The importance of ocean currents

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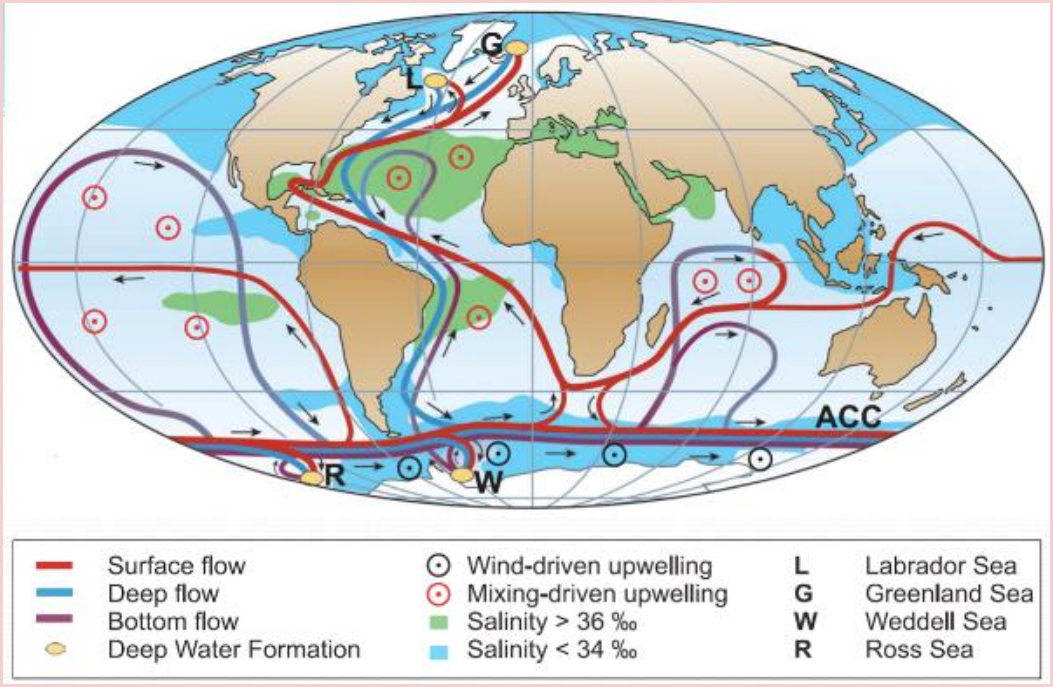
The ocean conveyor belt (1)

- Ocean waters are in perpetual motion. They are constantly on the move as a result of marine currents, which are of two main types:
  - Surface currents effecting oceanic movements up to a depth of 800 m, equivalent to about 10% of total water mass. These currents flow clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.
  - Deep currents, which operate at depths greater than 800 m, where thermohaline circulation drives ocean movements.
- These interconnected ocean currents provide a number of ecosystem services.
  - They specifically facilitate the transfer of nutrients and minerals, essential to marine ecosystem development. As they move, deep cold water mixes with higher layers and rises to the surface, enabling plankton blooms.

The ocean's CO_2-storing "conveyor belt"



Source : T. Kuhlbrodt, "On the driving processes of the Atlantic meridional overturning circulation", *Reviews of Geophysics*, Vol. 45, Issue 2.

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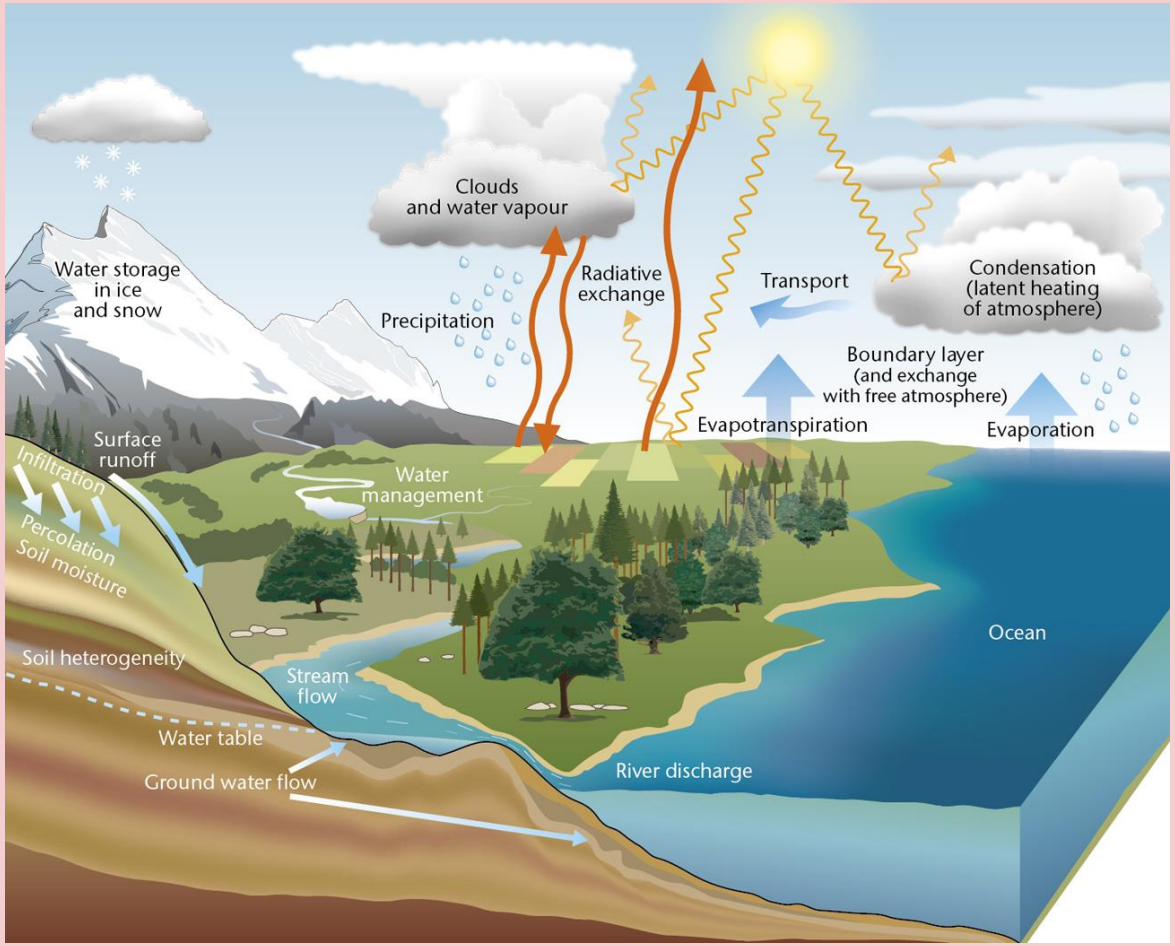
The water cycle (2)

- Ocean currents also take part in the water cycle. This cycle takes place over three stages:
  - Water heats up under the effect of the sun, evaporates and reaches the atmosphere.
  - Then the water vapor cools down (condensation) and turns into droplets.
  - These form clouds which, pushed by the winds, mix with cold air masses, thereby generating precipitation.
- In this way, water circulates continuously on Earth: it goes from liquid to gaseous state, then comes back to Earth in solid or liquid form (rain, snow, fog).
- This continual movement of water, driven by the ocean, is essential to the planet's habitability.

The water cycle



Source: United Kingdom's national weather service

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Ocean-atmosphere interaction: the El Niño phenomenon

- Atmospheric circulation has an impact on ocean currents, as illustrated by the El Niño oceanic phenomenon, induced by a substantial temperature anomaly of the South Pacific Ocean's surface waters.
- This phenomenon stems from a warming of surface waters off South America, combined with atmospheric variations between the eastern and western Pacific. Winds from the East push warm surface waters towards the West, while cold deep waters rise off the coast of Peru.
- This ocean/atmosphere interaction causes disruption to ocean currents and trade wind patterns, leading to severe drought episodes (southeast Africa) and accelerating desertification in the Sahel, for example (3).

The climate issue

- Proper ocean current circulation is a fundamental climate issue, as disrupting it causes severe climatic consequences.

  - On one hand, currents are instrumental in distributing the CO_2 absorbed by the ocean. The "conveyor belt" transports warm surface waters loaded with CO2 towards the colder poles.
  - On the other, these currents regulate both continental heat and air humidity. In fact, they redistribute the energy of solar radiation from warm areas to cold areas, e.g. the "Gulf Stream" which carries heat from the tropics to Europe..

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References

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3. Cai, W., McPhaden, M.J., Grimm, A.M. et al., 2020. Climate impacts of the El Niño : Southern Oscillation on South America in *Nature Reviews Earth & Environment 1, 215–231* [online]