CURRENTS OF THE ATLANTIC OCEAN

(1) North Equatorial Current (warm)

Normally, the north equatorial current is formed between the equator and 10^0 N latitude. This current is generated because of upwelling of cold water near the west coast of Africa. This warm current is also pushed westward by the cold Canary current. On an average, the north equatorial warm current flows from east to west but this saline current is deflected northward when it crosses the mid-Atlantic Ridge near 15^0 N latitude. This current, after being obstructed by the land barrier of the east coast of Brazil, is bifurcated into two branches e.g., (i) Antilles current and (ii) Caribbean current. The Antilles current is diverted northward and flows to the east of West Indies islands and helps in the formation of Sargasso Sea eddy while the second branch known as the Caribbean current enters the Gulf of Mexico and becomes Gulf Stream.

(2) South Equatorial Current (warm)

South Equatorial current flows from the western coast of Africa to the eastern coast of South America between the equator and 20^0 S latitude. This current is more constant, stronger and of greater, extent than the north equatorial current. In fact, this current is the continuation of the Benguela current. This warm current is bifurcated into two branches due to obstruction of land barrier in the form of the east coast of Brazil. The northward branch after taking north westerly course merges with the north equatorial current near Trinidad while the second branch turns southward and continues as Brazil warm current parallel to the east coast of South America. This current is basically originated under the stress of trade winds.

(3) Counter-equatorial current (warm)

The counter equatorial current flows from west to east in between the westward flowing strong north and south equatorial currents. This current is less developed in the west due to stress of trade winds. The counter equatorial current carries relatively higher temperature and lower density than the two equatorial currents. Several ideas have been put forth to explain the origin of the counter equatorial current. According to some scientists, this current is originated because of the influence of equatorial westerlies which blow from west to east in the calm zone of the doldrum or in the convergence zone of the north-east and south-east trade winds. It is argued that south-west monsoon winds develop in the zone of equatorial calm (doldrum) during northern summers. These equatorial westerlies drag the waters and force them to flow from west to east under their influence. This concept is disputed on the ground that the counter equatorial current is all year phenomenon. In other words, it flows throughout the year while the monsoon winds (say equatorial westerlies) in the equatorial calm zone disappear during winter season. According to another view the counter equatorial current is originated due to the piling up of immense volume of water because of the convergence of the two great equatorial warm current near the coast of Brazil. The pilling up of water raises the water level and hence water flows eastward as compensation current upto the Gulf of Guinea.

(4) Gulf Stream (warm)

The Gulf Stream is a system of several currents moving in north-easterly direction. This current system originates in the Gulf of Mexico around 20^0 N latitude and moves in north easterly direction along the eastern coast of North America and reaches the western coasts of Europe near 70^0 N latitude. This system, named Gulf Stream because of its origin in the Mexican Gulf, consists of (i) Florida current from the strait of Florida to Cape Hatteras, (ii) Gulf steam from Cape Hatteras to the Grand Bank, and (iii) North Atlantic Drift (current) from the Grand Bank to the Western European coast.

(i) Florida current is in fact, the northward extension of the earth equatorial current. This current flows through the Yucatan channel into the Gulf of Mexico, thereafter the current moves forward through the Florida Strait and 30^0 N latitude. Thus the Florida warm current contains most of the characteristics of the equatorial water mass. The average temperature of the water at the surface is 75^0F (24^0 C) while the salinity is $36^0/_{00}$. The temperature never falls below 43.7^0F (6.5^0C) at 39^0 N latitude. The current becomes narrow while passing through the Florida strait but thereafter its width increases and the current flows close to the coast. Further northward this current is joined by Antilles current, a branch of the north equatorial current, near 30^0 N latitude. The origin of Florida current is attributed to the pilling up of immense volume of water in the Gulf of Mexico due to powerful trade winds. Thus, the water is forced to move out of the Florida strait. The annual average velocity of Florida current is about 72 miles per day.

(ii) Gulf Stream was discovered for the first time by Ponce de Leon in the year 1513. The Florida current after having the water of Antilles current is known as Gulf stream beyond Cape Hatteras. This current is very wide and warm and is separated from the Sargasso sea to its right (in the east) and relatively cold water near the coast to its left. The temperature of water near the coast ranges between 4^0 and 10^0 C. This zone of cold water between the coast and the Gulf stream is called cold wall. The existence of this cold wall of cold water near the eastern coast of the USA is attributed to many factors. Some scientists opine that strong westerly winds drive the warm waters of the coast eastward and cold water of the cold Labrador current move southward along the coast up to Cape Hatteras, while some scientists believe that the cold water of the Gulf of St. Lawrence is deflected southward along the eastern coast of the USA. The Gulf stream carries warm water northward into the cold water of high latitudes and thus modifies the weather conditions of the adjoining areas. The Gulf stream generally follows the coast line but it is deflected eastward at 40^0 N latitude due to the influence of westerlies and deflective force of the earth's rotation. Further northward this current is divided into several branches known as the Delta of the Gulf Stream. The main north-easterly branch is still called Gulf Stream. There is wide range of variation in the velocity of the current. The average velocity in the open ocean is 10 to 15 miles per day. It attains the velocity of 72 miles per day near New York but it slows down to 30 miles per day further eastward. The Gulf Stream loses its original characteristics near 40^0 N latitude because it mixes with the cold Labrador current. The inversion temperature (warmer air above cool air) caused due to the convergence of warm Gulf Stream and cold Labrador current near Newfoundland results in the formation of dense fogs which present effective obstruction in the navigation of ships.

(iii) North Atlantic Current---The Gulfstream is divided into many branches at 45^0 N latitude and 45^0 W longitude. All the branches are collectively called as North Atlantic Drift or current. (A) Northern branch moves north-eastward. It undergoes major changes because of mixing of cool water of the cold Labrador current with its warm water. Though the temperature and salinity are significantly reduced yet it maintains its main characteristics as warm current.

The Gulf Stream system largely modifies the weather conditions of the eastern coast of the USA and the western coast of Europe. The temperatures of these coastal areas are 4^0 F higher than the average temperatures of their latitudes. Gulf Stream is responsible for unique characteristics of West European Type of Climate. The temperatures of the south-eastern and eastern USA become exceptionally high during summers because the wind coming from over the Gulf Stream bring more heat in these areas but the eastern coastal areas of the USA are not benefitted by the Gulf Stream during winter because the winds are off shore (from the land towards the Atlantic Ocean). The convergence of warm Gulf Stream and cold Labrador Current near Newfoundland causes inversions of temperatures which results in the formation of dense fogs, which hinder sea transport.

(5) Canary Current (cold)

The canary current, a cold current, flows along the western coast of North Africa between Maderia and Cape Verde. In fact, this current is the continuation of North Atlantic. Drift which turns southward near the Spanish coast of Canaries Island. The average velocity of this current is 8 to 30 nautical miles per day. This current brings cold water of the high latitudes to the warm water of the low latitudes and finally merges with the north equatorial current. The Canary cold current ameliorates the otherwish hot weather conditions of the western coasts of North Africa.

(6) Labrador Current (cold)

The Labrador current, an example of cold current, originates in the Baffin Bay and Davis Strait and after flowing through the coastal waters of Newfoundland and Grand Bank merges with the Gulf Stream around 50^0W longitude. This current brings with it a large number of big icebergs present effective hindrances in the oceanic navigation. Dense fogs are also produced due to the convergence of the Labrador cold current and the Gulf Stream near Newfoundland.

(7) Brazil current (warm)

The Brazil current is characterized by high temperature and high salinity. This current is generated because of the bifurcation of the south equatorial current because of obstruction of the Brazilian coast near Sun Rock. The northern branch flows northward merges with the north equatorial current while the southern branch knows as the Brazil current flows southward along the east coast of South America up to 40^0 S latitude. Thereafter it is

deflected eastward due to the deflective force of the rotation of the earth and flows in easterly direction under the influence of the westerlies. The Falkland cold current coming from the south merges with the Brazil Current near 40^0 S latitude.

(8) Falkland Current (cold)

The cold waters of the Antarctic sea flows in the form of Falkland cold current from south to north along the eastern coast of South America upto Argentina. This current becomes most extensive and developed near 30^0S latitude. This current also brings numerous icebergs from the Antarctic area to the South American coast.

(9) South Atlantic Drift (cold)

The eastward continuation of the Brazil current is called South Atlantic Drift. This current is originated because of the deflection of the Brazil warm current eastward at 40^0 S latitude due to the deflective force of the rotation of the earth. The South Atlantic Drift, thus, flows eastward under the influence of the westerlies. This current is also known as the Westerlies Drift or the Antarctic Drift.

(10) Benguela Current (cold)

The Benguela current, a cold current, flows from south to north along the western coast of south Africa. In fact, the South Atlantic Drift turns northward due to the obstruction caused by the southern tip of Africa. Further northward, this current merges with the South Equatorial Current.

Sargasso Sea

Introduction---- There is an anticyclonic circulation of ocean currents comprising of north equatorial current, the Gulf Stream and the Canary current in the North Atlantic Ocean. The water confined in this gyral is calm and motionless. Thus, the motionless sea of the said gyral is called Sargasso Sea which is derived from the Portuguese word 'sargassum' meaning thereby sea weeds. It may be pointed out that similar Sargasso sea is not found in the South Atlantic Ocean.

Extent----The extent of the Sargasso sea is delineated on the basis of the extent of sea weeds and the gyral of ocean currents. According to Marmer the Sargasso sea is found between 20^0-40^0N latitudes and 35^0-75^0 W longitudes. According to Wing the boundary is determined by 27^0 W longitude in the east, by 20^0N longitude in the south, by 40^0N latitude in the north and by the location of the Gulf Stream in the west.

Origin---The origin of the Sargasso sea is attributed of several factors. (i) The sizeable portion of the waters of the North Atlantic Ocean is confined in the gyral system formed by the anticyclonic circulation of the North Equatorial current, the Gulf Stream and the Canary current and thus the confined water does not have any connection with remaining water of the ocean. Thus, the confined water becomes clam and motionless. (ii) The Sargasso Sea is located in the transition zone of the trade winds (N.E. Trades) and the westerlies. This zone is characterized by the subsidence of air from above and the resultant anticyclonic conditions cause atmospheric stability and hence there are very feeble and calm winds due to which there is little mixing of confined water (Sargasso sea) with the remaining waters of the North Atlantic Ocean. (iii) The North Atlantic Ocean is less extensive between 20^0-40^0N latitudes than other oceans in the same latitudes. (iv) The confined waters become calm due to the higher velocity of the North Equatorial Current and the Gulf .

Main characteristics---- The Sargasso sea records the highest salinity ($37^0/_{00}$) of the Atlantic Ocean due to high temperature and evaporation. The salinity is also increased because of no mixing of the water of the Sargasso sea with the remaining water of the North Atlantic Ocean. The mean annual temperature is 28^0 C. The sea is covered with rootless sea weeds which obstruct navigation. There are contrasting opinions about the extent and origin of sargassum (sea weeds). According to one group to sea weeds grow along the banks of Azores and Bahamas and these are brought by the sea weeds grow in the Mexican Gulf and these are brought by the Gulf Stream to the Sargasso sea. The third group believes that the sea weeds of the Sargasso sea are floating plants without roots.

CURRENT OF THE PACIFIC OCEAN

(1) North Equatorial Current (warm)

The north equatorial current originates off the western coast of Mexico and flows in westerly direction and reaches the Philippines after covering a distance of 7500 nautical miles. This current is originated because of the Californian current and north-east monsoon. The volume of water continuously increases westward because numerous minor branches join the current from the north. A few branches also come out of the main current and turn towards north and south. One branch emerges from the north equatorial current near Taiwan and flows northward to join Kuroshio current while the southern branch turns eastward to form counter equatorial current. It is significant to note that north equatorial current flows as a continuous current in the North Pacific Ocean but there are seasonal variations in its northern and southern marginal areas. The velocity of the current ranges between 12 and 18 nautical miles per day. With the northward(northern summer) and southward (southern summer) migration of the sun this current moves northward and southward but it always remain to the north equator.

(2) South Equatorial Current (warm)

The south equatorial current is originated due to the influence of south-east trade winds and flows from east to west. This current is stronger than the north equatorial current. The average velocity is 20 nautical miles per day while the maximum velocity becomes 100 nautical miles a day. Numerous minor currents join this current from the left and thus the volume of water continuously increases westward. The current is bifurcated into northern and southern branches near New Guinea. The northern branches turns eastward and flows as counter equatorial current while the southern branch moves towards the northern and north-eastern coasts of Australia.

(3) Counter Equatorial Current (warm)

The current flowing west to east between the north and south equatorial current is termed counter equatorial current. Because of trade winds, immense volume of water is piled up in the western marginal parts of the ocean, with the result there is general slope gradient of water surface from the west to east. The higher water level in the west and descending slope gradient of water surface from west to east make the oceanic water flow in easterly direction in the name of counter equatorial current which is the most developed counter current in the Pacific Ocean. This counter equatorial current is extended upto the Panama Bay. The average temperature and salinity are 27.5^0 C and $34.5^0/_{00}$ respectively. The current transports oceanic water at the rate of 25 million m^3 per second.

(4) Kuroshia System (warm)

The Kuroshia system comprised of several currents and drift is similar to the Gulf Stream system of the Atlantic Ocean. This system runs from Taiwan to the Bering Strait and consists of the Kuroshia current, the Kuroshia extension, the north pacific drift, the Tsushima current and the counter Kuroshia current.

(i) **Kuroshia current**-----The north equatorial current turns northward due to the obstruction of Philippines and thus gives birth to the Kuroshia current which flows from Taiwan to Ryuku ridge at 30^0N latitude. The Kuroshio, a warm current, is similar to the Florida current of the North Atlantic Ocean. The average temperature and salinity are 8^0 C and $35^0/_{00}$ respectively.

(ii) **Kuroshio Extension**---The Kuroshio current leaves Japanese coast and turns eastward near 35^0N latitude under the influence of the westerlies and is bifurcated into two branches. One branch moves in easterly direction while the second branch flows in north-eastern direction upto 42^0 N latitude and thereafter is also turns eastwards. The northern branch ultimately merges with the cold Oyashio current coming from the north.

(iii) **North Pacific Drift**---The Kuroshio current is extended further eastward under the influence of the westerlies and reaches the western coast of North America. Just before 150^0 W longitude the major part of this current turns southward while the remaining water moves eastward upto Hawaiin coast and the western coast of N. America. The North Pacific Drift is bifurcated into two branches. The northern branch becomes Aleutian current while the southern branch gives birth to the Californian cold current. The Aleutian current is further divided into two branches. One branch goes towards the Bering Strait while the second branch moves towards Gulf of Alaska.

(iv) **Tsushima Current**----Near 30^0N latitude one branch separates from the Kuroshio current and enters the Japan Sea and flows along the western coast of Japan in the name of Tsushima current. This warm current with relatively higher temperature and salinity modifies the weather condition of the Japanese coast.

(v) **Counter Kuroshio Current**-----The Kuroshio current forms a gyral system between Hawaiian islands and the American coast and thus the oceanic water moves in westerly direction in the name of counter Kuroshio current.

(5) **Oyashio Current (cold)**

The Oyasahio cold current is also known as Kurile cold current. This cold current flows through the Bering Strait in southerly direction and thus transports cold water of the Arctic Sea into the Pacific Ocean. Near 50^0N latitude this current is bifurcated into two branches. One branch turns eastward and merges with the Aleutian and Kuroshio currents. The second branch moves upto the Japanese coasts. This current is comparable to the cold Labrador current of the North Atlantic Ocean. The convergence of cold Oyashio (Kurile) and warm Kroshio current causes dense fogs which become potential hazards for navigation.

(6) California Current (cold)

The California current, an example of cold current, is similar to the Canary cold current of the Atlantic Ocean in most of its characteristics. In fact, this current is the eastward-extended portion of the North Pacific drift. The cold California current is generated because of the movement of oceanic water along the California coast from north to south in order to compensate the loss of water which is caused due to the large-scale transport of water off the coast of Mexico under the influence of trade winds in the forms of the north equatorial current. This current after reaching the Mexican coast turns westwards and merges with the north equatorial current.

(7) Peru Current (cold)

The cold current flowing along the western coast of south American from south to north is called Peru current or Humboldt current. This current is known as Peru coastal current near the coast while it is called Peru Oceanic current off the coast. Mean annual temperature ranges between 14^0C and 17^0C and the average velocity of moving water is 15 nautical miles (27 km) per day. The temperature of sea water increases from the coast towards the ocean.

(8) EI Nino or Counter Current (warm)

A subsurface warm current, known as EI Nino Current flows from north to south between 3^0S and 36^0S latitudes at a distance of about 180km from the Peruvian coast. The southward shifting of the counter equatorial warm current during the southern winter gives birth to EI Nino Current. The temperature at Peruvian coast does not fall considerably because of this current. Though the amount of rainfall increases along the coasts due to this current but fishes die due to disappearance of planktons and occurrence of guano disease and pests caused by EI Nino. It may be pointed out that EI Nino also affects monsoons in the Indian Ocean. When EI Nino is extended to the southern end of S. America warm water is pushed eastward to join the South Atlantic westerlies drift which brings warm water in the Southern Indian Ocean during southern winters. Consequently, the high pressure in the Indian Ocean during southern winter is not intensified due to which the south-west summer monsoon is weakened.

EI Nino has been related to the increase of temperature of east Pacific Ocean off Peruvian coast while La Nina is related to the warming of the western Pacific Ocean. The strong EI Nino brings heavy rainfall exceeding normal rainfall resulting into lush green otherwise dry coastal land of Peru. The cold water mass near Peruvian coast becomes warm due to strong EI Nino event resulting into heavy rainfall in the first half of the year (January to March).

La Nina is a counter ocean current which becomes effective in the tropical western Pacific when EI Nino becomes ineffective in the tropical eastern pacific. The dry condition in the western Pacific is terminated and west condition is introduced in the tropical western Pacific by La Nina.

(9) East Australia Current (warm)

South equatorial current is bifurcated near the Australian coast into northern and southern branches. The southern branch flows as east Australia current from north to south along the eastern coasts of Australia. New Zealand is surrounded by this current. It is deflected eastward near 40^0S latitude due to the deflective force of the earth and flows in easterly

direction under the influence of the westerlies. This is a warm and more consistent current. It raises the temperature of east Australian coast for considerable distance southward.

(10) West Wind Drift (cold)

A strong ocean current, known as west wind drift, flows from west to east under the influence of the westerlies between Tasmania and South American coast in the zone of 40^0-50^0S latitudes. This current becomes much stringer because of immense volume of water mass and high velocity winds called as roaring forties and thus the current flows with great velocity. In the far east the current is bifurcated into two branches. One branch enters the Atlantic Ocean through the Cape Horn which the second branch turns northward and join Peru current.