Ocean currents

What are Ocean Currents?

- Ocean currents are the continuous, predictable, directional movement of seawater. It is a massive movement of ocean water that is caused and influenced by various forces. They are like river flows in oceans.
- Ocean water moves in two directions: horizontally and vertically.
    - Horizontal movements are referred to as currents, while vertical changes are called upwellings or downwellings.
- Ocean currents impact humankind and the biosphere due to their influence on climate.

Which are the Factors that Influences Ocean Current?

- Ocean currents are influenced by two types of forces namely:
    - **Primary forces:**
        - **Heating by solar energy:** Heating by solar energy causes the water to expand. That is why, near the equator the ocean water is about 8 cm higher in level than in the middle latitudes. This causes a very slight gradient and water tends to flow down the slope.
        - **Wind**: Wind blowing on the surface of the ocean pushes the water to move. Friction between the wind and the water surface affects the movement of the water body in its course.
        - **Gravity:** Gravity tends to pull the water down the pile and create gradient variation.
        - **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.
    - **Secondary forces:**
        - **Differences in water density:** It affects vertical mobility of ocean currents.
            - Water with high salinity is denser than water with low salinity and in the same way cold water is denser than warm water.
            - Denser water tends to sink, while relatively lighter water tends to rise.
        - **Temperature of water:** Cold-water ocean currents occur when the cold water at the poles sinks and slowly moves towards the equator.
            - Warm-water currents travel out from the equator along the surface, flowing towards the poles to replace the sinking cold water.

What are the Types of Ocean Currents?

- The ocean currents may be classified based on their depth:
    - **Surface currents:** Large-scale surface ocean currents are driven by global wind systems that are fueled by energy from the sun.
        - These currents transfer heat from the tropics to the polar regions, influencing local and global climate.
        - It constitute about 10% of all the water in the ocean, these waters are the upper 400 m of the ocean.
    - **Deep water currents:** Differences in water density, **resulting from the variability of water temperature (thermo)** and **salinity (haline)**, also cause ocean currents. This process is known as thermohaline circulation.
        - It makes up the other 90% of the ocean water.
        - These waters move around the ocean basins due to variations in the density and gravity.
        - Deep waters sink into the deep ocean basins at high latitudes, where the temperatures are cold enough to cause the density to increase.
        - This starts' the **global conveyor belt**, a connected system of deep and surface currents that circulate around the globe on a 1000 year time span.
        - This global set of ocean currents is a critical part of Earth's climate system as well as the ocean nutrient and carbon dioxide cycles.
- Ocean currents can also be classified based on temperature:
    - **Cold currents**: It brings cold water into warm water areas. These currents are usually found on the west coast of the continents in the low and middle latitudes (true in both hemispheres) and on the east coast in the higher latitudes in the Northern Hemisphere.
    - **Warm currents**: It brings warm water into cold water areas and is usually observed on the east coast of continents in the low and middle latitudes (true in both hemispheres).
        - In the northern hemisphere they are found on the west coasts of continents in high latitudes.

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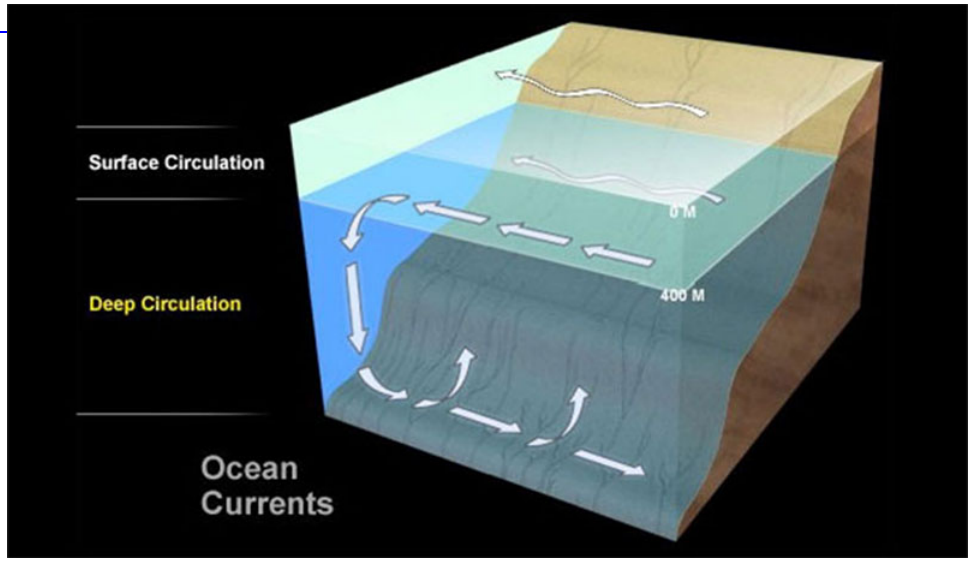
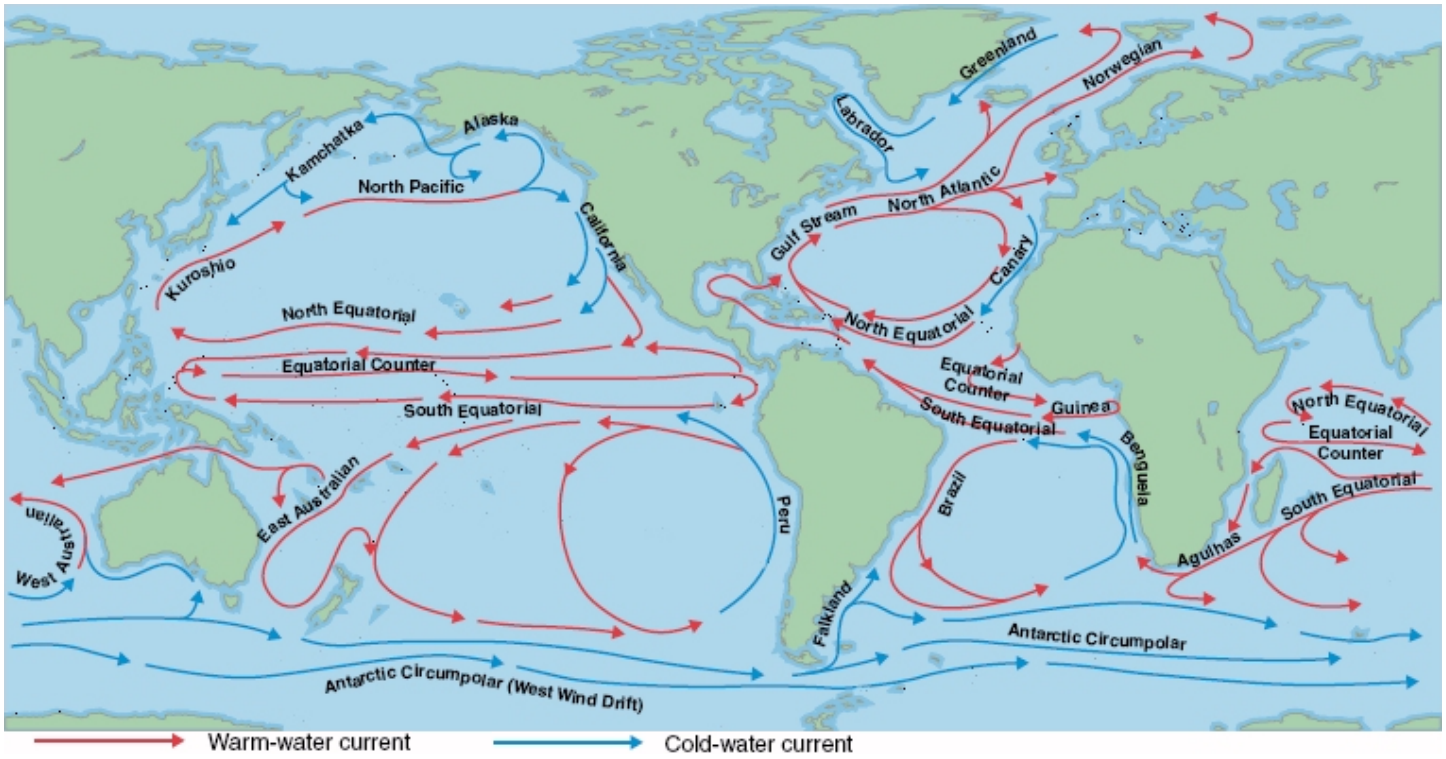


What are the Characteristics of Ocean Currents?

- Major ocean currents are greatly **influenced by the stresses exerted by the prevailing winds and coriolis force.** The oceanic circulation pattern roughly corresponds to the earth's atmospheric circulation pattern.
- The air circulation over the oceans in the **middle latitudes is mainly anticyclonic** (more pronounced in the southern hemisphere than in the northern hemisphere). The oceanic circulation

pattern also corresponds with the same.

- At **higher latitudes**, where the **wind flow is mostly cyclonic**, the oceanic circulation follows this pattern.
- In regions of pronounced monsoonal flow, the **monsoon winds influence the current movements.**
- **Due to the coriolis force,** the **warm currents from low latitudes tend to move to the right in the northern hemisphere** and to **their left in the southern hemisphere.**
- The oceanic circulation **transports heat from one latitude belt to another** in a manner similar to the heat transported by the general circulation of the atmosphere.
- The **cold waters of the Arctic and Antarctic circles move towards warmer water in tropical and equatorial regions,** while the **warm waters of the lower latitudes move polewards.**



What are the Various Ocean Currents?

- **Equatorial Currents System**: Every ocean, except the Arctic Ocean, has a North Equatorial Current, a South Equatorial Current and an Equatorial Counter Current.
    - The North and South equatorial currents flow from east to west.
- **Equatorial Counter Current**: It is located between the North and South equatorial currents and flows in opposition to them, that is, from west to east.
- **Antarctic Circumpolar Current (ACC):** The ACC is an ocean current that flows clockwise from west to east around Antarctica. An alternative name for the ACC is the West Wind Drift.
- **Humboldt or Peruvian Current:** This low-salinity current has a large marine ecosystem and serves as one of the major nutrient systems of the world.
    - Flows from the southernmost tip of Chile to northern Peru, along the west coast of South America.
- **Kurile or Oyashio Current**: This sub-arctic ocean current circulates in a counterclockwise direction.
    - It originates in the Arctic Ocean flows south via the Bering Sea in the western North Pacific Ocean.
    - It is a nutrient-rich current.
    - It collides with Kurioshio off the Japanese eastern shore to form the North Pacific Drift.

- **California Current:** It is the extension of the Aleutian Current along the west coast of North America in a southward flowing direction.
    - It is a part of North Pacific Gyre.
    - Region of strong Upwelling.
- **Labrador Current:** It flows from the Arctic Ocean towards the south and meets the warm northward moving Gulf Stream.
    - The combination of cold Labrador Current and warm Gulf Stream is known for creating one of the richest fishing grounds of the world.
- **Canary Current:** Low salinity current extending between Fram Strait and Cape Farewell.
    - It connects the Arctic directly to the North Atlantic.
    - Major freshwater sink for the Arctic.
    - It is a major contributor to sea-ice export out of the Arctic.
- **Benguela Current:** Branch of West Wind Drift of the Southern Hemisphere.
    - Eastern portion of South Atlantic Ocean Gyre.
    - Low salinity, presence of upwelling- excellent fishing zone.
- **Falkland Current:** It is a branch of Antarctic Circumpolar Current.
    - It is also known as Malvinas Current.
    - It is named after the Falkland Islands.
    - This cold current mixes with warm Brazil current and forms the Brazil-Malvinas Confluence Zone which is responsible for the region's temperate climate.
- **Northeast Monsoon Current:** Indian North Equatorial Current flows southwest and west, crossing the Equator.
- **Somali Current:** Analogous to the Gulf Stream in the Atlantic Ocean.
    - The Current is heavily influenced by monsoon.
    - Region of major upwelling system.
- **Western Australian Current:** It is also known as West Wind Drift.
    - It is a part of the Antarctic Circumpolar Current.
    - It is a seasonal current- strong in summer and weak in winter.'
- **Kuroshio Current:** This west boundary current is also known as Japan current or Black Current. The term **"Kuroshio" in Japanese means "Black Stream ''.**
    - It is the Pacific analogue of the Gulf Stream in the Atlantic Ocean.
    - The average surface temperature of this current is warmer than the surrounding ocean.
    - This also helps in regulating the temperature of Japan, which is relatively warmer.
- **North Pacific Current:** It is formed by the collision of Kurioshio & Oyashio.
    - It circulates counterclockwise along the Western North Pacific Ocean.
- **Alaskan Current:** It results from a northward diversion of a part of the North Pacific Ocean.
- **East Australian Current:** Acts to transport tropical marine fauna to habitats in sub-tropical regions along the southeast Australian coast.
- **Florida Current:** Flows around Florida Peninsula and joins the Gulf Stream at Cape Hatteras.
- **Gulf Stream**: Western intensified current-driven mainly by wind stress.
    - It splits into North Atlantic Drift (crossing Northern Europe & southern stream) and Canary Current (recirculating of West Africa)
- **Norwegian Current:** This wedge-shaped current is one of the two dominant Arctic inflows of water.
    - It is a branch of North Atlantic Drift and sometimes also considered as an extension of the Gulf Stream.
- **Brazilian Current:** Flows along the south coast of Brazil till Rio de la Palta.

    - It joins the cold Falkland Current at the Argentine Sea making it a temperate sea.
- **Mozambique Current:** Flows between Mozambique and the island of Madagascar along the African east coast in the Mozambique Channel.
- **Agulhas Current:** Largest western boundary ocean current.
    - Flows south along the east coast of Africa.
- **Southwest Monsoon Current:** It dominates the Indian Ocean during the southwest monsoon season (June–October).
    - It is a broad eastward flowing ocean current that extends into the Arabian Sea and Bay of Bengal.

What are the Effects of Ocean Currents?

- **Climatic Conditions:** Currents influence the climatic conditions of the regions in which they flow.
    - The warm Equatorial currents raise the temperature of the region in which they flow. Similarly, the cold currents lower the temperature of the places where they flow.
    - For example, the 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.
- **Rainfall:** The winds blowing over warm currents pick up and carry moisture and bring rainfall like 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 due to the cold Benguela current.
- **Fog Formation:** The meeting of the warm and the cool currents results in the formation of fog.
    - The ship's face danger due to 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 are not able to view icebergs due to poor visibility.
- **Creates Fishing Zone:** The mixing of warm and cold currents results in the deposition of planktons. Therefore, at such places, fishes can be found in abundance.
- **Desert formation:** Cold ocean currents have a direct effect on desert formation in west coast regions of the tropical and subtropical continents.
    - There is fog and most of the areas are arid due to **desiccating effects** (loss of moisture).
- **Trade and Commerce:** Currents help 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.
- **Violent Storms:** At times the meeting line of a warm and a cold current may result in a violent storm.
    - The hurricanes which occur off the coast of the U.S.A. follow the line where the Gulf Stream merges with the Labrador Current.

Mains Question

Q. Explain the factors responsible for the origin of ocean currents. How do they influence regional climates, fishing and navigation?

Q. Which factors impact ocean currents formation and how do they influence climate in different regions of the world?

Q. What are different types of ocean current? Also discuss the characteristics of ocean currents.

Prelims Question

Q. The most important fishing grounds of the world are found in the regions where:(2013)

(a) warm and cold atmospheric currents meet

(b) rivers drain out large amounts of fresh water into the sea

(c) warm and cold oceanic currents meet

(d) continental shelf is undulating

Q.Consider the following factors:

1. Rotation of the Earth
2. Air pressure and wind
3. Density of ocean water
4. Revolution of the Earth

Which of the above factors influence the ocean currents?

(a) 1 and 2 only

(b) 1, 2 and 3

(c) 1 and 4

(d) 2, 3 and 4

Q. Consider the following statements:

1. Ocean currents are slow-surface movement of water in the ocean.
2. Ocean currents assist in maintaining the Earth's heat balance
3. Ocean currents are set in motion primarily by prevailing winds
4. Ocean currents are affected by the configuration of the ocean

Which of these statements are correct?

(a) 1 and 2

(b) 2, 3 and 4

(c) 1, 3 and 4

(d) 1, 2, 3 and 4

Q. The most important fishing grounds of the world are found in the regions where

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