

Ocean Currents

Ocean currents are influenced by two types of forces namely:

1. primary forces that initiate the movement of water;
2. secondary forces that influence the currents to flow.

- The primary forces that influence the currents are:

- 1. heating by solar energy;**

- 2. wind;**

- 3. gravity;**

- 4. Coriolis force.**

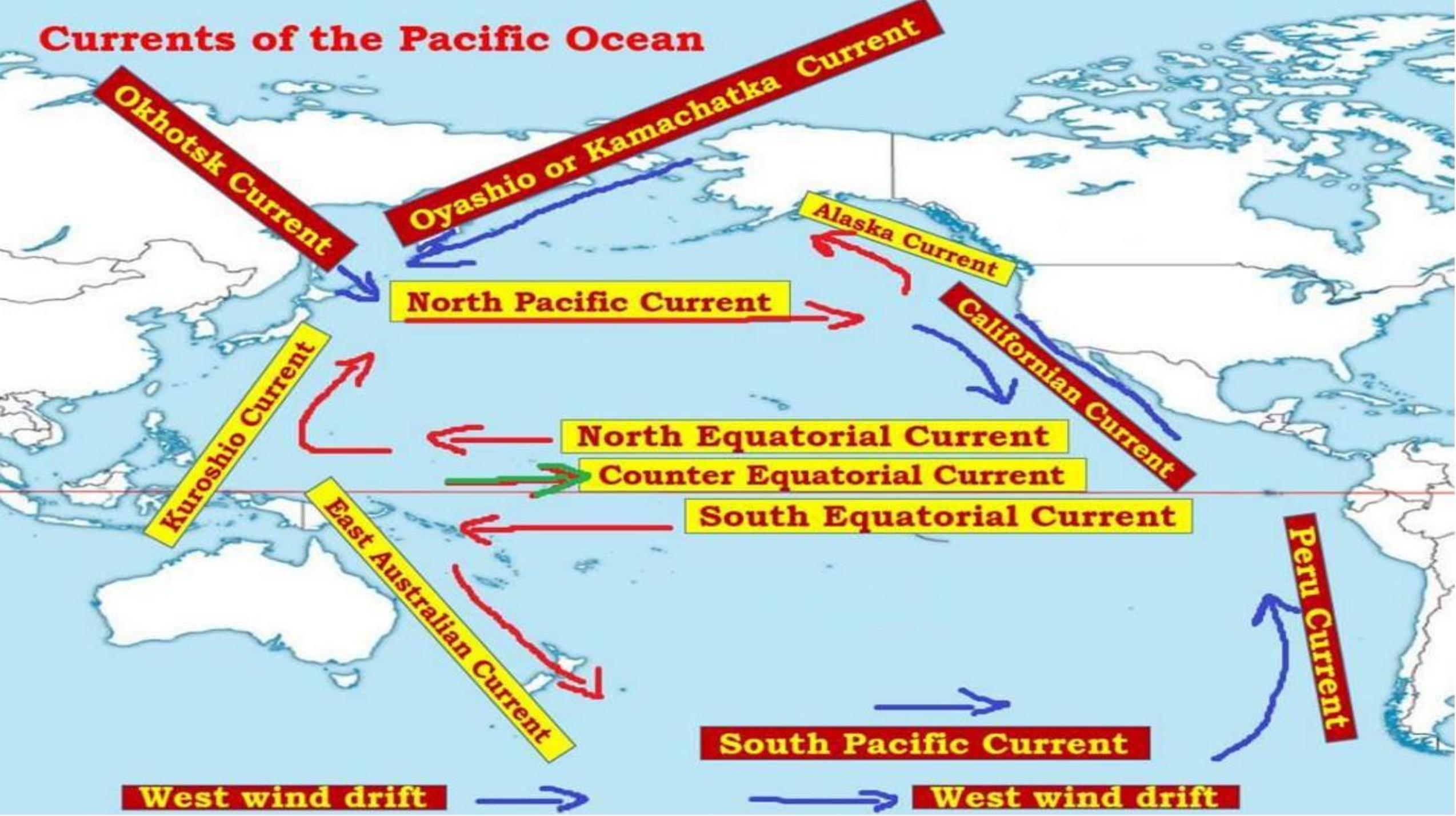
Influence of Coriolis force

- The Coriolis force intervenes and causes the water to move to the **right** in the northern hemisphere and to the **left** in the southern hemisphere.
- These large accumulations of water and the flow around them are called **Gyres**. These produce large circular currents in all the ocean basins. One such circular current is the **Sargasso Sea**

Secondary Forces Responsible for Ocean Currents

- **Temperature difference** and **salinity difference** are the secondary forces. They create **density differences**.
- Differences in water density affect **vertical mobility** of ocean currents (vertical currents).
- Water with high salinity is denser than water with low salinity.
- Similarly, cold water is denser than warm water.
- Denser water tends to sink, while relatively lighter water tends to rise.

Currents of the Pacific Ocean



Equatorial currents – warm

- Under the influence of **prevailing trade winds [tropical easterlies]**, the **north equatorial current** and the **south equatorial current** start from the eastern Pacific (west coast of Central America) and traverses a distance of 14,500 km moving from **east to west**.
- This raises the level of western Pacific (near Indonesia and Australia) ocean by few centimetres.
- And this creates a **counter-equatorial current** which flows between the north equatorial current and the south equatorial current in **west-east** direction.

Factors that aid the formation of Counter-Equatorial current

1. Piling up of water in the western Pacific due to trade winds.
2. The presence of doldrums (calm region in equatorial low-pressure belt) in between the north equatorial current and the south equatorial current.

Kuroshio current – warm

- The north equatorial current turns northward off the Philippines to form the **Kuroshio current**.
- It flows in the **sub-tropical high-pressure belt**, and its northern part is under the influence of **westerlies**.

Oyashio Current and Okhotsk current – cold

Oyashio flows across the east coast of Kamchatka Peninsula to merge with the warmer waters of Kuroshio.

- Okhotsk current flows past **Sakhalin Islands** to merge with the Oyashio current off Hokkaido (Northern Japanese Island).
- The **convergence of cold and warm currents makes the zone one of the richest fishing grounds**.

North-Pacific current – warm

- From the south-east coast of Japan, under the influence of prevailing westerlies, the **Kuroshio current** turns eastwards and moves as the North-Pacific current, reaches the west coast of North America, and bifurcates into two.

Alaska current – warm

- The northern branch of North-Pacific current flows anti-clockwise along the coast of British Columbia and Alaska and is known as the **Alaska current**.
- The water of this current is relatively warm as compared to the surrounding waters in this zone.

Californian current – cold

- The southern branch of the North-Pacific current moves as a cold current along the west coast of USA and is known as the **Californian current**.
- The Californian current joins the north equatorial current to complete the circuit.

East Australian current – warm

- Following the pattern in the northern hemisphere, the south equatorial current flows from east to west and turns southwards as the East Australian current.
- It then meets the South Pacific current near Tasmania which flows from west to east.

Peru current or Humboldt Current – cold

- Reaching the south-western coast of South America, South Pacific current turns northward as the Peru current. It is a cold current, which finally feeds the south equatorial current, thus completing the great circuit.
- **The zone where Peru Cold current meets the warm equatorial ocean waters is an important fishing zone.**

Atlantic Ocean Currents

Equatorial Atlantic Ocean Currents – warm

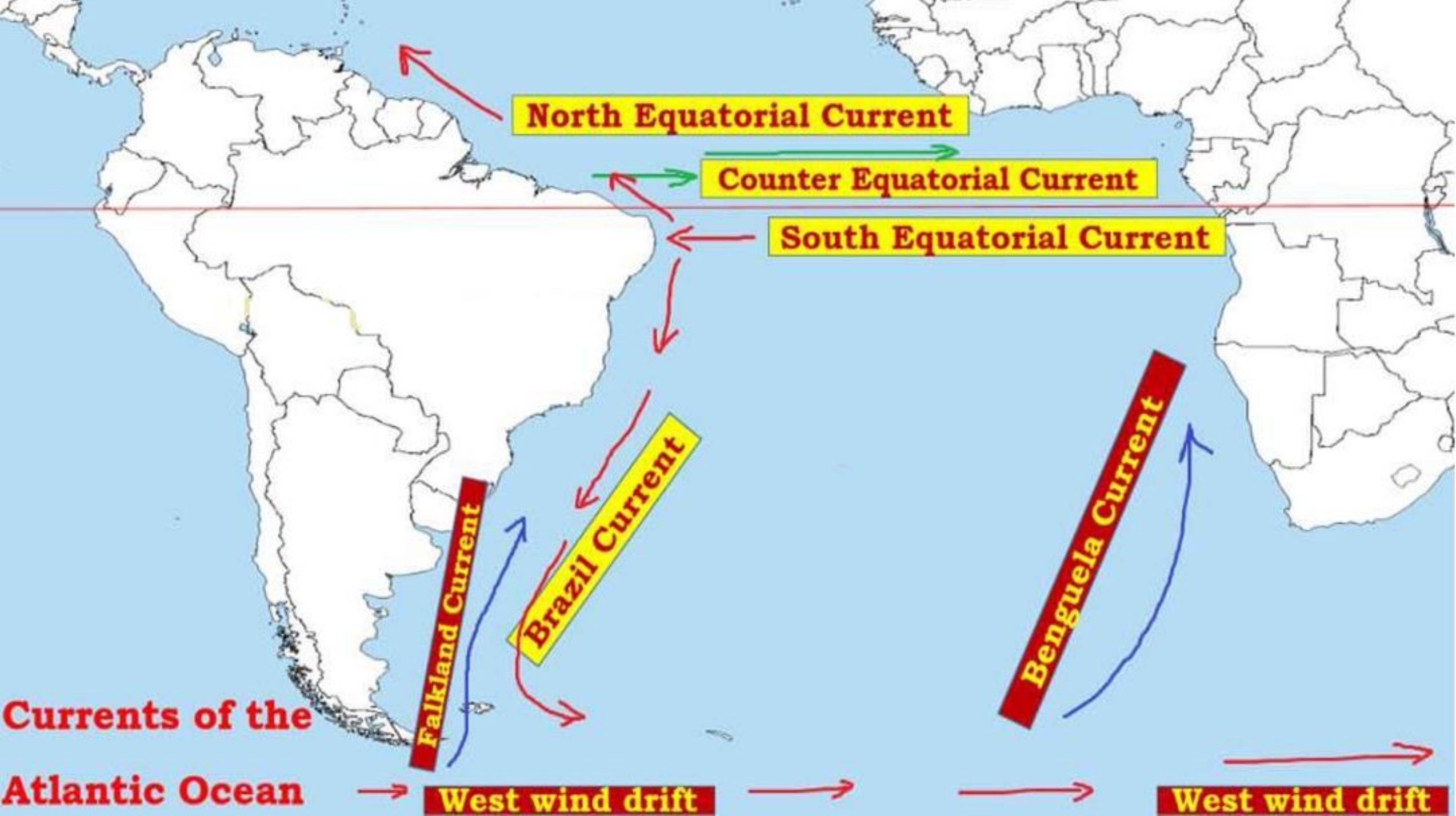
- Under the influence of **prevailing trade winds (easterly trade winds)**, the north equatorial current and the south equatorial current start from the eastern Atlantic (west coast of Africa), moving from east to west.
- This raises the level of western Atlantic (north of the Brazil bulge) ocean by few centimetres.
- And this creates a **counter-equatorial current** which flows between the north equatorial current and the south equatorial current in **west-east** direction.

Antilles current – warm

- The south equatorial current bifurcates into two branches near **Cape de Sao Roque (Brazil)**.
- Part of the current enters the Caribbean Sea along with north equatorial current into the Mexican Gulf, while the remainder passes along the eastern side of the West Indies as the **Antilles current**.
- There is a rise in water level in the Mexican Gulf because of large amounts of water brought by the **Mississippi River** and branches of north and south equatorial currents

Gulf Stream and North Atlantic Drift – warm

- **Antilles current** creates a current that flows out through the Strait of Florida as **Florida current**, which mixes with Antilles current from the south.
- This combined current moves along the east coast of USA and is known as the Florida current up to the **Cape Hatteras** and as the **Gulf Stream** beyond that.
- Near the **Grand Banks**, the **Gulf Stream mixes with cold Labrador and East Greenland currents and flows eastward across the Atlantic as the North Atlantic Drift**.
- Here, westerly movement of North Atlantic Drift is due to the influence of **westerlies**.



Currents of the Atlantic Ocean

Norwegian current – warm

- The North Atlantic Current breaks up into two branches on reaching the eastern part of the ocean.
- The main current, continuing as the North Atlantic Drift, reaches the British Isles from where it flows along the coast of Norway as the **Norwegian current** and enters the Arctic Ocean.
- Norwegian current is **very important** as it **keeps ocean to the north of Norway partly free from ice** and also moderates the extremes of climate.
- It is because of this current, Russia is able to move cargo in summers through **Arctic ocean (Barents Sea)**.
- The southerly branch flows between Spain and Azores as the cold Canary current.
- This current finally joins the north equatorial current completing the circuit in the North Atlantic.
- The **Sargasso Sea**, lying within this circuit, is full of large quantities of **seaweed** and is an important geographical feature.

Brazil current – warm

- In the South Atlantic Ocean, the south equatorial current, flowing from east to west, splits into two branches near **Cape de Sao Roque (Brazil)**.
- The northern branch joins the north equatorial current (a part of it flows in Antilles Current and other into Gulf of Mexico), whereas the southern branch turns southward and flows along the South American coast as the warm Brazil current.
- The south-flowing Brazil current swings eastward at about latitude 35°S (due to westerlies) to join the **West Wind Drift** flowing from west to east.
- A small branch of West Wind Drift splits and flows between Argentinian coast and **Falkland Islands**, and this current is called as **Falkland cold current**.
- It mixes with warm Brazil current at the southern tip of Brazil.

Benguela current – cold current

- A branch of the South Atlantic splits at the southern tip of Africa and flows along the west coast of South Africa as the cold Benguela current, which joins the south equatorial current to complete the circuit.

Indian Ocean Currents

- Indian ocean is **half an ocean**, hence the behavior of the North Indian Ocean Currents is different from that of Atlantic Ocean Currents or the Pacific Ocean Currents.

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- Also, **monsoon winds** in Northern Indian ocean are peculiar to the region, which directly influence the ocean surface water movement (North Indian Ocean Currents)

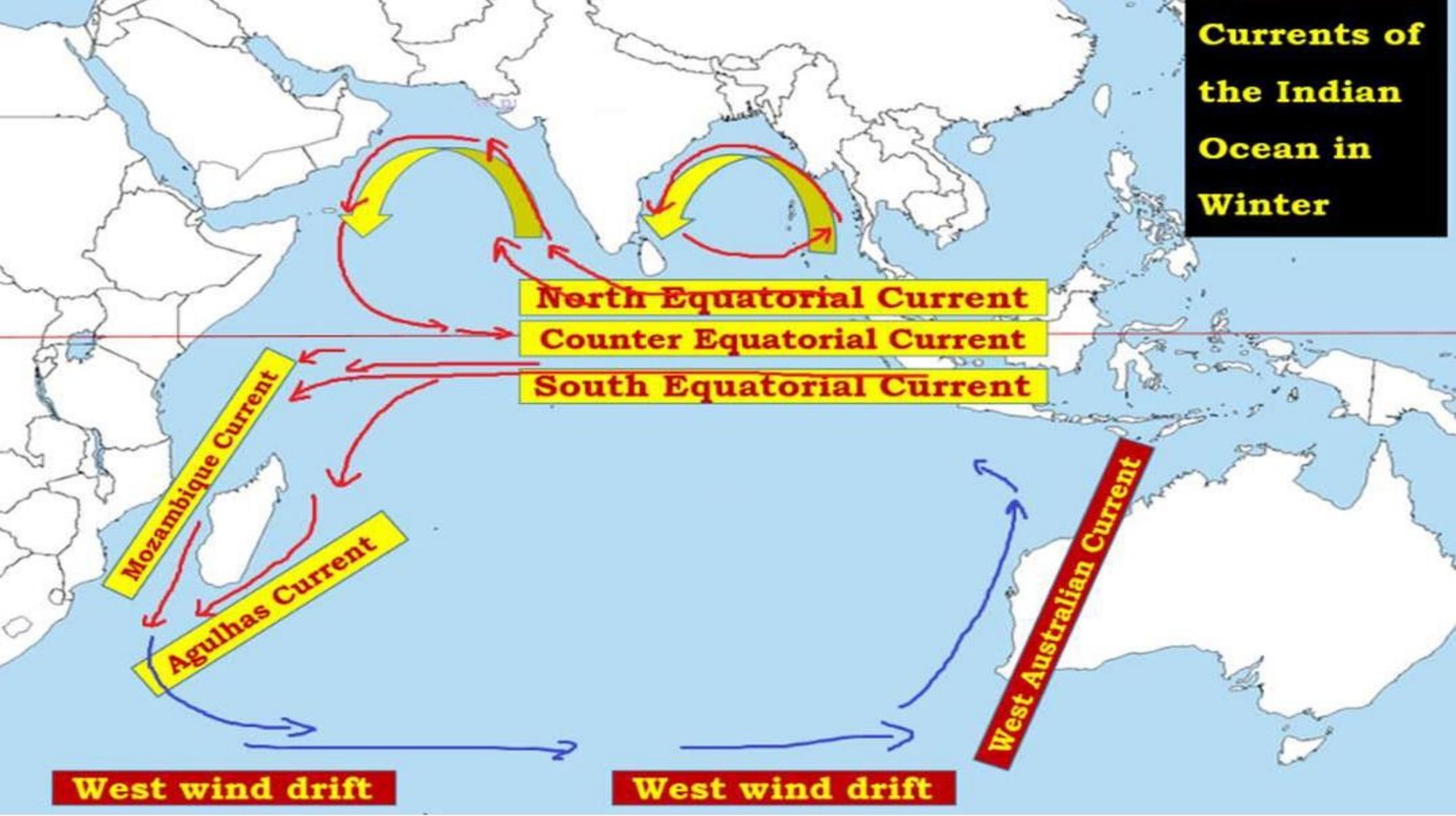
Indian Ocean Currents and Monsoons

- The currents in the northern portion of the Indian Ocean change their direction from season to season in response to the **seasonal rhythm of the monsoons**.
- The effect of winds is comparatively more pronounced in the Indian Ocean.

Winter Circulation

- Under the influence of **prevailing trade winds**, the north equatorial current and the south equatorial current start from the south of Indonesian islands, moving from east to west.
- This raises the level of western Indian (south-east of horn of Africa) ocean by few centimetres.
- And this creates a **counter-equatorial current** which flows between the north equatorial current and the south equatorial current in **west-east** direction.

**Currents of
the Indian
Ocean in
Winter**



North Equatorial Current
Counter Equatorial Current
South Equatorial Current

Mozambique Current

Agulhas Current

West Australian Current

West wind drift

West wind drift

Southern Indian Ocean Currents

- The general pattern of circulation in southern part of the Indian Ocean is quite similar to that of southern Atlantic and Pacific oceans. It is **less marked by the seasonal changes**.
- The south equatorial current, partly led by the corresponding current of the Pacific Ocean, flows from east to west.

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- It splits into two branches, one flowing to the east of Madagascar known as **Agulhas current** and the other between Mozambique and Western Madagascar coast known as **Mozambique current**.
- At the southern tip of Madagascar, these two branches mix and are commonly called as the Agulhas current. It still continues to be a warm current, till it merges with the West Wind Drift.
- The **West Wind Drift**, flowing across the ocean in the higher latitudes from west to east, reaches the southern tip of the west coast, of Australia.
- One of the branches of this cold current turns northwards along the west coast of Australia. This current, known as the **West Australian current**, flows northward to feed the south equatorial current.

Effects of Ocean Currents

- Ocean currents have a number of direct and indirect influences on human activities.

Desert formation

- Cold ocean currents have a direct effect on **desert formation** in west coast regions of the **tropical and sub-tropical continents**.
- There is **fog**, and most of the areas are **arid due to desiccating effect (loss of moisture — fog or temperature inversion inhibits convection)**.

Rains

- Warm ocean currents bring rain to coastal areas and even interiors. Example: Summer Rainfall in **British Type climate (North Atlantic Drift)**.
- Warm currents flow parallel to the east coasts of the continents in tropical and subtropical latitudes. This results in warm and rainy climates. These areas lie in the western margins of the subtropical anti-cyclones.

Moderating effect

- They are responsible for moderate temperatures at coasts. (**North Atlantic Drift brings warmth to England. Canary cold current brings cooling effect to Spain, Portugal** etc.)

Fishing

- Mixing of cold and warm ocean currents bear richest fishing grounds in the world.
- Example: **Grand Banks around Newfoundland, Canada and North-Eastern Coast of Japan**.
- The mixing of warm and cold currents helps to replenish the oxygen and favour the growth of **planktons**, the primary food for fish population.
- The best fishing grounds of the world exist mainly in these mixing zones.
- Mixing of cold and warm ocean currents create foggy weather where precipitation occurs in the form of drizzle (**Newfoundland**).