

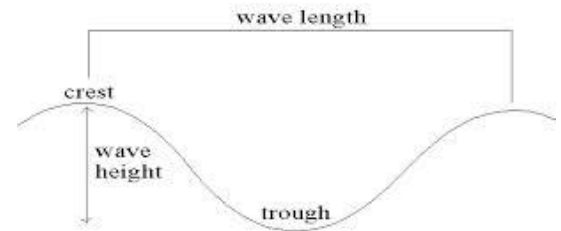
Movement of Ocean Waters

Seawater is mobile. It moves horizontally and vertically. The movement of seawater takes place in three different ways—through waves, tides and currents.

Waves

Waves are the alternate rise and fall of the sea surface or seawater. The following is the structure of a wave:

- A wave has a curve-like structure. The top part of the wave is known as the **crest**.
- The lower part of the wave between two crest points is known as the **trough**.
- The distance between two consecutive crests and two consecutive troughs is known as the **wavelength**.
- **Wave period** is the time taken by two consecutive crests to pass any fixed point.
- The vertical distance between a trough and a crest is called the **wave height**.



Structure of a wave

Tides

The rise and fall of seawater because of the gravitational forces of the Sun and the Moon are called tides. Sea waves produced by tides are known as **tidal waves**. The rise of seawater and its movement towards the coast is called **tide**. As a result, when the water level is high, it is known as **high water tide**. The fall of seawater and its movement towards the sea is called **ebb**. The resultant low water level is called **low tide water**. The difference between high tide water and low tide water is called **tide range**.

Factors Causing Tides

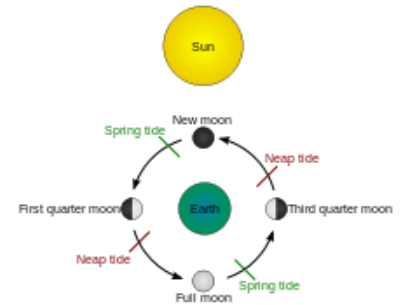
Tides are caused by the following reasons:

- Tides are basically caused by the gravitational pull of the Moon and the Sun.
- The Earth revolves round the Sun and the Moon revolves around the Earth in an elliptical orbit. The distance between the Earth and the Moon changes many times during a month.
- The surface of the Earth which faces the Moon experiences maximum gravitational pull of the Moon. As a result, the water of the Earth's surface gets pulled up and thus high tides occur.
- High tides also occur in the part of the Earth which is facing away from the Moon because of the centrifugal force (the force which draws a rotating body away from the centre of rotation) of the gravitational pull of the Moon causing an outward bulge of water.
- The period of farthest distance between the Moon and the Earth is called apogee. The period of the nearest distance between the Moon and the Earth is known as perigee.

Some Facts about Tides

- Tides and ebbs occur twice on the Earth's water surface in 24 hours. High tides take place when the Sun, the Earth and the Moon are in the same line. When their gravitational forces work together, high tides are formed.
- When the Sun and the Moon are at the position of right angles with reference to the Earth, the gravitational forces of the Sun and the Moon work against each other resulting in low tides.

- Every place experiences tides twice a day.
- When the Sun, Moon and Earth are in the same line, the tides are highest and they are called spring tides.
- When the Moon is in its first and last quarter, the ocean water gets pulled in the opposite direction of the Moon by the Sun's and Earth's gravitational force causing low tides. These tides are also known as neap tides.



Importance of Tides

- Tides can cause a change in the landforms of the Earth. While tides can destroy the coastlines, they also help in the formation of creeks and inlets.
- Strong tides help in building lower floodplains of rivers. These are very fertile.
- Because the debris is swept away by the tides, they help keep the harbours clean.
- In cold countries, tides bring in saltwater to the shore and their continuous movement prevent the harbour from becoming ice bound.
- The low-lying areas of the sea coast during high tides trap water which is used for the manufacturing of salt. Salt is manufactured along the west coast of India in this manner.
- The alternate rise and fall of tides help fisherman to sail out and return to the coast.
- Tidal energy is fast becoming an important source of non-convectional sources of energy. They are used in the production of electricity along the Gulf of Kachchh in Gujarat.

Ocean Currents

Ocean currents are the regular movements of water in the oceans. They move in a circular pattern around the oceans. Based on temperature and depth, ocean currents may be divided into the following divisions:

Based on temperature	Warm currents and cold currents	Warm currents: These currents flow from low latitudes in the tropical zone towards the high latitudes in the temperate and sub-polar regions. These currents bring warm water to cold regions. Cold currents: These currents flow from the polar regions to the equatorial regions. These currents bring cold water to warm regions.
Based on depth	Surface currents and deep water currents	Surface currents: These currents make about 10% of all water in the ocean. Deep water currents: These currents make about 90% of all water in the ocean.

Causes of Ocean Currents

Factors which affect ocean currents:

Temperature: Temperature affects the origin and nature of ocean currents. As equatorial and tropical regions are warm, the oceans lying near the Equator and the tropics are warmer than the oceans lying near the Polar Regions. Thus, the ocean currents from warm equatorial regions move towards the Polar Regions as warm currents. Similarly, the cold currents move from the Polar Regions to the equatorial regions as cold currents.

Level of Salinity: Oceans with a higher level of salinity are denser than oceans with lower levels of salinity. Generally, the ocean currents are generated from areas of less salinity to areas of high salinity.

Because the Mediterranean Sea is more saline than the Atlantic Ocean, most ocean currents flow from the Atlantic Ocean to the Mediterranean Sea.

Rotation of the Earth: The Earth rotates from west to east. The speed of rotation of the Earth is maximum at the Equator. All the moving bodies move in a clockwise direction in the Northern Hemisphere and in an anti-clockwise in the Southern Hemisphere. This is also known as the **Coriolis Effect**.

Planetary Winds: Winds affect the ocean currents. The trade winds blow between the Equator and the Tropics. These winds thus move the equatorial water towards the poles. For example, the Southeast Trade Winds drift the equatorial current to the eastern coast of Australia as the warm East Australian Current.

Landforms: A landform may influence the ocean currents. For example, the shape of various landmasses may obstruct the flow of water and influence its movement. For example, the South Equatorial Current gets deflected towards the Northern Hemisphere.

The circulation pattern of the ocean currents is influenced by the Earth's atmospheric circulation pattern. At higher latitudes, the wind flow is cyclonic. Thus, the oceanic currents move in a cyclonic pattern. Similarly, in middle latitudes, air circulation is mainly anti-cyclonic. The currents thus move in an anti-cyclonic pattern.

Major Ocean Currents

Name of Current	Type of Current	Origination	Characteristics
The Gulf Stream	Warm Current	Gulf of Mexico, the Atlantic Ocean	- It is a powerful warm current which keeps the climate of Western and Northern Europe warm. - Its presence has led to the development of strong cyclones. It is also used as a source of power generation.
The North Atlantic Drift	Warm Current	The Atlantic Ocean	- The Gulf Stream current gets deflected towards the east because of the Westerlies and the rotation of the Earth and reach Europe as the North Atlantic Drift. - This current keeps the ports of Europe free of ice even during winters.
The Kuroshio Current	Warm Current	The Atlantic Ocean	- It begins from the east coast of Taiwan and flow towards Japan. - The warm waters of this current sustain the coral reefs in the world.
The Labrador Current	Cold Current	The Atlantic Ocean	- It flows from the Arctic Ocean and meets the warm Gulf Stream in the southeast coast of Newfoundland. - In early summers, this current transports icebergs from the glaciers of Greenland to the Trans-Atlantic shipping lanes. - It has a cooling effect on the Canadian Atlantic provinces.

The Oyashio Current	Cold Current	The Atlantic Ocean	- It impacts the climate of the Russian Far East. - The waters of the current form the richest fishing grounds in the world because of high nutrient content of the cold waters.
North Equatorial Current	Warm Current	The Pacific Ocean	It flows from the western coast of Mexico to the Philippines.
South Equatorial Current	Warm Current	The Pacific Ocean	It flows in the southern Pacific Ocean and bifurcates into the northern and southern branches near New Guinea.
California Current	Cold Current	The Pacific Ocean	It flows along the western coast of USA and merges with the warm North Equatorial Current.
West Wind Drift	Cold Current	The Pacific Ocean	It flows from west to east in the zone of 40°S–50°S under the influence of the Westerlies.
Peruvian	Cold Current	The Pacific Ocean	It flows northwards along the western coast of South America.
Indian Equatorial Current	Warm Current	The Indian Ocean	It flows westwards in the South Indian Ocean.
Southwest Monsoon Current	Warm Current	The Indian Ocean	It flows along the coast of India in the easterly direction.
Northeast Monsoon Current	Warm Current	The Indian Ocean	It flows along the eastern coast of India during winters.

Effects of Ocean Currents

- **Affect Temperatures:** Currents influence the climatic conditions of the regions in which they blow. The warm equatorial currents raise the temperature of the region in which they blow. Similarly, the cold currents lower the temperature of the places where they blow. For example, British Isles would have been extremely cold without the warm North Atlantic Drift. The hot climate of Peru is cooled by the cold Peru Current.
- **Affect Rainfall:** The winds blowing over warm currents pick up and carry moisture and bring rainfall. For example, the North Atlantic Drift brings rainfall in some areas located along the western coasts of Europe. On the contrary, cold currents do not bring rainfall and make the region cooler and drier. The Kalahari Desert hardly experiences rainfall because of the cold Benguela Current.
- **Fog:** The meeting of the warm and cool currents results in the creation of fog. For example, the Japanese coast experiences heavy fog when the warm Kuroshio current meets the cold Oyashio current.
- **Violent Storms:** At times, the meeting line of a warm and a cold current may cause a violent storm. The hurricanes which occur off the coast of USA follow the line where the Gulf Stream merges with the Labrador Current.
- The mixing of warm and cold currents results in the **deposition of plankton**. Therefore, at such places, fish can be found in abundance.
- Currents help the ships to sail if they follow the directions of the currents.
- Many warm currents keep the ports of Europe ice-free even during the winters. This helps in trade and commerce.
- The ships face danger because of the fogs caused by the meeting of the warm currents with the cold currents. This has resulted in the wreckage of many ships in the past as they were not able to view icebergs because of poor visibility.