

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

GEO 435
Oceanography

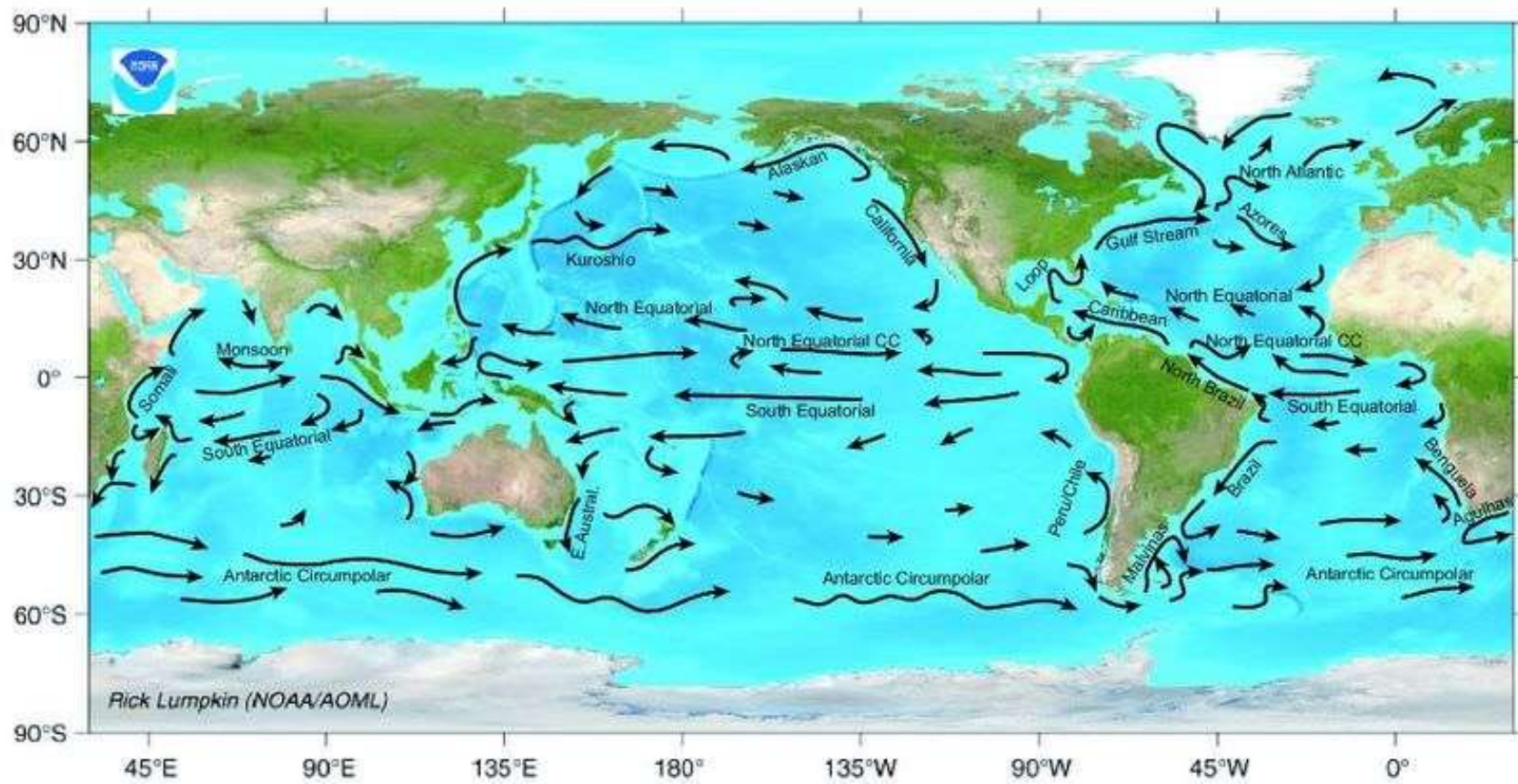
Dr. Sattam Abdulkareem Almadani

Ocean Circulation:

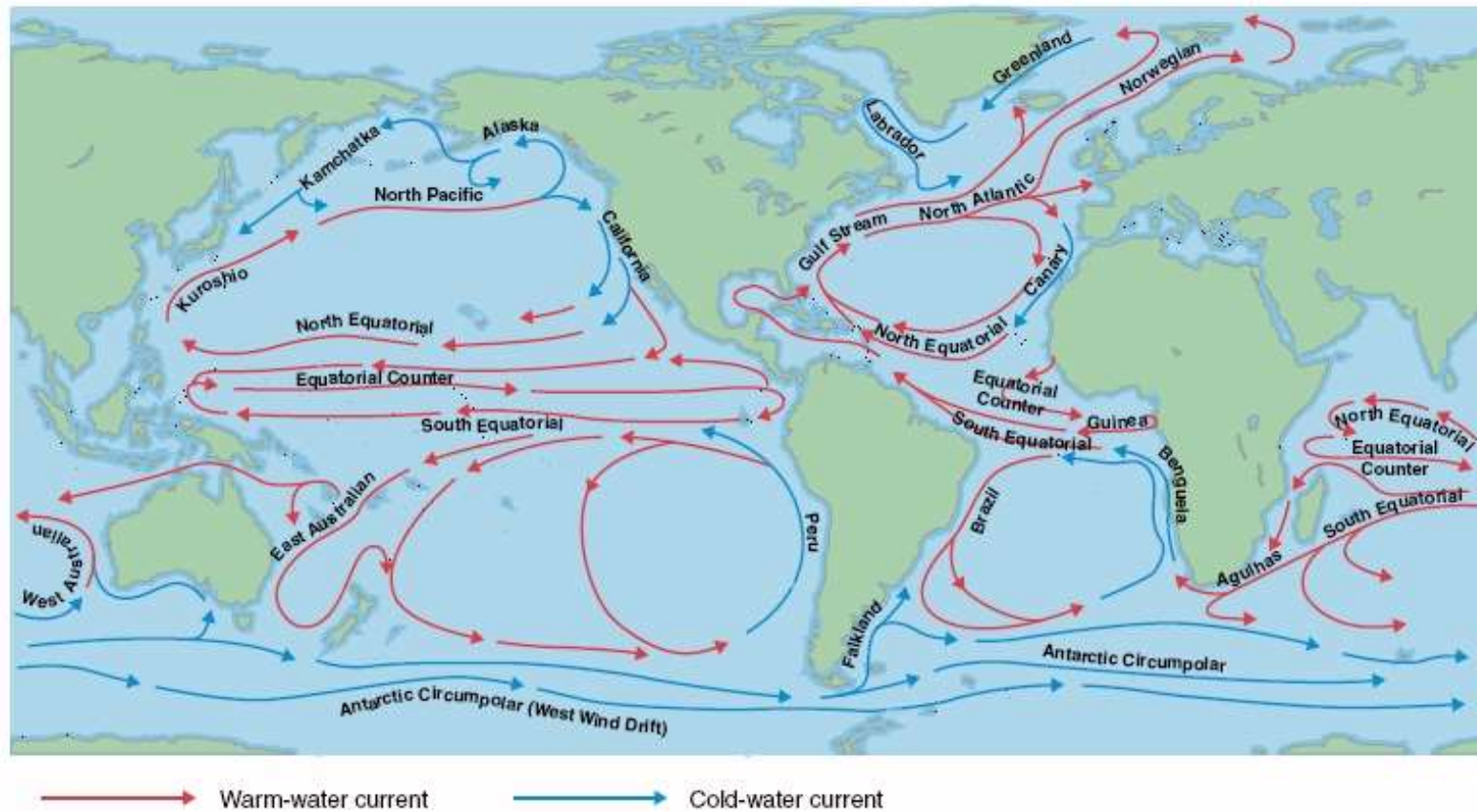
- Ocean currents
- Measurements of ocean currents
- Ocean surface currents
- Upwelling and downwelling
- Main surface circulation pattern
- El Nino
- Deep-ocean currents

Q. What are ocean currents?

- Ocean currents are masses of ocean water that flow from one place to another.
- The amount of water can be large or small, currents can be at the surface or deep below, and the phenomena that creates them can be simple or quite complex.



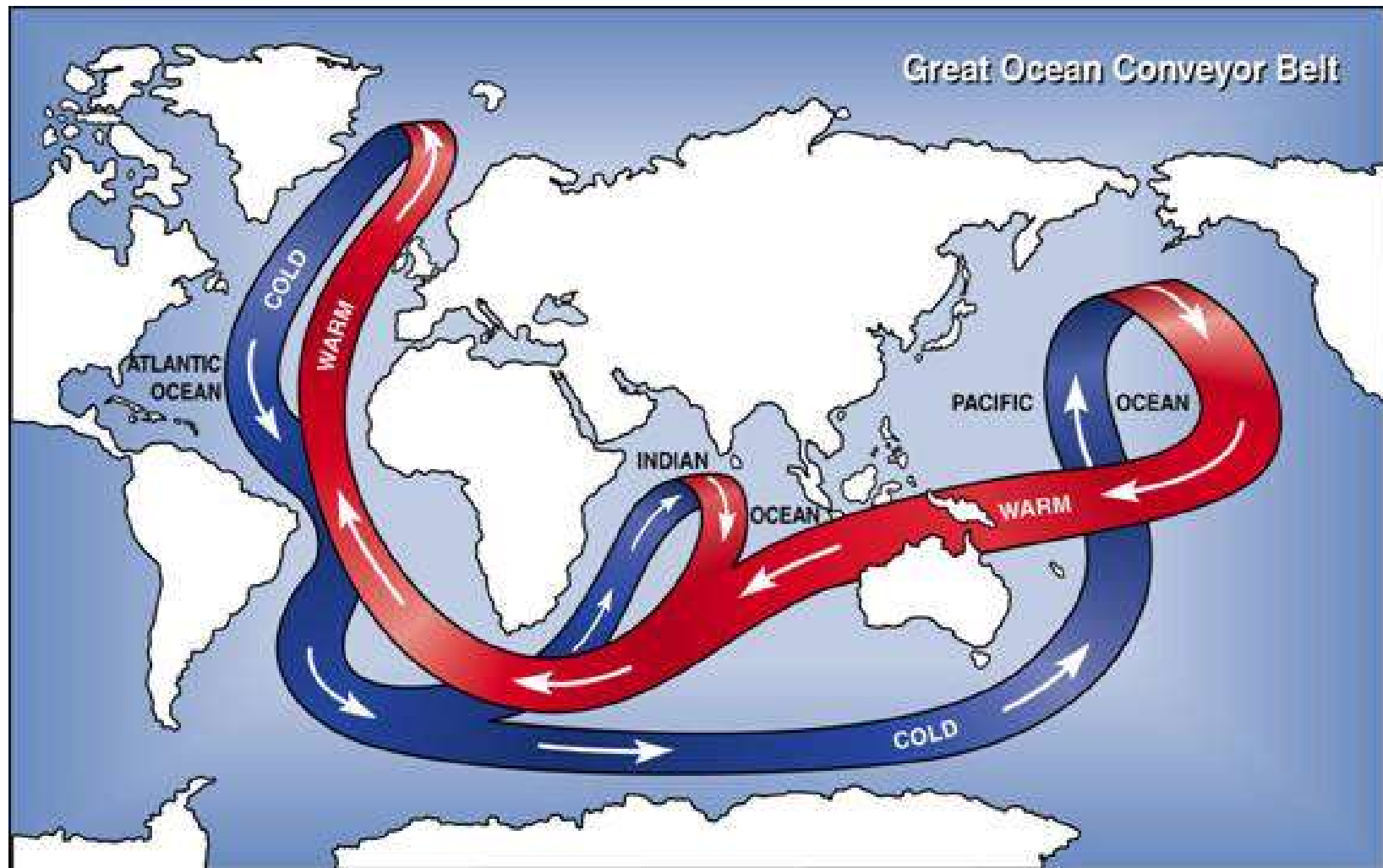
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Q. What do ocean currents transfer?

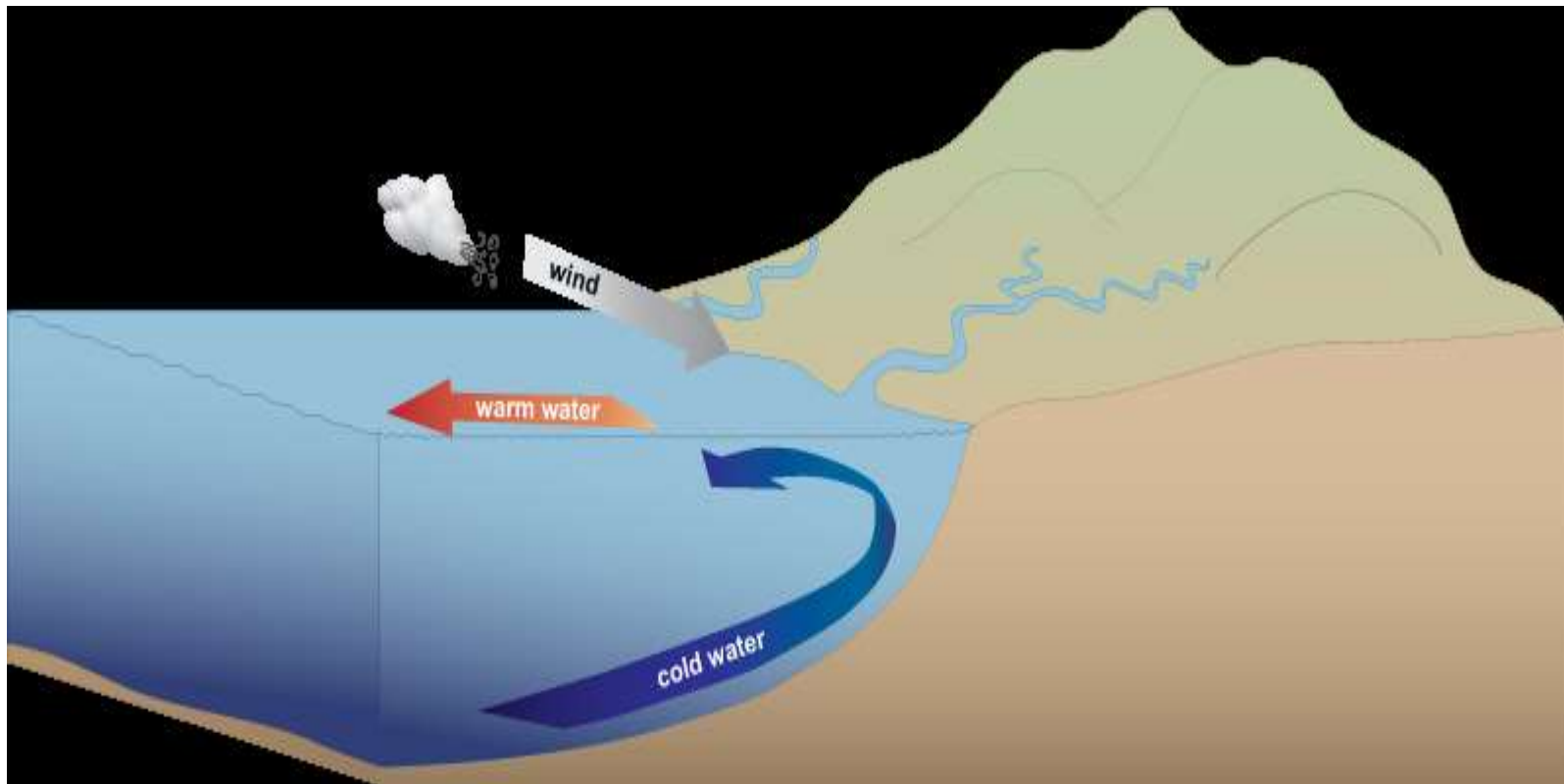
Ocean currents transfer heat from warmer to cooler area on Earth, just as the major wind belts of the world do.



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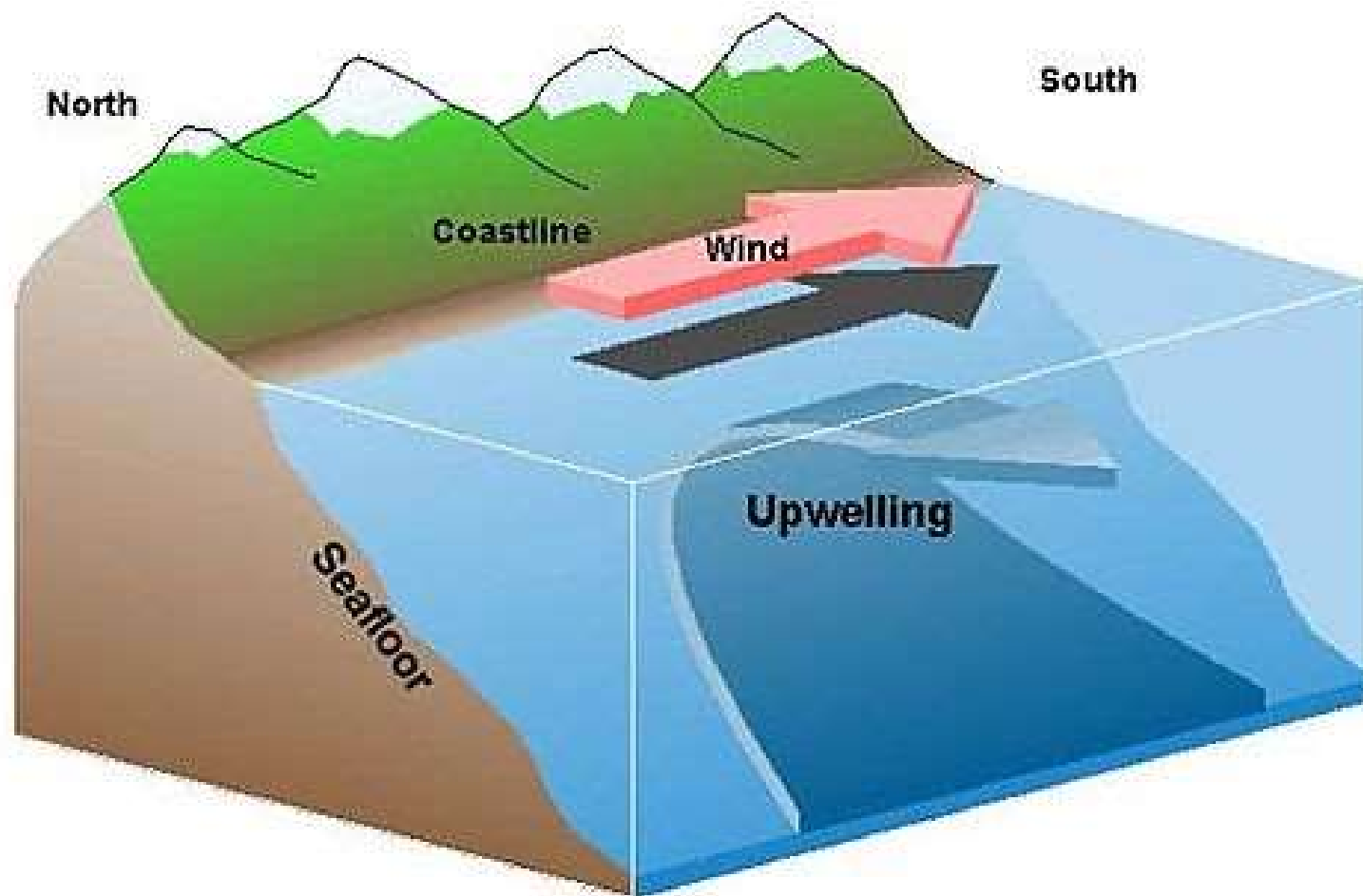
Q. How do ocean currents exist?

Ocean currents are either wind driven or density driven

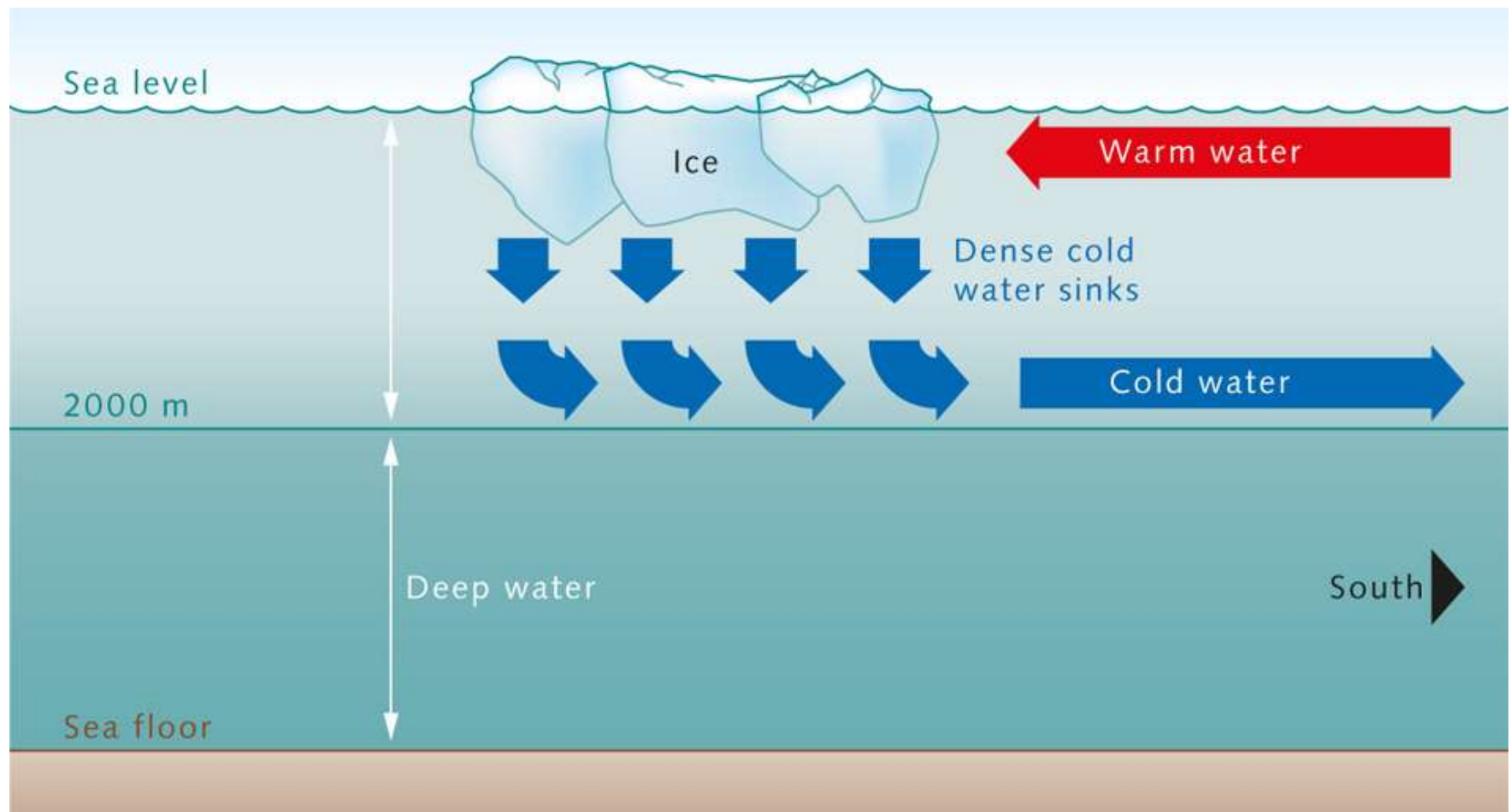


Q. How many types of ocean currents there are?

1. Surface currents: motion is parallel to the surface (horizontal) and occurs primarily in the ocean's surface waters
2. Deep currents: motion is vertical and occur beneath the surface



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Q. What are the forces which control the surface
and the deep ocean currents?

1. Surface currents are controlled by the wind driven
2. Deep currents are controlled by density driven

Q. How are ocean currents are measured?

1. Surface currents

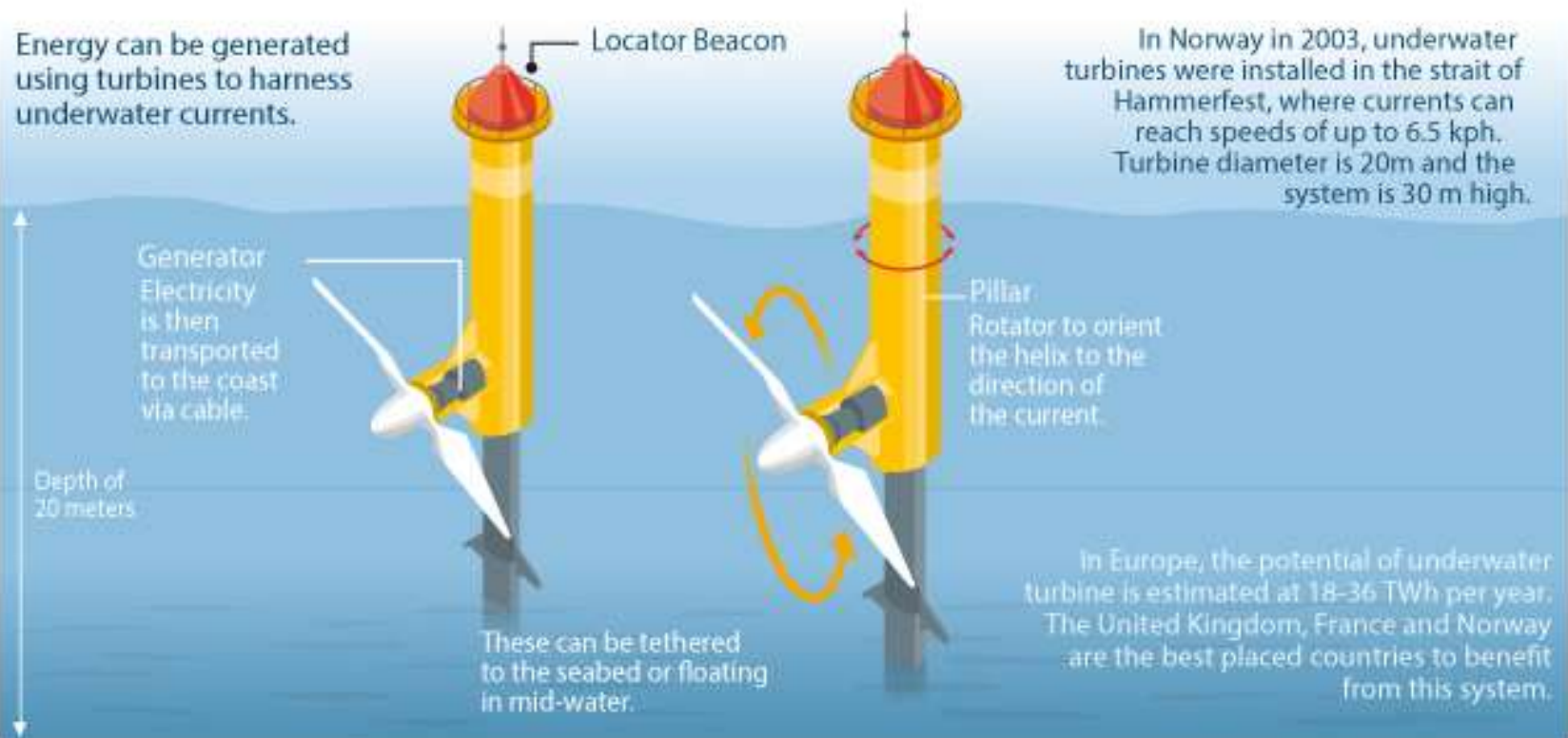
1. Direct methods:

1. A floating device is released into the currents and tracked through time.
2. From fixed position where a current-measuring device.

2. Indirect methods:

1. Water flows parallel to a pressure gradient.
2. Radar altimeters (satellite).
3. Doppler flow meter.

Energy can be generated using turbines to harness underwater currents.



In Norway in 2003, underwater turbines were installed in the strait of Hammerfest, where currents can reach speeds of up to 6.5 kph. Turbine diameter is 20m and the system is 30 m high.

These can be tethered to the seabed or floating in mid-water.

In Europe, the potential of underwater turbine is estimated at 18-36 TWh per year. The United Kingdom, France and Norway are the best placed countries to benefit from this system.

2. Deep currents

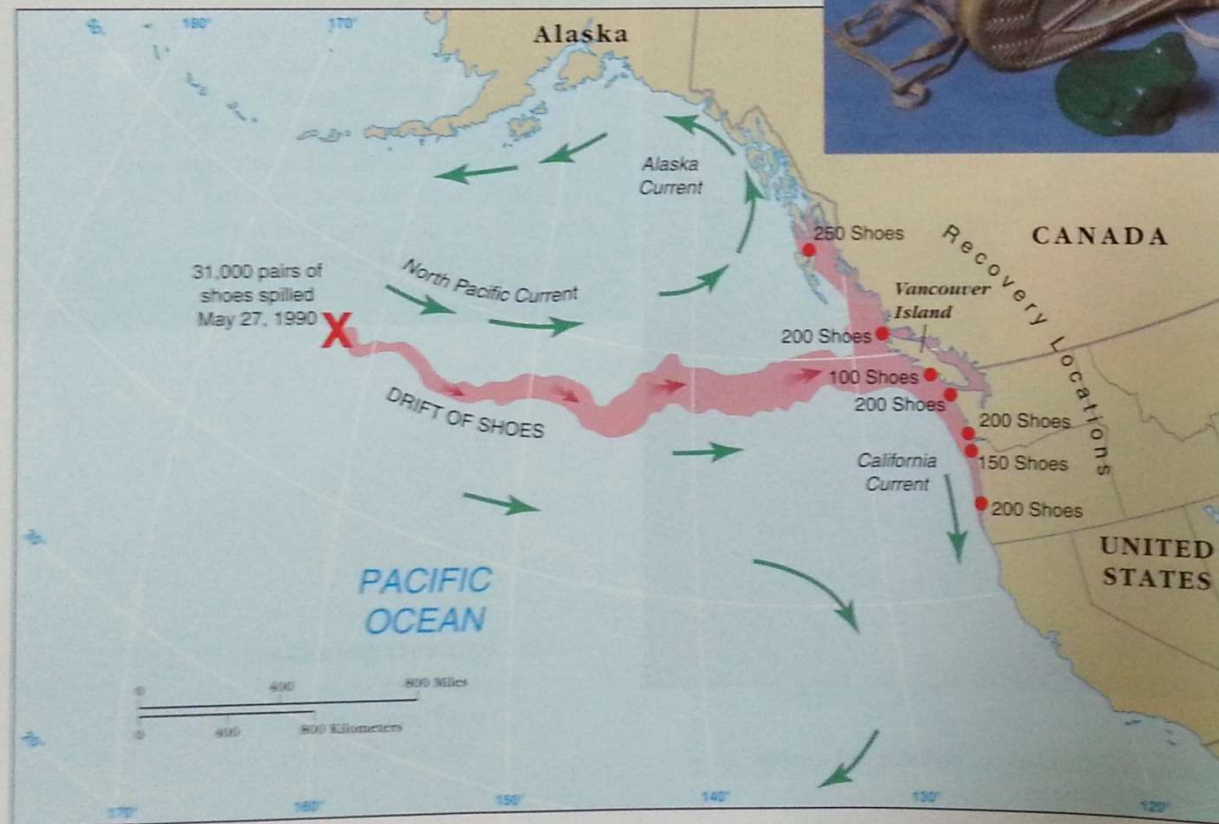
- The great depth at which deep currents exist makes them even more difficult to measure than surface currents.
- Often, they are mapped using devices that are carried with the current or by tracking telltale chemical traces.
- Other techniques include measuring the distinctive temperature and salinity characteristics of a deep-water mass.



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12.2-meter (40-foot)-long rectangular metal shipping containers, many of which were lashed to the ship's deck for the voyage. During the storm, the ship lost 21 deck containers over-

Figure 7A Path of drifting shoes and recovery locations from the 1990 spill; recovered shoes and plastic bathtub toys (inset).



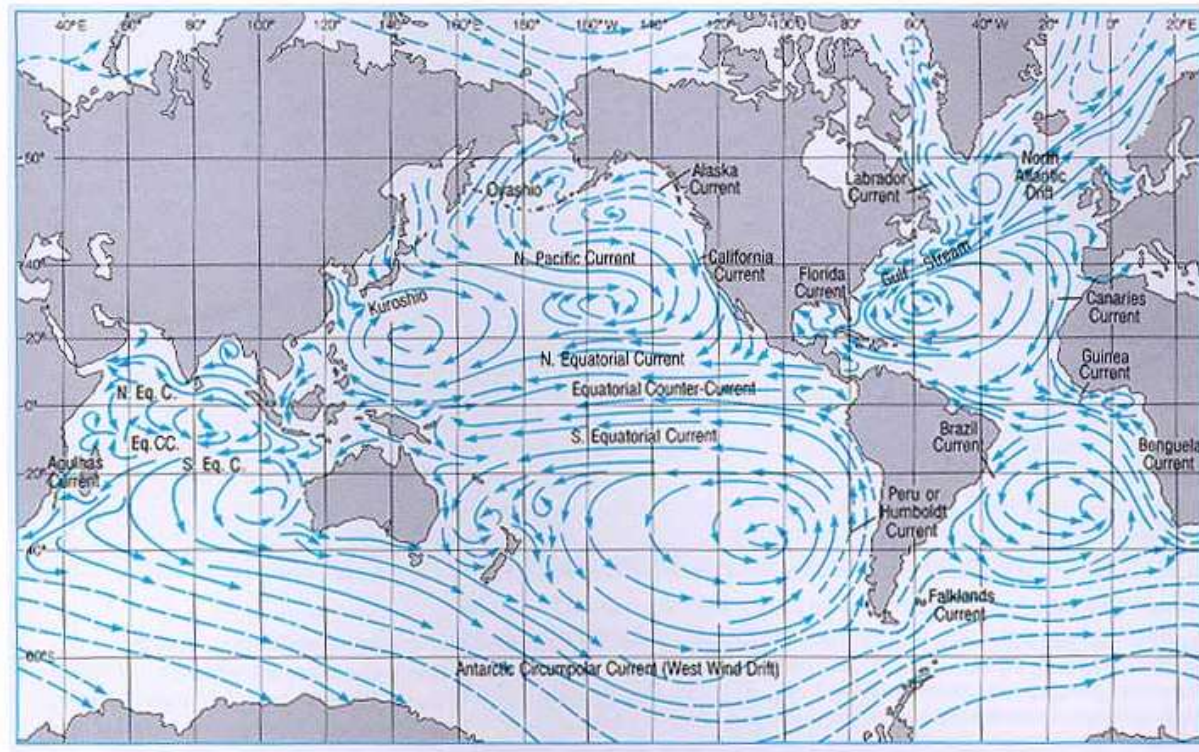
ducks, and g (Figure Even th were ho tic pack a cardbo studies after 24 water, th orated 100,000 were rel

The f tub toy come ashore in southeast Alaska later, verifying the computer models indicate that many of toys will continue to be carried by the Current, eventually dispersing the North Pacific Ocean. Some their way into the Arctic Ocean could spend time within the Arctic pack. From there, the toys may travel to the North Atlantic, eventually washing up on beaches in northern Europe, 100 kilometers from where they were released into the ocean.

Oceanographers continue to study ocean currents by tracking other floats spilled by cargo ships (Table 7A).

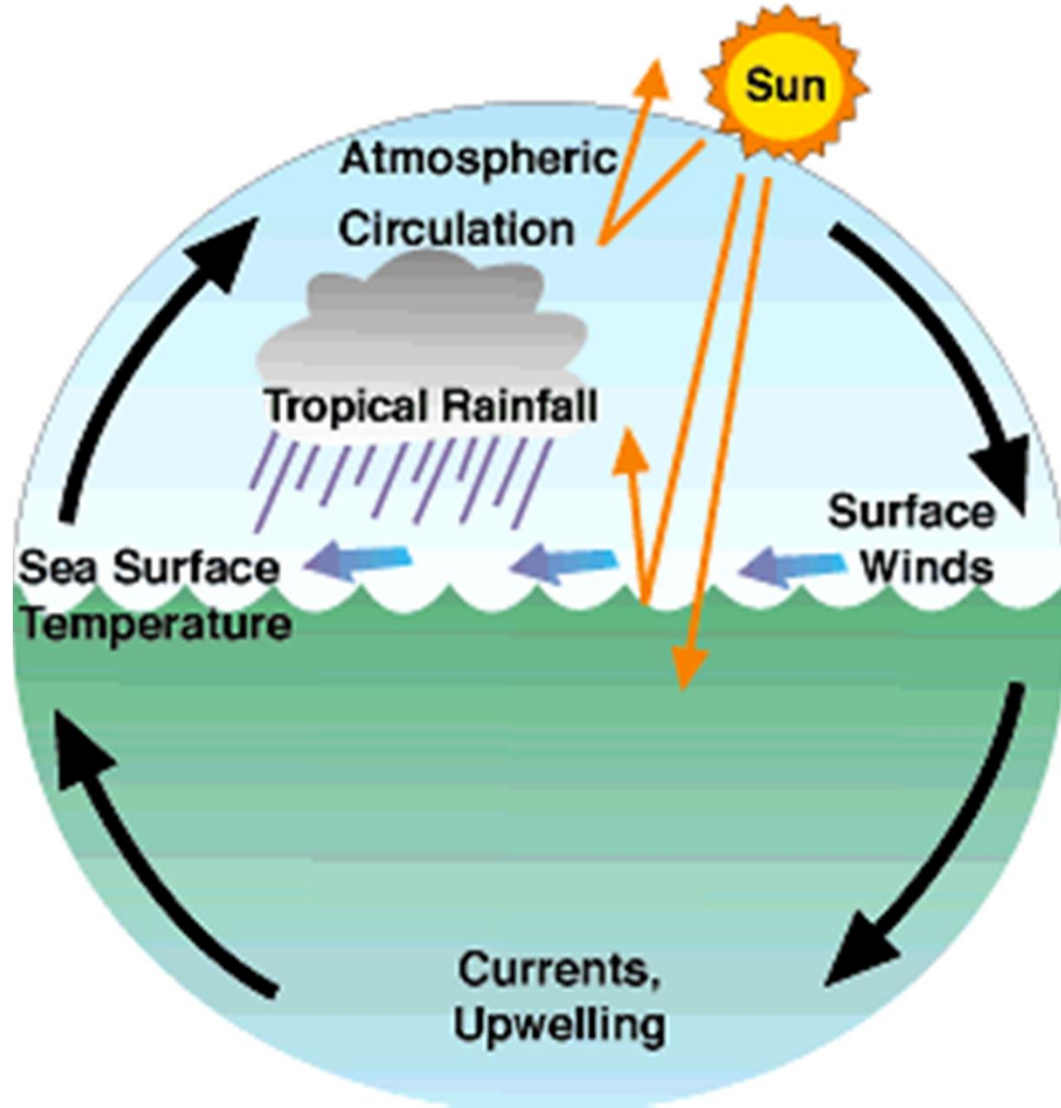
Q. What are the main components of ocean surface circulation?

The principal ocean surface current pattern consist of subtropical and saub-polar that are large circular-moving loops of water powered by the major wind belts of the world.



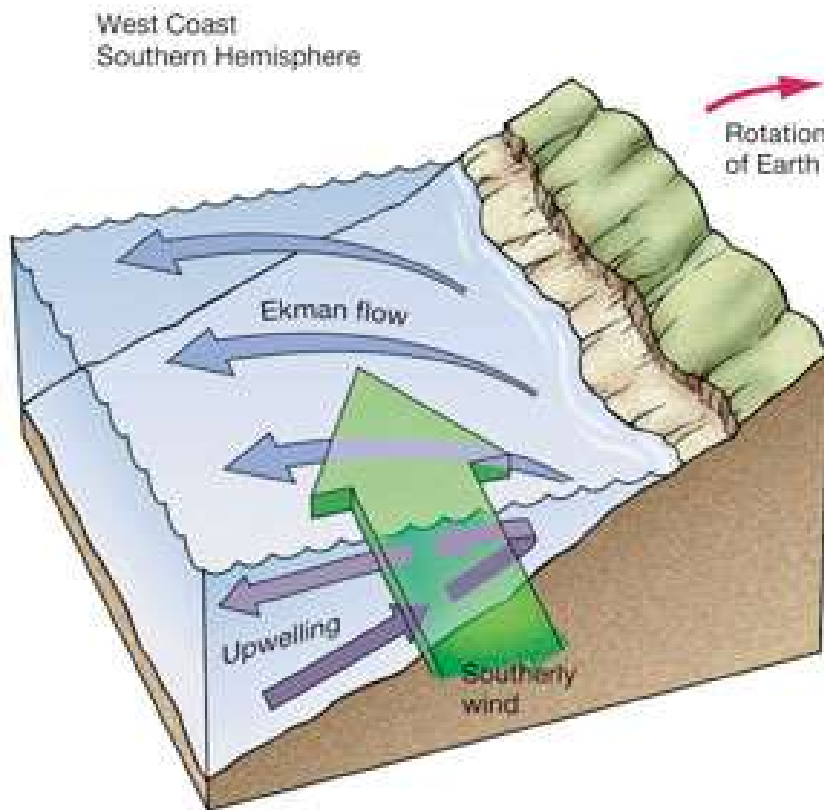
Q. Can ocean currents affect climate?

- Ocean surface currents directly influence the climate of adjoining landmasses.
- For instance, warm ocean currents warm the nearby air. This warm air can hold a large amount of water vapor, which puts more moisture (high humidity) in the atmosphere.

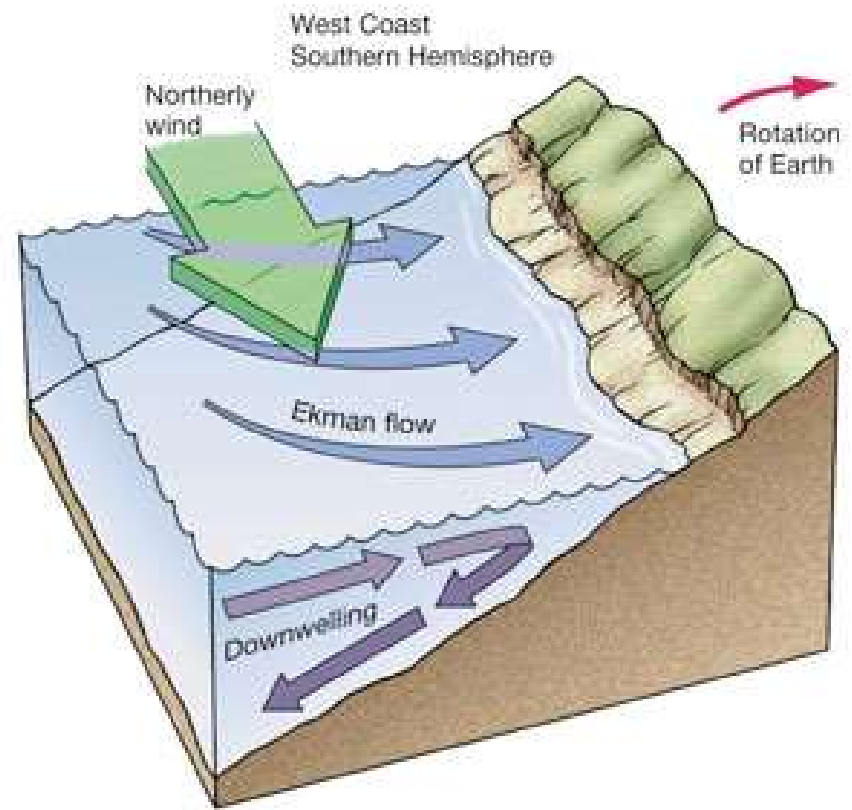


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- Upwelling is the vertical movement of cold, deep, nutrient-rich water to the surface.
- Downwelling is the vertical movement of surface water to deeper parts of the ocean.
- Upwelling and downwelling provide important mixing mechanisms between surface and deep waters and are accomplished by a variety of methods.



(a)



(b)

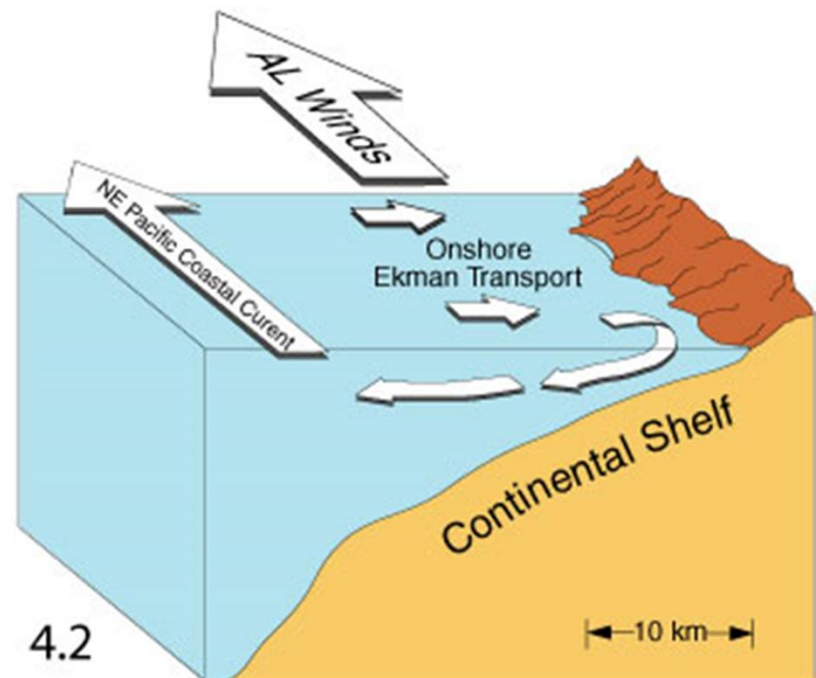
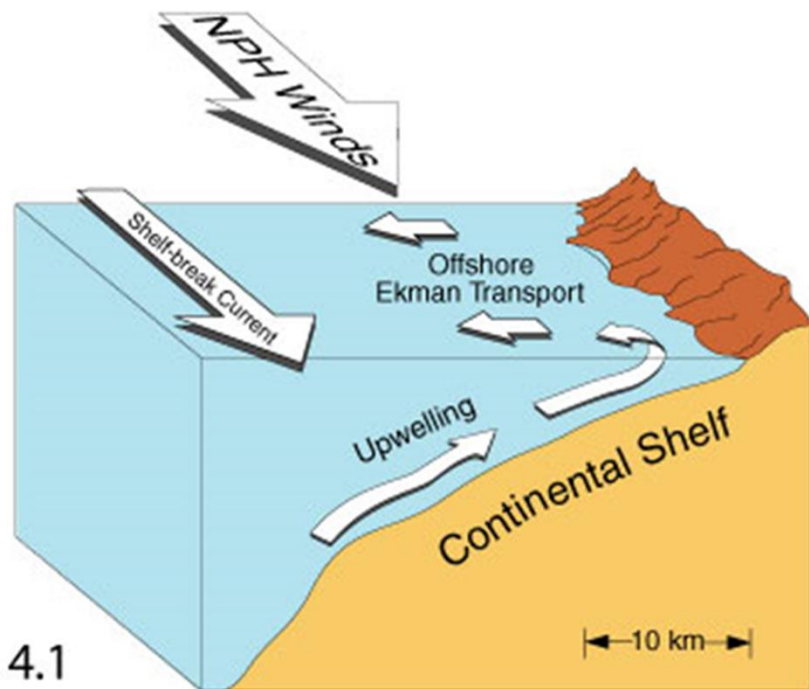
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Q. What causes upwelling and downwelling?

1- Diverging surface water: occurs when surface waters move away from an area on the ocean's surface, such as along the equator.

2- Converging surface water: occurs when surface waters move towards each other.

3- Coastal upwelling and downwelling: coastal winds can cause upwelling or downwelling due to Ekman transport.

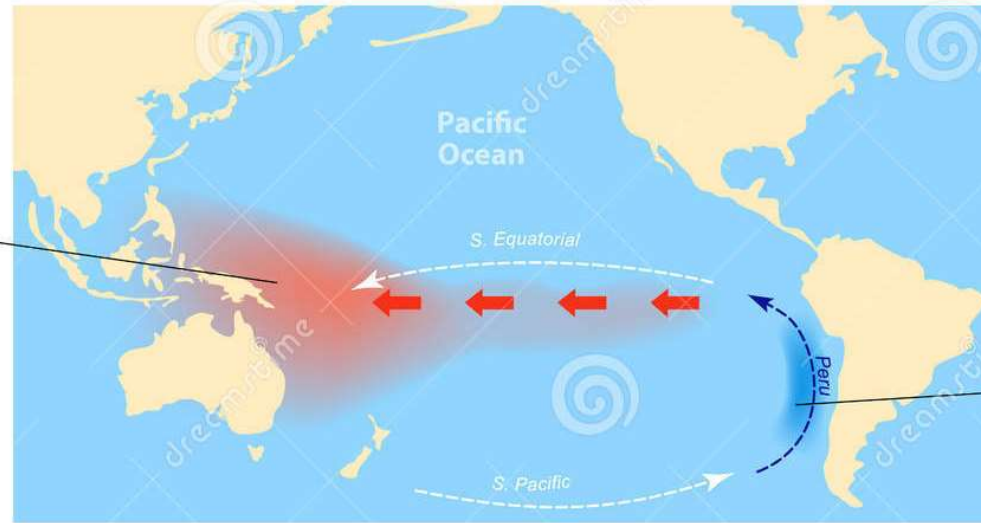


Q. What is El Nino?

- El Niño, as a oceanic phenomenon along the coasts of northern Peru and Ecuador, has been documented since the 1500s.
- Originally, the term El Niño was used to describe the annual appearance of warm waters along the coast of northern Peru around Christmastime.
- In some years the warm waters appeared earlier and lasted longer. Eventually, the term El Niño was applied to the periods of anomalous warming.
- The stronger events disrupted local fish and bird populations.

NORMAL YEAR

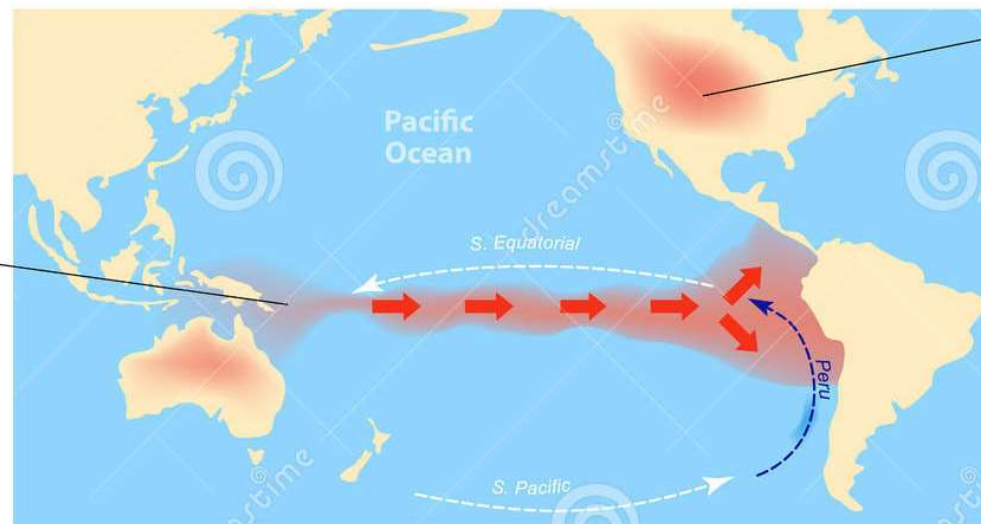
Equatorial winds gather warm water pool toward the west.



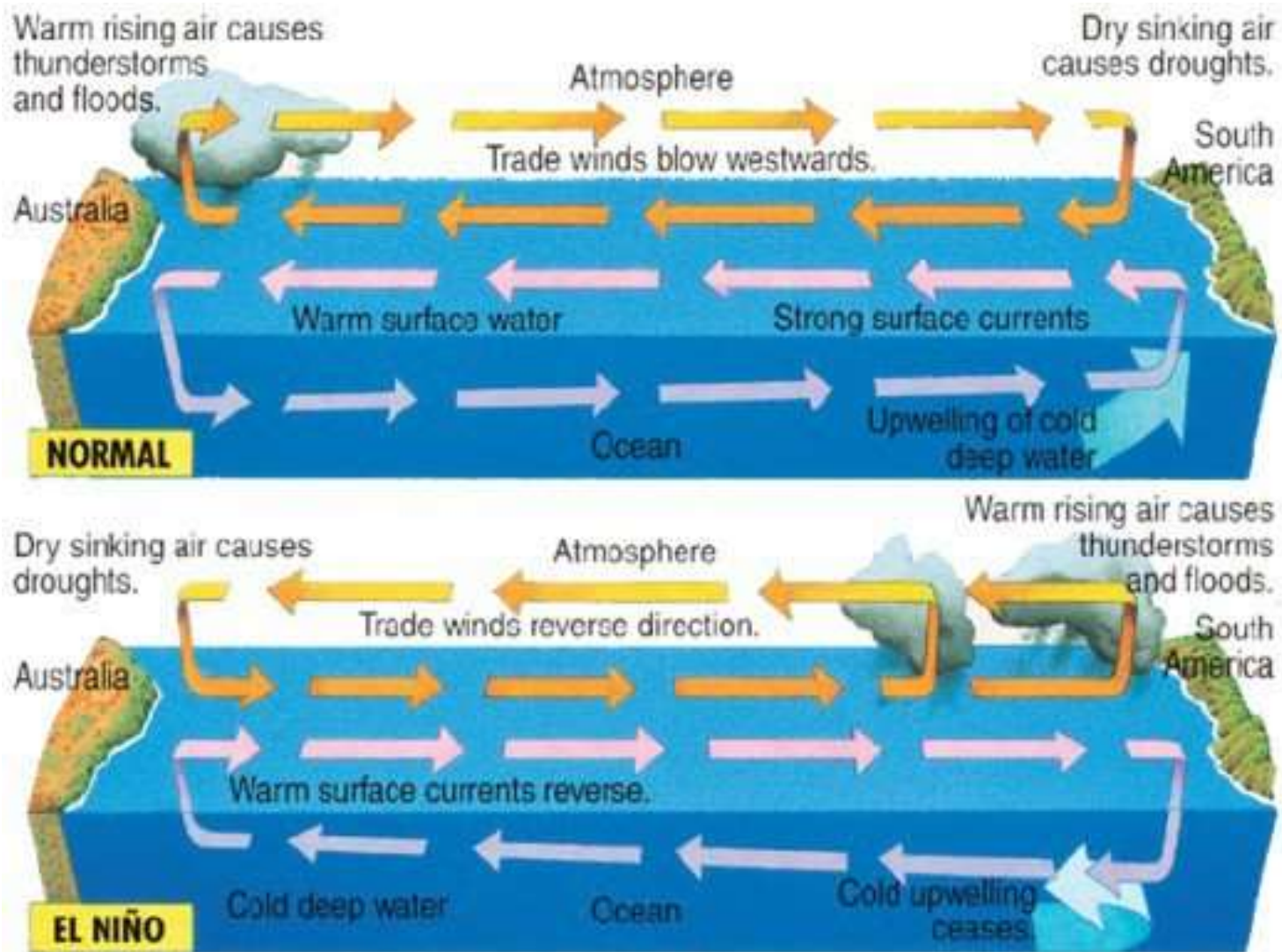
Cold water along South American coast.

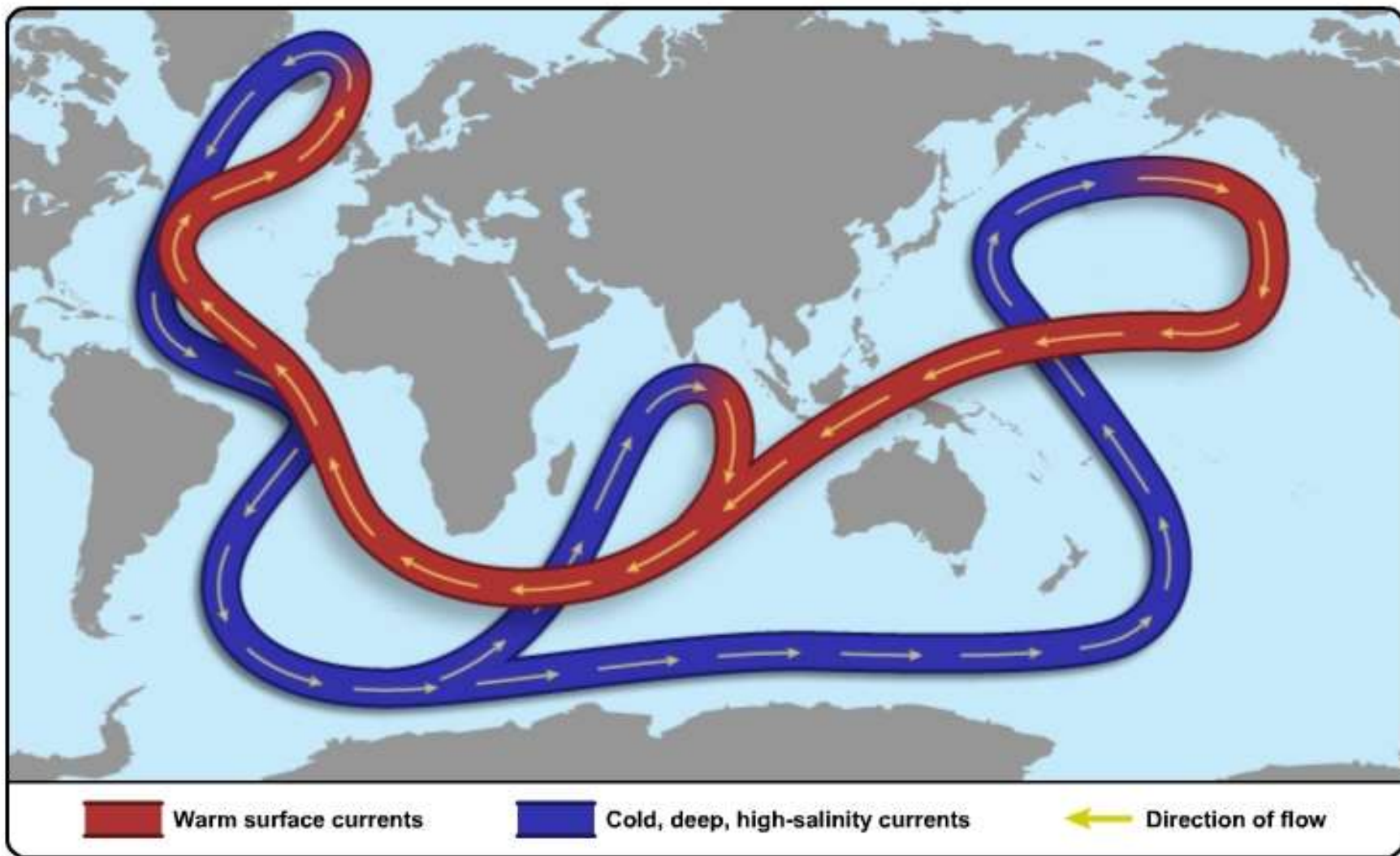
EL NIÑO YEAR

Easterly winds weaken. Warm water to move eastward.



Warmer winter





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