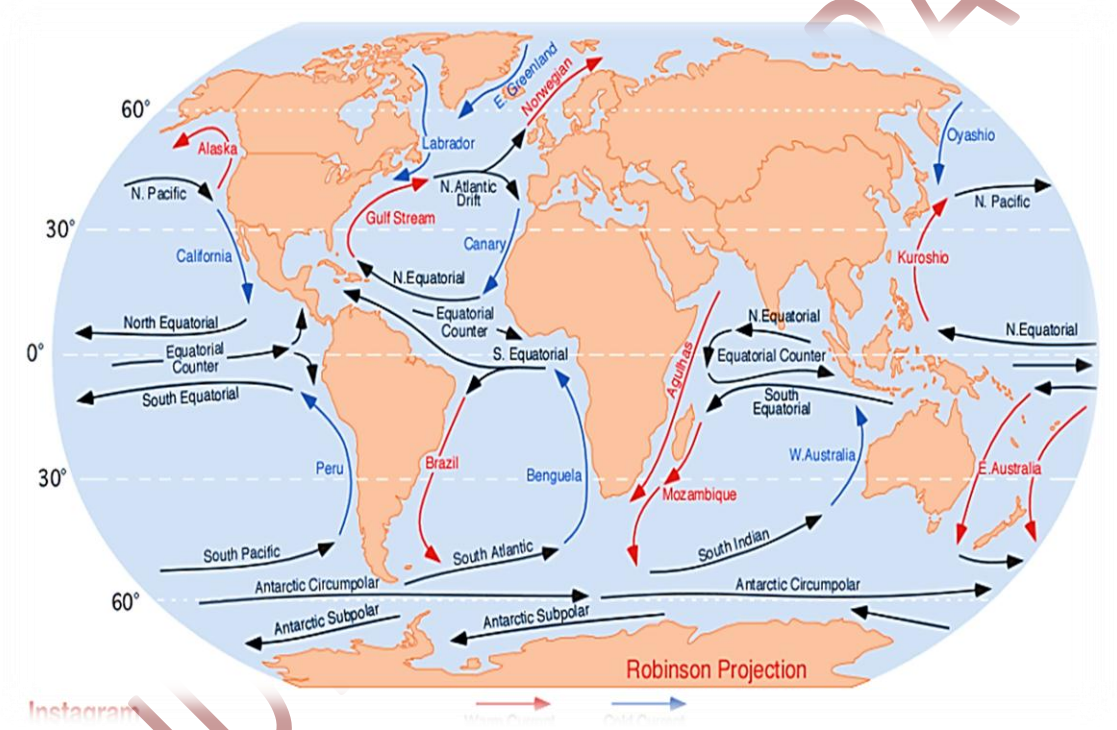
Chapter- 14

Movements Of Ocean water

- Ocean currents are the continuous flow of huge amount of water in a definite direction. Ocean currents are like river flow in oceans. They represent a regular volume of water in a definite path and direction.



Waves

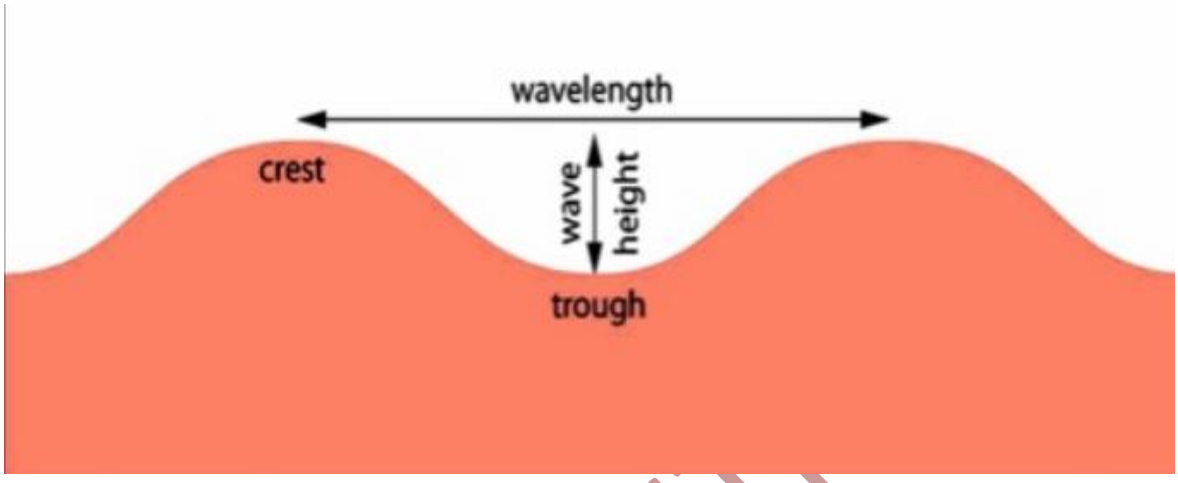
Waves are nothing but the oscillatory movements that result in the rise and fall of water surface.

• Waves are a kind of horizontal movements of the ocean water. • They are actually the energy, not the water as such, which moves across the ocean surface.

• This energy for the waves is provided by the wind.

• In a wave, the movement of each water particle is in a circular manner.

• A wave has two major parts: the raised part is called as the crest while the low-point is called as the trough.



Tides

The periodical rise and fall of the water level in oceans and sea, once or twice a day, due to the gravitational pull of the sun and the moon, is called a tide. The study of tides is very complex, spatially and temporally, as it has great variations in frequency, magnitude and height

The Ocean's Tide

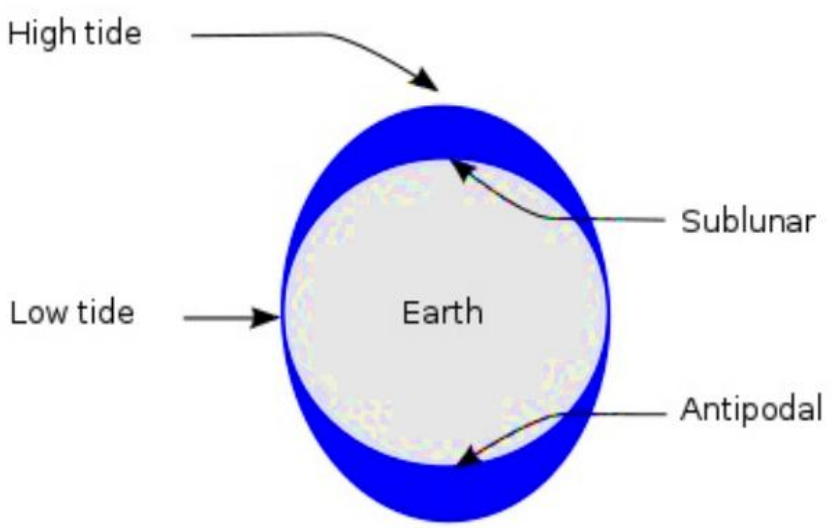
There are three major forces causing an occurrence of tides they are

1. Moon s gravitational pull

2. Sun s gravitational pull.

3. Centrifugal force which acts opposite to gravitational pull of the Earth

- Tides occur due to an imbalance between the various forces acting on the ocean water at a point in time. In general, the tidegenerating force is the difference between these two forces; i.e. the gravitational attraction due to the mass of the moon and the centrifugal force due to rotation of the earth.



MECHANISM

• When the two forces are not in balance, it gives rise to the tide-generating force. The side of the Earth which is closest to the moon has the strongest gravitational attraction towards the moon while water on the other side of the Earth experiences a weaker gravitational force.

• The moons gravitational force has a greater effect than the sun's gravitational force due to the relative distance of moon and sun respectively. The tide-generating force is proportional to the product of the mass of the two bodies but also inversely proportional to the square of the distance between them.

• The tide-generating force due to the Sun is 0.46 that of the moon

OTHER FACTORS CONTROLLING TIDES

• Uneven distribution of water over the globe.

• Irregularities in the configuration of the oceans.

• Differences in the coastal topography of a region. For example, Funnel-shaped bays greatly change tidal magnitudes. When the tide is channelled into bays and estuaries they are called tidal currents.

TYPES OF TIDES

There is no single method to classify them hence they are grouped arbitrarily based on

• Frequency

• The position of the earth, moon, and sun

• The time period between high tide and low tide

• Magnitude

Based on frequency

• **Semi-diurnal Tide:** This is the most common tidal pattern, featuring two high tides and two low tides each day.

• **Diurnal Tides:** Only one high tide and one low tide each day. The successive high and low tides are approximate of the same height.

• **Mixed Tide:** Tides having variations in heights are known as mixed tides. They generally occur along the west coast of North America and also in the Pacific Ocean

Based on sun, moon and earth s positions

• **Spring Tides:** When the position of the sun, the moon, and the earth are aligned in such a way that it forms a straight line, the

height of the tide will be higher than normal. These are called as spring tides. It occurs twice in a month-one on the full moon and the other on the new moon.

- **Neap Tides:** After seven days of spring tides the sun and the moon form a 90-degree angle between each other. The resultant force of gravitation gives rise to a tide of very low magnitude which is termed as the neap tide. It also occurs twice in a month

Based on magnitude

- **Perigee:** When the moon s orbit is closest to the earth, it is called as perigee. During this period, unusual heights of high and low tide occur.

- **Apogee:** When the moon s orbit is farthest from the earth, it is called as apogee. Tidal ranges will be much less than average height during this period.

- **Perihelion:** It is the position where the earth is closest to the sun (around January 3rd). Unusually high and low tides occur at this time.

- **Aphelion:** It is the position where the earth is farthest from the sun (around July 4th). Tidal ranges will be much less than the average height during this period.

The time period between high tide and low tide

The time between the high tide and low tide, when the water level is falling is called the ebb. The time between the low tide and high tide, when the tide is rising, is called the flow.

IMPORTANCE OF TIDES

• They help in navigation. During high tide when the water level rises, large ships can enter or leave harbour safely. Diamond Harbour in West Bengal and Kandla in Gujarat are examples of such ports.

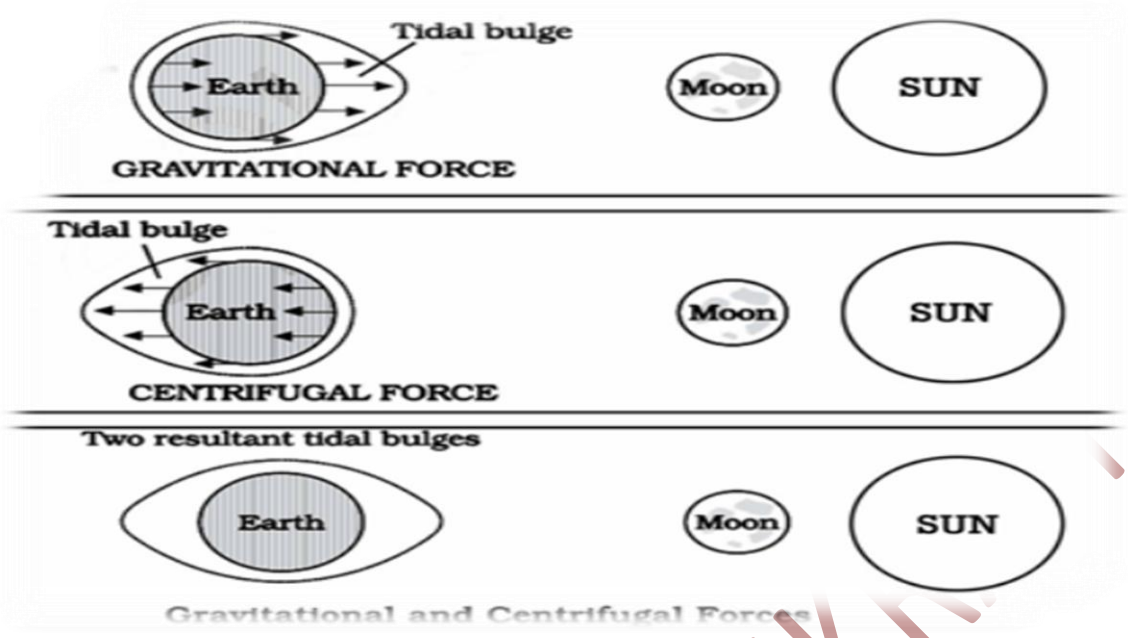
• They help the ships to travel up the mouth of the river in case of river ports. High tide increases the volume of water at the river ports to a high volume so that large ships can sail in safely and use a retreating tide to leave the port. Hooghly (Kolkata), London and New York are examples of some of the important river ports of the world

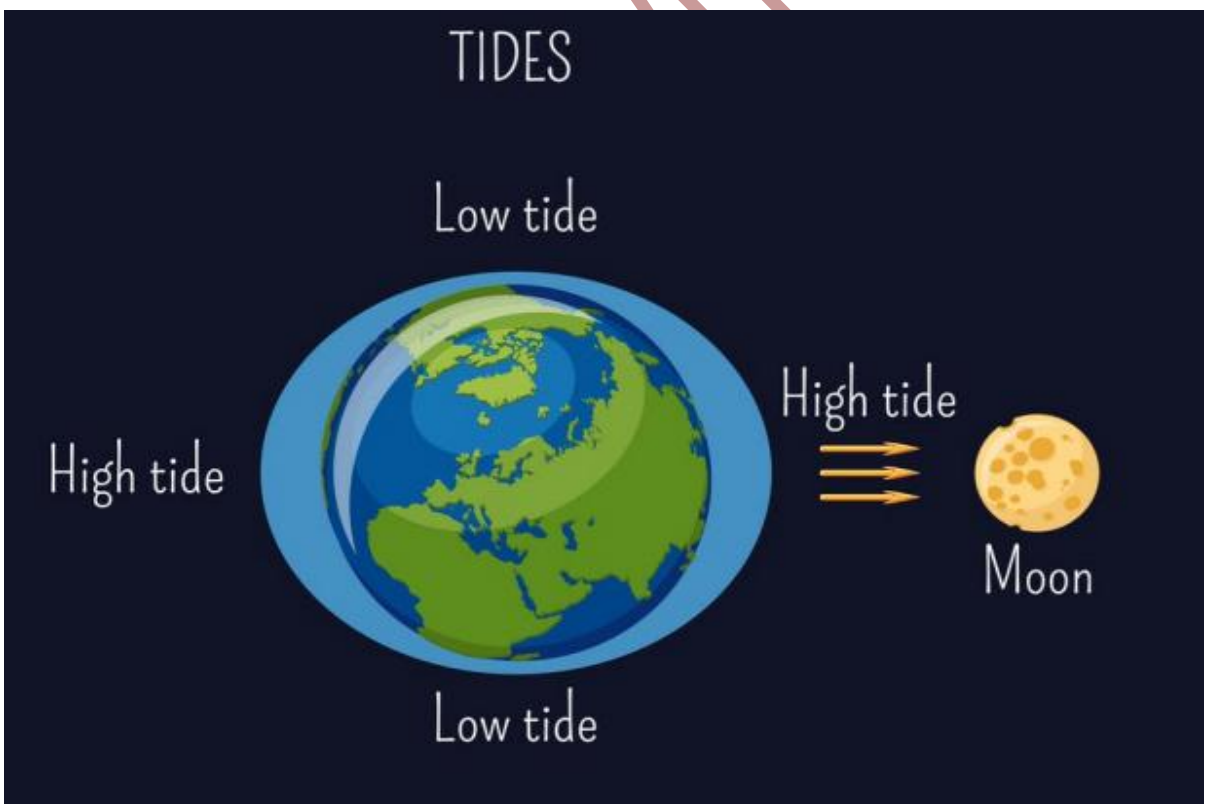
• They help in removal of silt. Rivers wear away and carry down a lot of soil and sand. Tides wash away these deposits and help to keep the mouth of the river clear.

• Saltwater freezes at a temperature that is low than that of fresh water. In cold regions whereas the rivers are frozen in winter, the warmer seawater rushes into the harbours to keep it free from freezing.

• Tidal energy is largely being harnessed to produce electricity as a renewable source of energy.

• They also bring in huge volumes of fish and these areas serve as fishing zones for fishermen without venturing too deep into the sea


Tidal bulge
Earth
Moon
SUN
GRAVITATIONAL FORCE
Tidal bulge
Earth
Moon
SUN
CENTRIFUGAL FORCE
Two resultant tidal bulges
Earth
Moon
SUN
Gravitational and Centrifugal Forces


TIDES
Low tide
High tide
High tide
Moon
Low tide

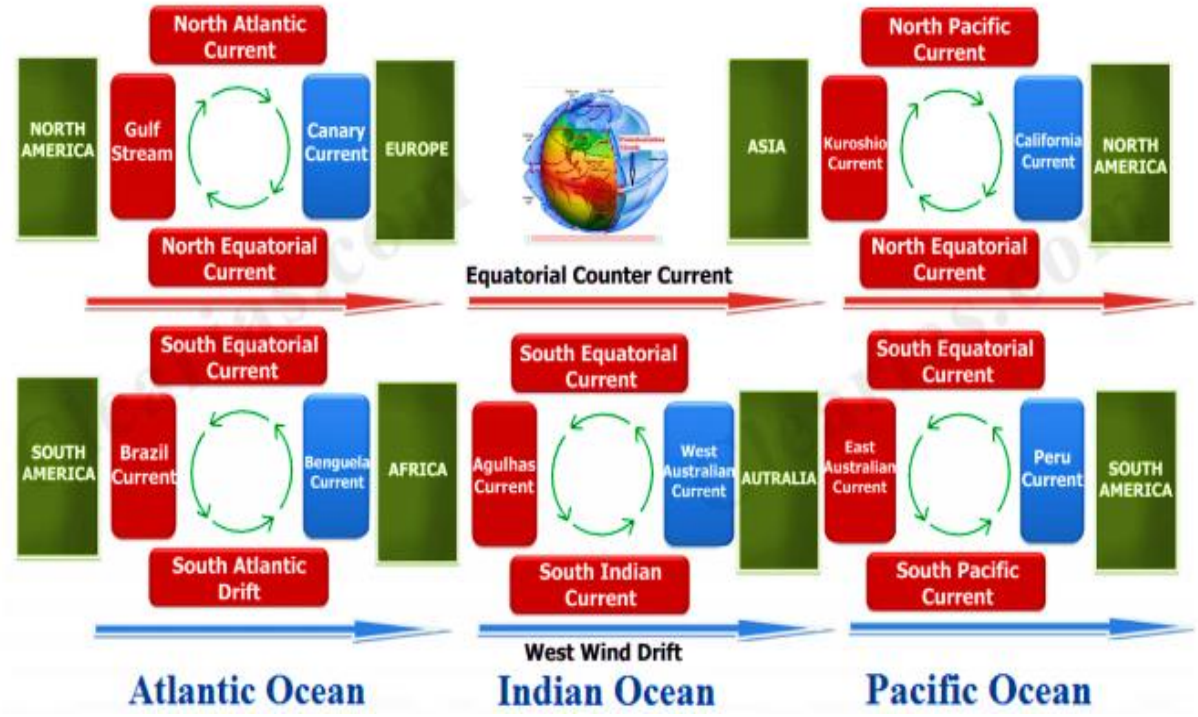
Bay of Fundy

- The highest tides in the world occur in the Bay of Fundy in Nova Scotia, Canada.
- The tidal bulge is 15 – 16 m.
- Because there are two high tides and two low tides every day (slightly more than a 24 hour period); then a tide must come in within about a six hour period.

How to learn the names of ocean currents, faster?

shown the major current systems in the three oceans – Atlantic ocean, Indian ocean and Pacific ocean – from left to right.

Continents are represented in '**Green**', **warm ocean currents** in '**Red**', and **cold ocean currents** in '**Blue**'. Hope it's easy now!



What are the points to remember?

• There are gyres in each of the oceans – The Pacific, Atlantic and Indian ocean. (Any large system of rotating ocean current, particularly those involved with large wind movements is called as a Gyre.).

• **Current direction:** In general, currents in the northern hemisphere travel in the clockwise direction in a gyre, while currents in southern hemisphere travel in the anti-clockwise direction (the only exception is the current direction in the Indian ocean, which changes seasonally.)

• The ocean current movement in the north-Atlantic gyre, as well as northPacific gyre, is clockwise, while the gyres in the Southern hemisphere are anti-clockwise.

• **Current temperature:** In general, currents in the western part of every continent are cold (the exceptions are mentioned in the article on movements of the ocean water).

• Currents coming from the polar region are generally cold

• Currents near to equator are generally warm.

• There is a counter-equatorial current, which moves from west to east (warm).

• The west-wind drift moves from west to east (cold)

1.North Equatorial Current

• It is a significant Pacific and the Atlantic Ocean current that flows from east to west.

• They flow in between 100 north and 200 north latitudes.

• Despite its name, the North Equatorial Current is not connected to the equator.

• In both oceans, it is separated from the equatorial circulation by the equatorial countercurrent, which flows eastward.

2. South Equatorial Current

• It is a significant ocean current in the Pacific, Atlantic and the Indian Ocean that flows from east to west.

• They flow in between the equator and about 200 south.

• In the Pacific and Atlantic Oceans, it extends across the equator to about 50 north

3. Equatorial Counter Current

• It is an eastward flowing current found in the Atlantic, Indian and Pacific Oceans.

• It is found in between the North Equatorial and South Equatorial Currents at about 3-100 northern latitudes.

• This counter-current replaces the water removed from the eastern side of the ocean by the North Equatorial and South Equatorial Currents.

• In the Indian Ocean, the current tends to reverse hemispheres seasonally due to the impact of reversing Asian monsoons.

4. Antarctic Circumpolar Current or West Wind Drift

• It is an ocean current that flows from west to east around the Antarctica.

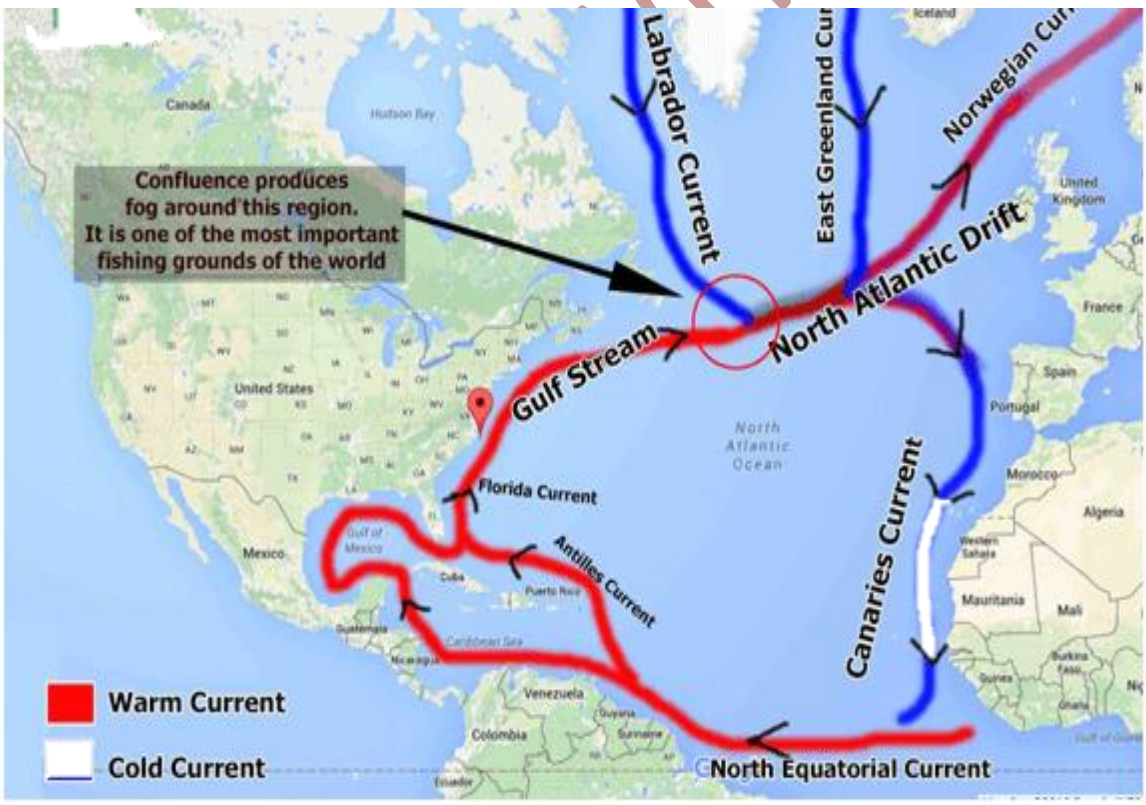
• The current is circumpolar due to the lack of any landmass connecting with the Antarctica and thus keeps warm ocean waters away from the Antarctica.

• The Antarctic Convergence is associated with this current. It is the region where the cold Antarctic waters meet the water of the SubAntarctic, creating a zone of upwelling (a zone of very high marine productivity)

Currents of the Atlantic Ocean

• To the north and south of the equator, there are two westward moving currents, i.e., the North and the South Equatorial Currents.

• Between these two, there is the counter equatorial current which moves from west to east.



ATLANTIC OCEAN: NORTHERN HEMISPHERE

• The South Equatorial Current bifurcates into two branches near the Cape De Sao Roque in Brazil and its northern branch joins the North Equatorial Current.

• A part of this combined current enters the Caribbean Sea and the Gulf of Mexico, while the remaining current passes along the eastern side of the West Indies as the Antilles Current.

• The part of the current which enters the Gulf of Mexico comes out from the Florida Straight and joins the Antilles current.

• This combined current moves along the south-eastern coast of the U.S.A and is known as the Florida Current up to Cape of Hatteras.

• Beyond Cape of Hatteras, it is known as the Gulf Stream

A cold current from the Arctic Ocean called Labrador Current, which flows along the eastern coast of Canada, meets the warm Gulf Stream near the north-east corner of U.S.A.

• The confluence of these two currents, one cold and the other warm, produce fog around the region and makes it the most important fishing ground in the world.

• The Gulf Stream then deflected eastward under the combined influence of the westerlies and the rotation of the earth.

• It then crosses the Atlantic Ocean as the warm North Atlantic Drift.

• In this journey, another cold current from the Arctic called as the East Greenland Current joins with the North Atlantic Drift.

• The North Atlantic Drift bifurcates into two branches on reaching the eastern part of the ocean.

• The northern branch continues as North Atlantic Drift; reaches the British Isles from where it flows along the coast of Norway as the warm Norwegian Current and enters the Arctic Ocean.

• The southern branch flows between Spain and Azores Island as the cold Canaries Current.

• The Canaries Current finally joins the North Equatorial Current and completes the circuit.

ATLANTIC OCEAN: SOUTHERN HEMISPHERE

• The South Equatorial Current turns south and flows along the eastern coast of South America as Brazil Current.

• At about 350 south latitude, due to the influence of westerlies and the rotation of the earth, the current moves eastward.

• A cold current called as the Falkland Current which flows along the south-eastern coast of South America from south to north joins with the current at this time.

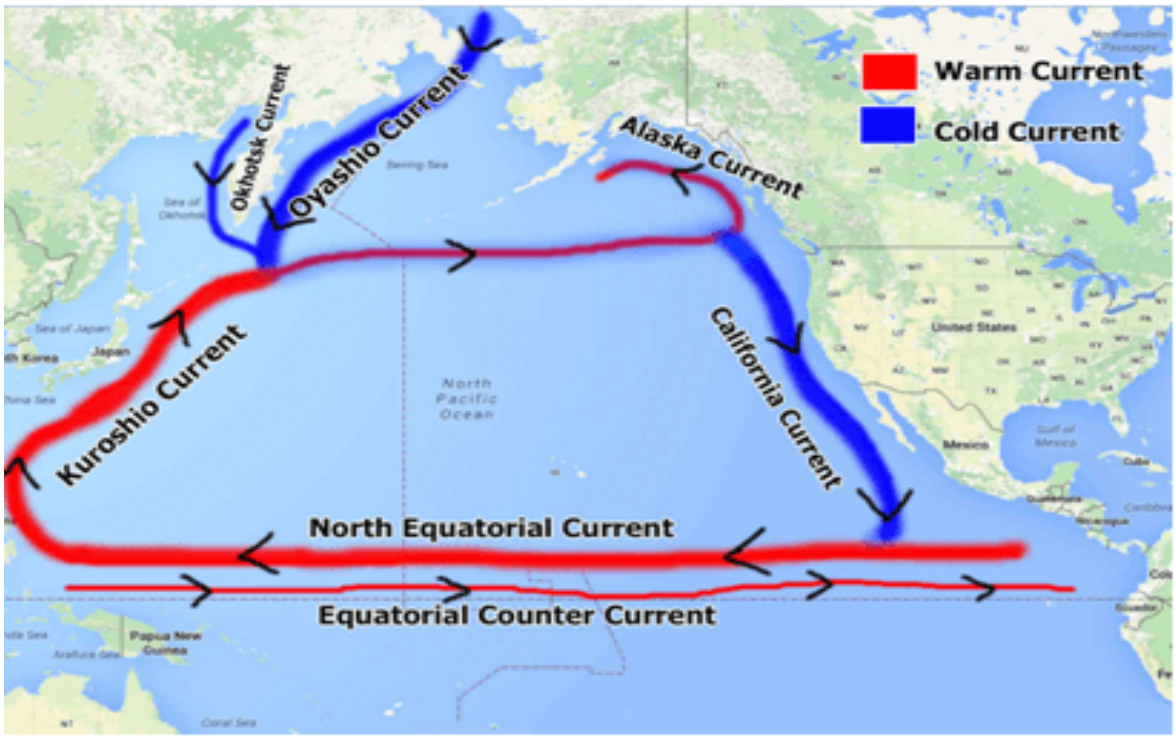
• The Brazil Current moves eastward and crosses the Atlantic Ocean as South Atlantic Current.

• A part of the west wind drift or the Antarctic Circumpolar Current merges with the South Atlantic Current while crossing the Atlantic.

• Near the Cape of Good Hope, the South Atlantic Current is diverted northward as the Cold Benguela Current

. • Benguela Current finally joins with the South Equatorial Current and completes the circuit

Currents of the Pacific Ocean



PACIFIC OCEAN: NORTHERN HEMISPHERE

• The North Equatorial Current turns northward and flows along the Philippines Islands, Taiwan, and Japan to form the warm Kuro Shio or Kuro Siwo current.

• Later, a cold current called Oya Shio or Oya Siwo which flows along the eastern coast of the Kamchatka Peninsula merges with the Kuro Shio Current (Okhotsk Current is a cold current which merges with the Oya Shio before its confluence with Kuro Shio).

• From south-east coast of Japan, the Kuro Shio current comes under the influence of westerlies and flow right across the ocean as the North Pacific Current.

• After reaching the west coast of North America, it bifurcates into two branches: the northern branch flows anti-clockwise along the coast of Alaska as warm Alaska Current and the southern branch

moves southward along the coast of California as the cold California Current.

• California Current eventually joins with the North Equatorial Current and completes the circuit.

PACIFIC OCEAN: SOUTHERN HEMISPHERE

• In the South Pacific Ocean, the South Equatorial Current flows towards the west and turns southward as the East Australian Current.

• From Tasmania, it flows as the cold South Pacific Current from west to east and crosses the Pacific Ocean along with the West Wind Drift.

• On reaching the south-western coast of South America, it turns northward and flows as the cold Peru Current or Humbolt Current.

• The cold waters of the Peru Current are partially responsible for making the coast of the northern Chile and western Peru with very scanty rainfall.

• Peru Current eventually joins with the South Equatorial Current and completes the circuit

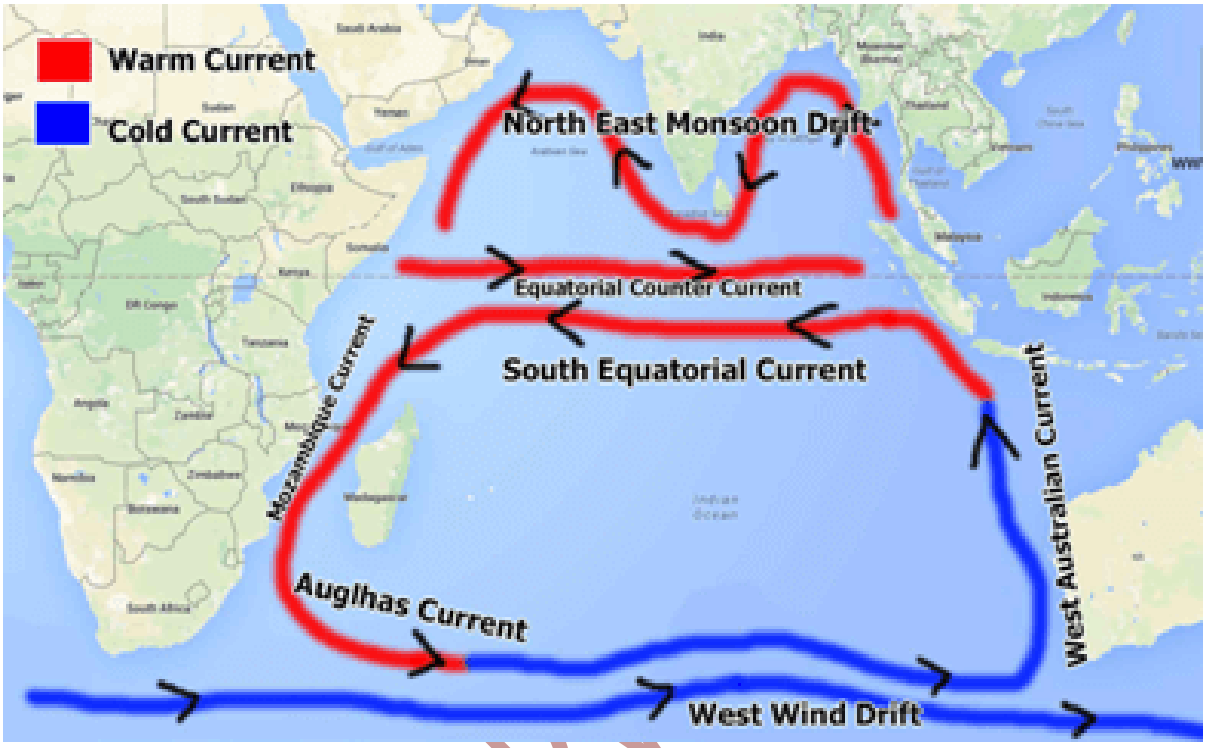
Currents of the Indian Ocean

• The pattern of circulation of ocean currents in the Indian Ocean differs from the general pattern of circulation in the Atlantic and the Pacific Oceans.

• This is because the Indian Ocean is blocked by the continental masses in the north.

• The general pattern of circulation in the southern hemisphere of the Indian Ocean is anti-clockwise as that of the other oceans.

• In the northern hemisphere, there is a clear reversal of currents in the winter and summer seasons, which are completely under the influence of the seasonal changes of monsoon winds.



INDIAN OCEAN: NORTHERN HEMISPHERE DURING WINTER

• During winter, Sri Lanka divides the currents of the Arabian Sea from those of the Bay of Bengal.

• The North East Monsoon Drift flows westward just south of Sri Lanka with a countercurrent flow between it and the South Equatorial Current.

• During the winter season, in the northern section, the Bay of Bengal and the Arabian Sea are under the influence of North East Monsoon Winds.

• These North East Monsoon winds drive the waters of the Bay of Bengal and the Arabian Sea westward to circulate in an anti-clockwise direction

INDIAN OCEAN: NORTHERN HEMISPHERE DURING SUMMER

• In summer, the northern part comes under the influence of the South West Monsoon.

• It results in an easterly movement of water in the Bay of Bengal and the Arabian Sea in a clockwise direction

. • This current is called as the South West Monsoon Drift.

• In the Indian Ocean, the summer currents are more regular than those of the winter.

INDIAN OCEAN: SOUTHERN HEMISPHERE

• In the southern part, the South Equatorial Current which flows from east to west is strengthened by its corresponding current of the Pacific Ocean.

• It then turns southward along the coast of Mozambique in Africa

. • A part of this current moving in between the African mainland and the Mozambique is called as the warm Mozambique Current.

• After the confluence of these two parts, the current is called as Agulhas Current.

• Agulhas Current merges with the West Wind Drift when it crosses the Indian Ocean.

• A branch of this merged current flows along the western coast of the Australia as cold West Australian Current.

• It later joins with the South Equatorial Current to complete the circuit

Impact of Ocean Currents

Local Climate

• Warm and Cold currents affect the local climate of a region.

• For example, the Gulf Stream which is driven to the western coast of Europe as the North Atlantic Drift keeps the coasts of North Sea warm which is unusual for such high latitudes.

• Similarly, the warm waters of the Kuroshio current in the North Pacific ocean are carried as the North Pacific Drift keeping the ports of the Alaskan coast ice-free in winter.

Rains and Desert Formation

• Warm ocean currents bring rains to the coastal regions and also the interiors while cold currents do not.

• Warm currents flow along the east coast of continents in tropical and sub-tropical latitudes resulting in warm and rainy climates while cold currents flow along the west coast of continents.

• Cold currents are one of the reasons why deserts are located the western margins of continents in the sub-tropical belts.

• For example, Californian current which is a cold current brings a dry and desert type of climate to the region.

Fishing grounds

• The mixing of warm and cold currents help to replenish the oxygen and favour the growth of planktons which is the regions are rich in microscopic marine plants and animals.

• These are crucial for the survival of marine ecosystems.

• Hence these regions form excellent fishing grounds as phytoplankton is the primary source of food for the fish.

• For example, the Great Banks near Newfoundland is formed by the mixing of cold Labrador current with the warm Gulf Stream.

Navigation

• The atmospheric circulation of the winds and the oceanic circulation of the currents are almost coincidental and together they aid in the navigation of the ships.

• Ocean currents flow for great distances and together with the winds create a conveyor belt kind of system for navigation of the ships.