

The image features a background of a blue sky with light, wispy clouds and a blue ocean surface. A central graphic consists of a blue banner with wavy top and bottom edges. Inside this banner is a horizontal rectangular box with a bright green border. The text "OCEAN CURRENT" is written in a bold, green, sans-serif font with a white outline, centered within the green box.

OCEAN CURRENT

Circulation in Ocean

The circulations in ocean are important in three ways

1. It helps to distribute the heat thus controls the climate condition
2. It helps in proper distribution of nutrients
3. For sailing of ships the major ocean currents are of great significance.

The major currents of the ocean are caused by the combined effects of **wind action** and barometric **pressure** on the surface and **density differences** between different parts of the sea.

The density differences exist mainly because of inequalities of **heat exchange** between atmosphere and water at various parts of the sea surface and also because of differences of **salinity**.

Factors That Create Ocean Currents

Wind

Wind is the single biggest factor in the creation of surface currents. The major winds that most often effect the creation of ocean currents are the Trade Winds, which blow east to west and the Westerlies, which blow west to east.

Water Density

Another major factor in the creation of currents is water density, caused by the amount of salt in a body of water, and its temperature. Water with a higher salinity, or colder water, is more dense and likely to sink. Sinking water pushes the water below it up. The combination of sinking and rising in the same area causes a current.

Ocean Bottom Topography

Water contours to the topography of the ocean floor or bed. If the ocean bottom "drops out," like in a valley or trench, the moving water will move downward. If there is a rise in the ocean bottom, like a ridge or mountain, the water moving along it will be forced upward. The sudden upward or downward change of direction causes water displacement, creating a current.

Coriolis Effect

The Earth's rotation creates two currents: one, a clockwise movement of water in the Northern Hemisphere; the other, a counter-clockwise movement of water in the Southern hemisphere. When these currents are deflected by land masses, they create gyres.

The **course** taken by currents is influenced by the **rotation of the earth** and by the **shape and the topography** of the continents and ocean floor.

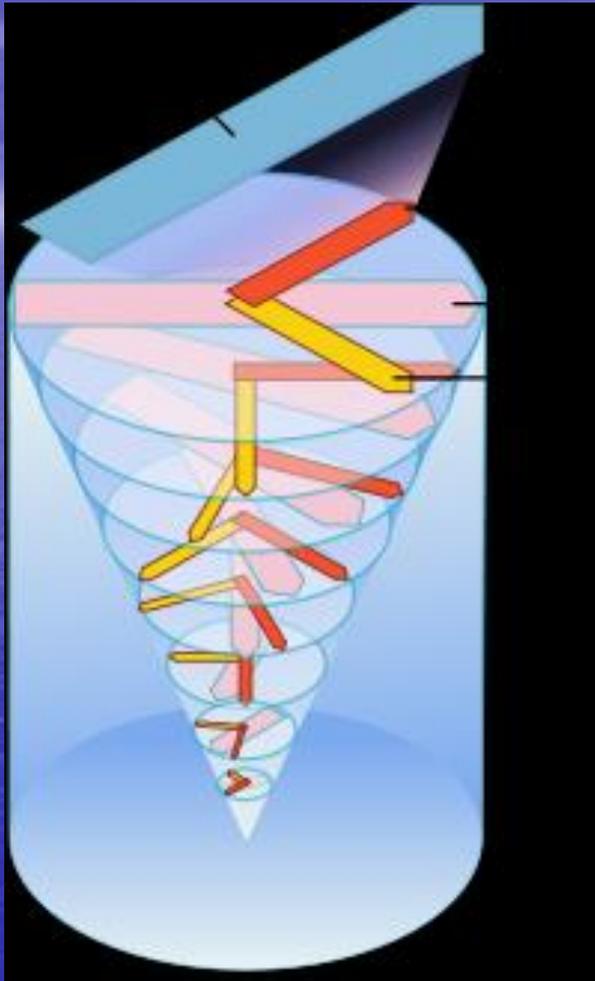
Rotation of the earth deflects currents to the **right in the region north of the equator** and to the left in the regions south of the equator.

Ekman's Theory

The first reasonable theory of how the wind affects surface currents was derived by Swedish oceanographer Valfrid Ekman in 1890. Ekman divided ocean into an infinite number of horizontal layers. The **top layer is affected by the wind and by friction with the layer below it.** The second layer is also affected by friction at top and bottom, and so on. The Coriolis force also affects the layers.

Balancing the friction and the Coriolis force led Ekman to conclude that the resulting currents decreased exponentially with depth, that the surface current moved at a 45-degree angle to the wind direction, and that **deviations from the surface wind direction increased with depth, forming a spiral (known as the Ekman spiral).**

Because the oceans are neither infinitely wide nor of constant density, as Ekman assumed, complications arise at the boundaries, where water tends to "pile up." The surface of the ocean is then no longer flat, but has a slope, which sets up a horizontal pressure gradient.



Winds drive ocean currents in the upper 100 meters of the ocean's surface. However, ocean currents also flow thousands of meters below the surface. These deep-ocean currents are driven by differences in the water's density, which is controlled by temperature (*thermo*) and salinity (*haline*). This process is known as **thermohaline circulation**.

Thermohaline circulation drives a global-scale system of currents called the “**global conveyor belt.**” The conveyor belt begins on the surface of the ocean near the **pole in the North Atlantic.** Here, the water is chilled by arctic temperatures. It also gets saltier because when sea ice forms, the salt does not freeze and is left behind in the surrounding water. The cold water is now more dense, due to the added salts, and sinks toward the ocean bottom. Surface water moves in to replace the sinking water, thus creating a current.

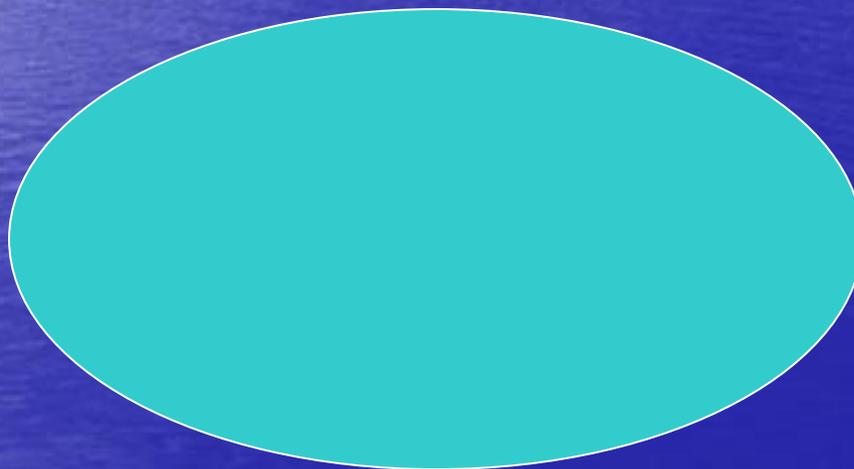
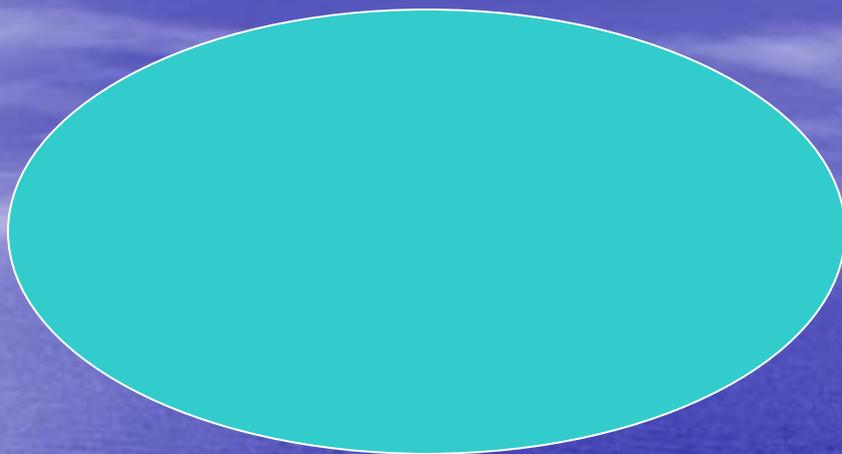
This **deep water moves south**, between the continents, past the equator, and down to the ends of Africa and South America. The current **travels around the edge of Antarctica**, **where the water cools and sinks again**, as it does in the North Atlantic. Thus, the conveyor belt gets "recharged." As it moves around Antarctica, two sections split off the conveyor and turn northward. One section moves into the Indian Ocean, the other into the Pacific Ocean.

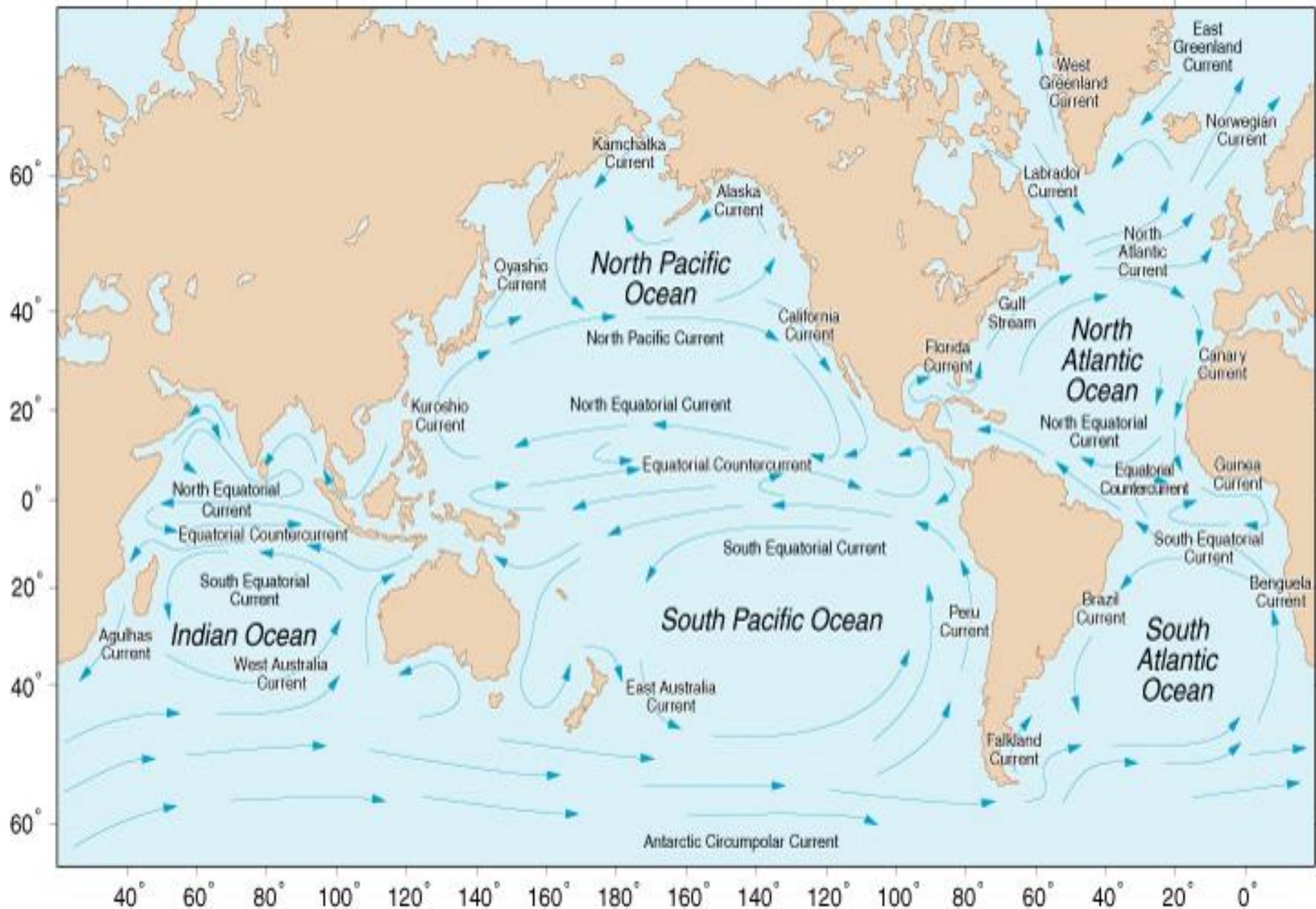
The ocean circulation can be broadly divided into two

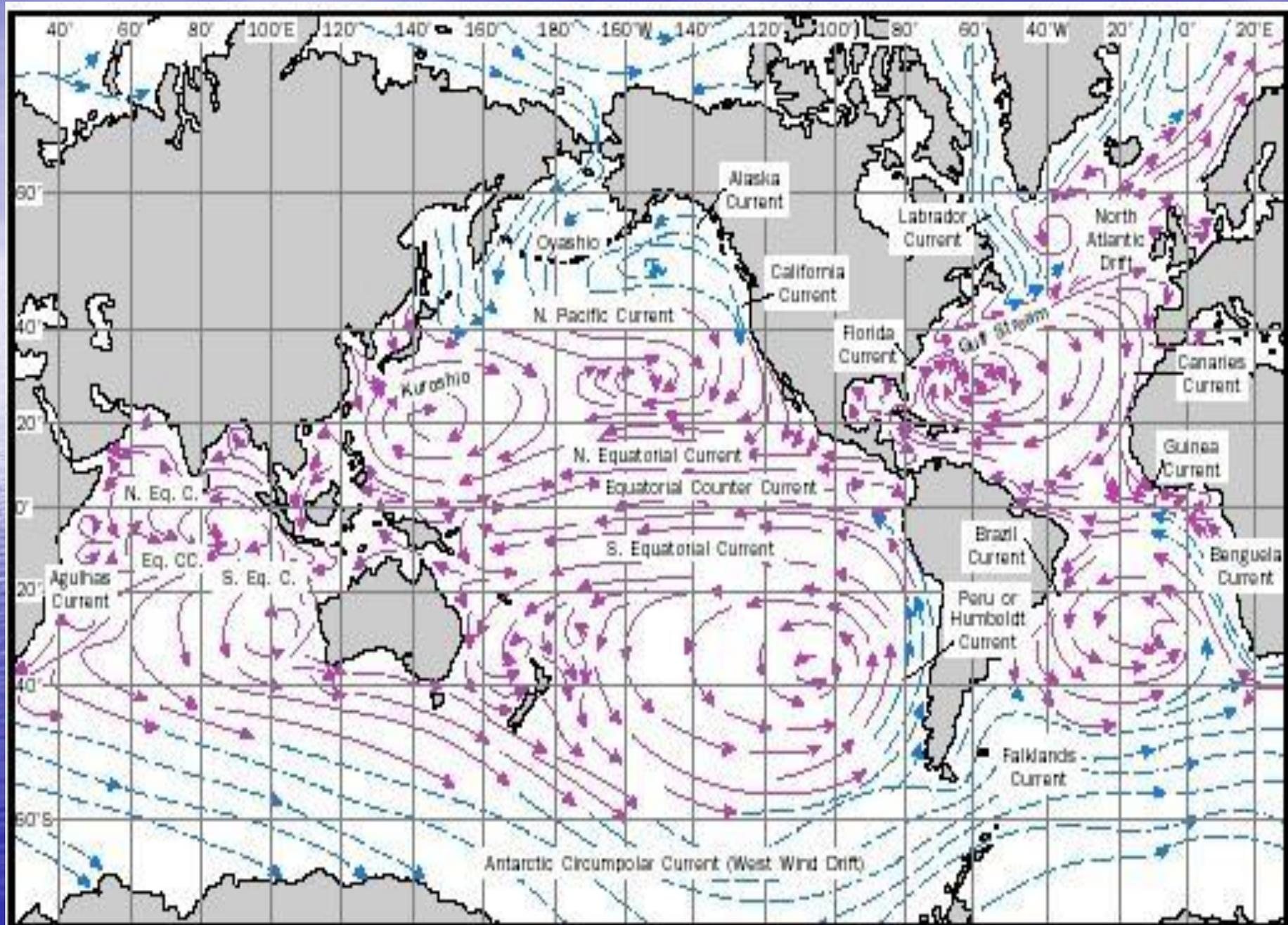
1. Circulation taking place in the shallow surface layer within the upper water mass
2. The deep water circulation

Surface currents of Atlantic Ocean

It consists of **two gyres** or circles. A **counter clockwise** circle in **south Atlantic** and a clockwise one in the north Atlantic. **The two circles** are driven separately each by the trade winds in its own hemisphere and they are separated from the equatorial region by eastward flowing counter current.







South Atlantic ocean

In south Atlantic ocean the surface circulation extends from the **surface to a depth of 200 mtr** near the **equator** & to **about 800 mtr** at the **southern limit** of the gyre. The wind stress of the **south east trade winds between the equator & 15° S** is the main drifting force for the currents in the S. A. Ocean. This acts upon the sea & cause south equatorial current to flow west towards the American side of the south Atlantic.

Part of the current crosses the equator into the north Atlantic & the remainder turns south along the south American continent which is known as **Brazil Current (warm current)**. This **turns east** & continues up to the Atlantic as a part of **West wind drift** & then **turns north** of African coast & known as **Benguela current**. The Brazil current is warm & saline because it comes from the trade wind region & Benguela current is cold because it comes from higher latitude.

Currents of North Atlantic ocean

In the north Atlantic the **clockwise gyre** may be considered to start with the **North equatorial current driven by north east trade winds**. The current flows to the west & join from south by the part of South equatorial current which has turned across equator into north Atlantic part of this combined flow & go north west as **Antillis current** outside the west indies & **part goes between these islands into the Gulf of Mexico**.

From here it flows between Florida & Cuba as **Florida current**. Off the coast of Florida the Florida current joined by the **Antilles current** and from Cape Hatteras it is known as **Gulf Stream**. The gulf stream is a strong ocean current that brings warm water from the Gulf of Mexico into the Atlantic ocean. It extends all the way up the eastern coast of United States and Canada. From there the flows which continues **east & north** is called the **North Atlantic current**. This divides into two & one part turns north east between Iceland & Scotland contributing to the circulation of the Norwegian & Greenland areas & also to Arctic sea.

The reminder of N A Current turns south past the coast of Spain & North Africa to complete the gyre.

Gulf Stream:

- i) Water is deep indigo blue & transparent
- ii) More saline & warmer compared to adjacent waters
- iii) High Velocity(250 cm/sec)
- iv) Average surface temp: 27⁰ c in first 400m
- v) High salinity: up to 36.5 ppt

between the Gulf stream & the shore of N America there is south west ward flowing coastal current. The currents are **Labradar Current & East Greenland Current.**

Currents of Pacific Ocean

The surface movements of the Pacific Ocean have a broadly similar pattern to those of the Atlantic. There is a clockwise gyre in the North Pacific & counter clockwise in the South Pacific.

- i) A well developed westward flowing South Equatorial current between latitudes 10° S & 3° N.
- ii) A well developed westward flowing North Equatorial current between latitudes 8° N & 20° N.
- iii) Between these two there is an equatorial counter current flowing east between latitude 3° N & 8° N.
- iv) South Equatorial counter current flowing east between 10° S & 12° S.

There is also an equatorial under current known as **Cromwell current**. It is a thin current having only 0.2 Km thickness but 400 km wide extending from 2° N to 2° S. Its length is 6500 Km. Speed of 150 cm/sec at the core. The Cromwell current was discovered in 1952 by Townsend Cromwell. It is hidden 300 feet (100 m) under the surface. The *Cromwell current* was listed in the 1964 edition of the *Guinness Book of World Records*.

The current transports around 30 million cubic meters per second of water—about 1,000 times the volume of the Mississippi River.

Flowing in a **north-eastern** direction past the south island of Japan is the **Kurosiwo current**, which is the counterpart of Gulf Stream. After leaving the Japanese coast it **flows north east & then further towards east** where it is known as **North Pacific Current**. As the N Pacific current approaches the **north African continent one part turns south**, flowing **along the California coast** which is known as **California current** and this finally feeds into the north equatorial current. The **remainder part turns north** forming the **Alaska current**. In addition to these there is **Oyosiwo, a cold current** which flows down the western side of the Pacific towards the north Japanese island.

Currents in south pacific:

- i) South equatorial current
- ii) East Australia current
- iii) Peru current

Currents in Indian ocean

South Indian ocean:

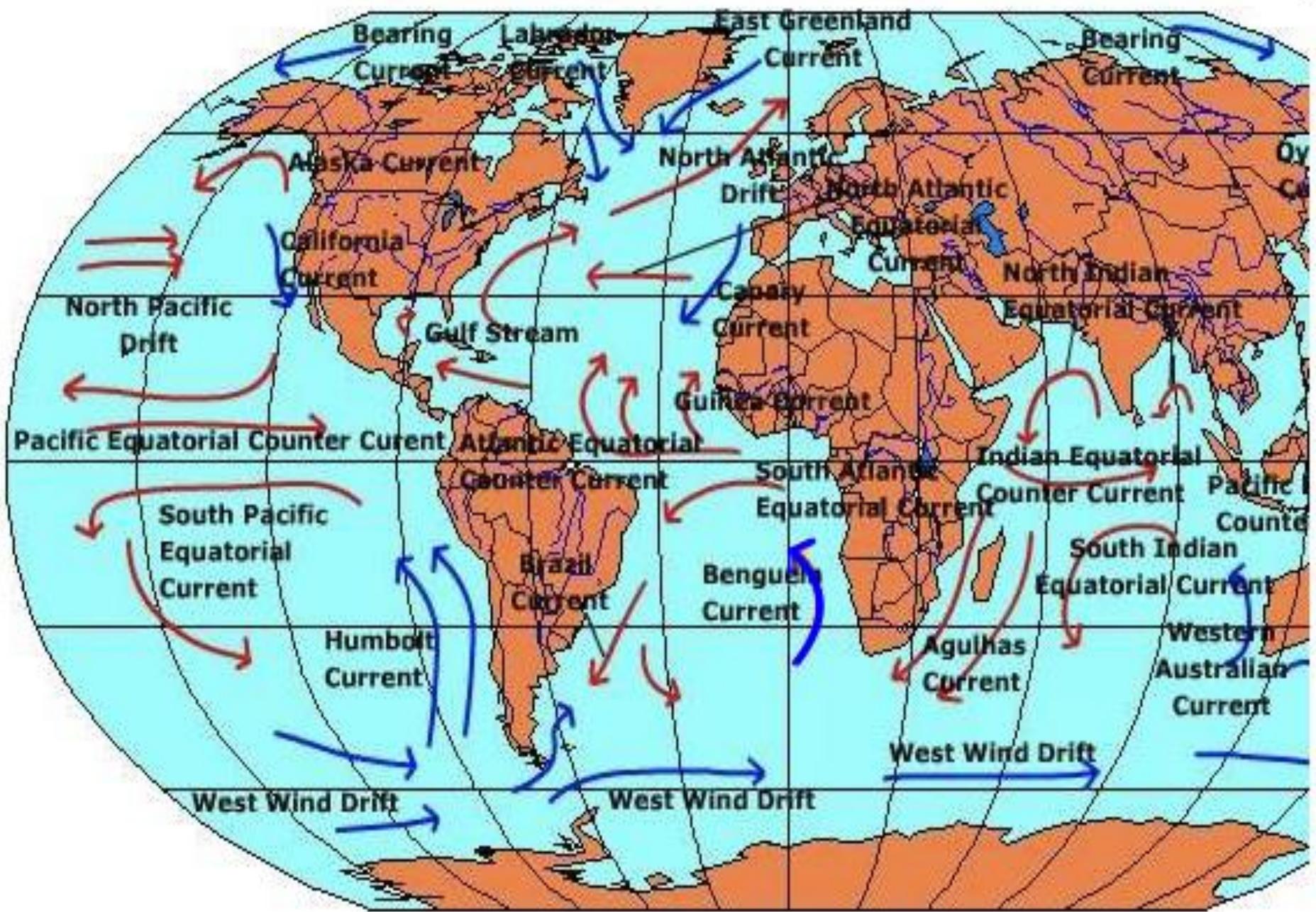
In the southern part of Indian ocean currents are similar to those of southern part of Atlantic & Pacific ocean. In this part there is anticlockwise circulation with south equatorial current flowing westward starting from north west corner of Australia towards African coast. This current branches into two off the coast of Madgasca. The northern branch supplies the flow to the equatorial counter current & the southern branch is known as Mozambic current which joins with the south flowing Aghulus current which mixes with the east flowing West wind drift.

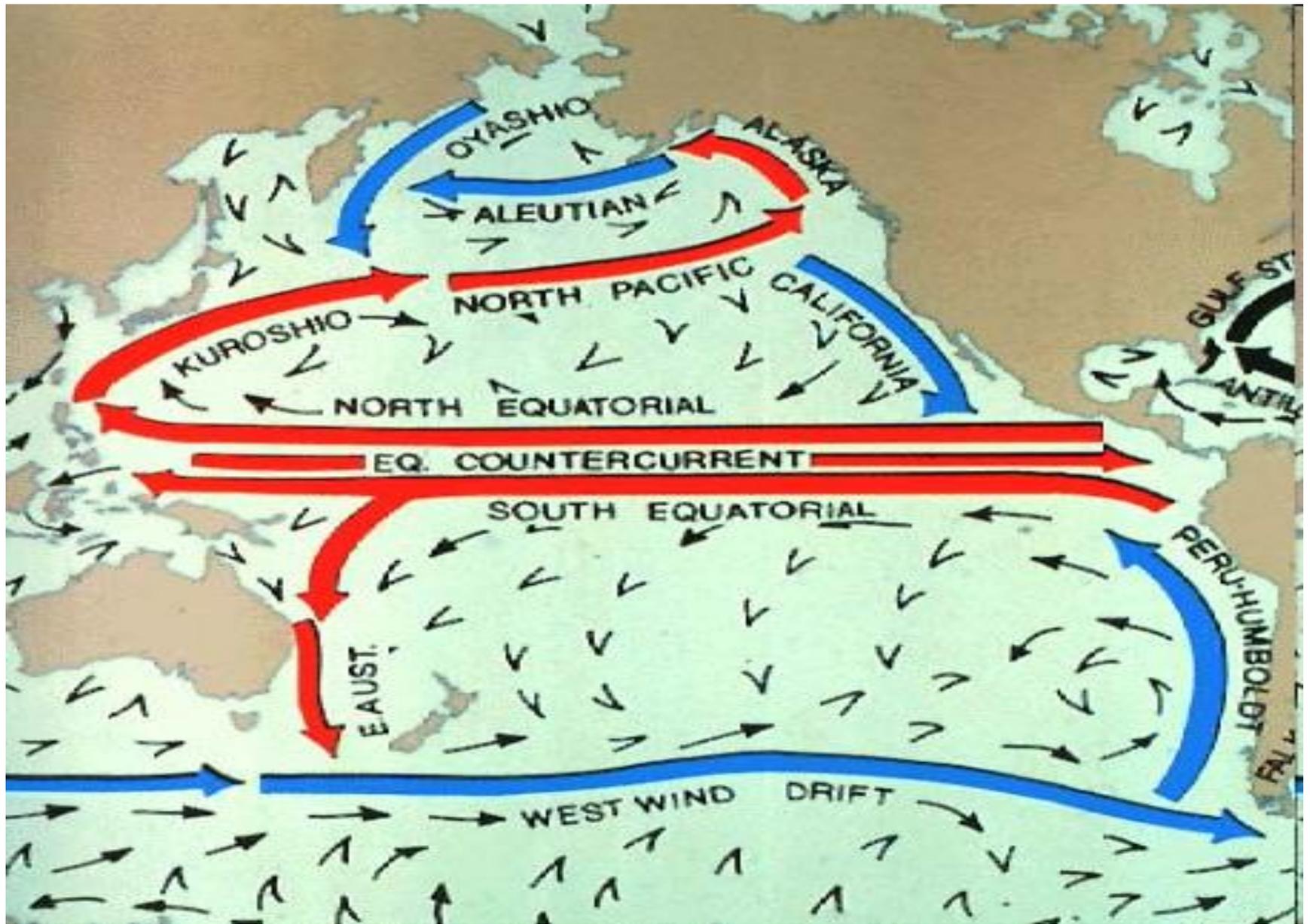
The west wind drift swings north west along the coast of Australia & this part is known as **West Australian Current** & this finally joins the south equatorial current.

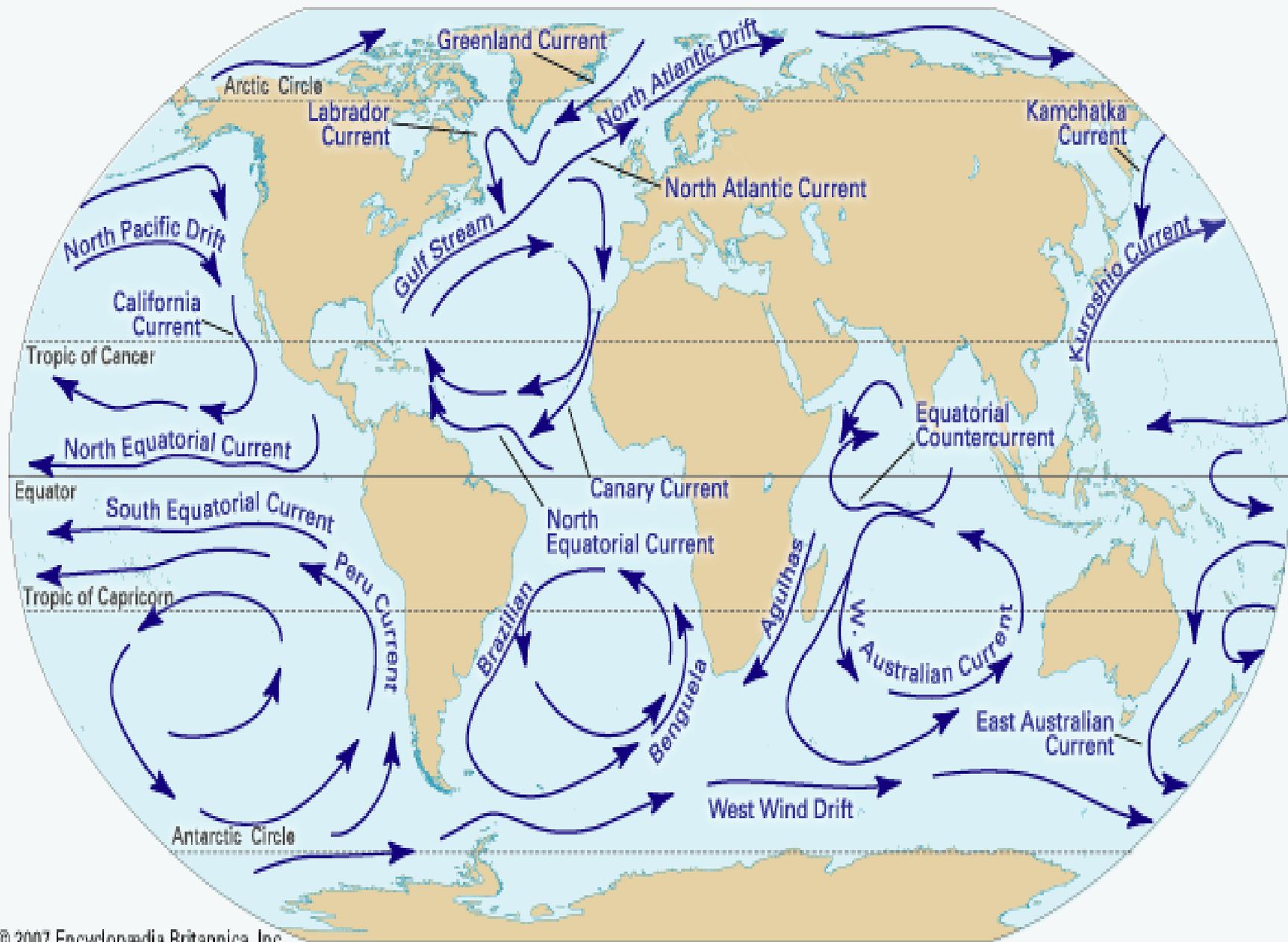
Currents in N. Indian Ocean:

In the northern part of Indian Ocean **due to seasonal changes in wind condition** coming from the landmass to the north of the ocean, there is a marked **seasonal variation in the current system.**

N. E. monsoon: during this period from Nov to March the westward flowing north equatorial current







World Ocean

