water*.

READING CHECK

Why is Antarctic Bottom Water the densest in the world?

Antarctic Bottom Water is very cold. It also has a high salinity. The extreme cold and high salinity combine to make the water extremely dense.

North Atlantic Deep Water

- **In the North Atlantic, south of Greenland, the water is very cold and has a high salinity. This cold, salty water forms a deep current that moves southward under the northward flowing Gulf Stream.**
- **The dense, highly saline water of the Mediterranean Sea forms a deep current as it flows through the strait of Gibraltar and into the less dense Atlantic Ocean.**

Turbidity Currents

- **A turbidity current is a strong current caused by an underwater landslide.**
- **The sediment causes the water to become cloudy, or turbid, and denser than the surrounding water.**
- **The dense water mass of the turbidity current moves beneath the less dense, clear water.**

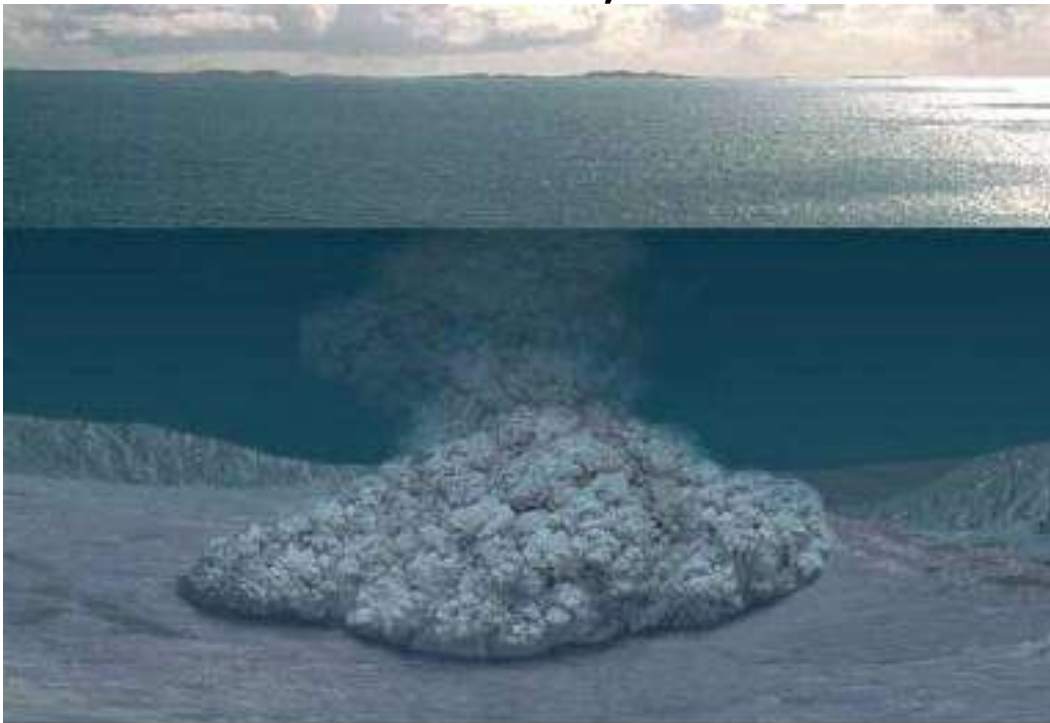


Image courtesy of the Open University

model of a turbidity current

