



The Slowdown in Overturning Circulation

For Prelims: [Overturning circulation](#), Bottom Water, [Antarctica](#), Greenhouse effect, [ocean currents](#).

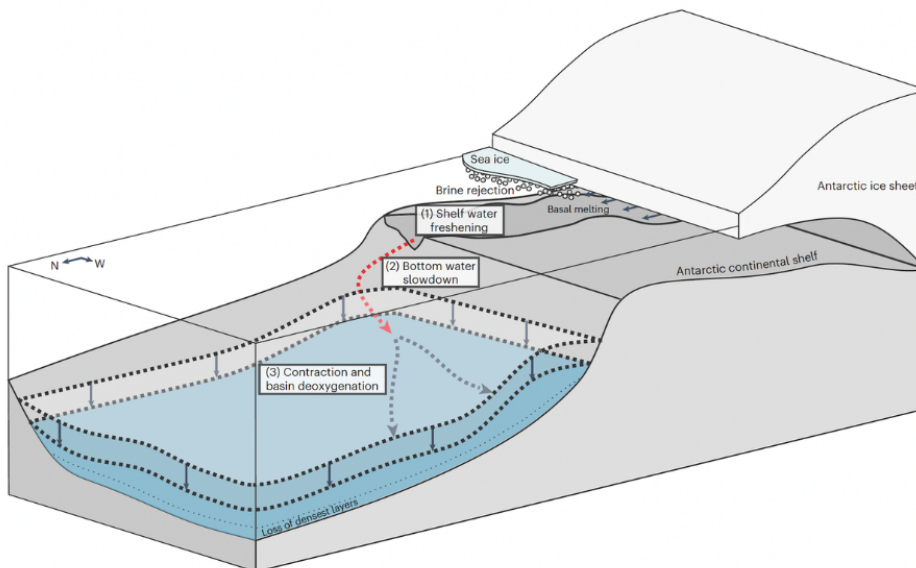
For Mains: Overturning circulation and its significance in maintaining climate stability, Slowdown in deep ocean currents in Antarctica and its consequences.

Why in News?

Recently, **Deep Ocean currents in Antarctica are slowing down** earlier than predicted, potentially **disrupting the crucial overturning circulation**.

- The slowdown in circulation and declining oxygen levels in the deep ocean have been observed, indicating significant changes in the **Antarctic deep ocean over the past three decades**.
- The consequences of this phenomenon are further underscored by the **impacts of melting Antarctic ice** on the overturning circulation.

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Freshening of shelf waters reduces the flow of dense water and slows the deepest parts of the overturning circulation while also reducing deep oxygenation.

What is Overturning Circulation?

- **About:**
 - Overturning circulation refers to the **global network of ocean currents that redistribute heat, carbon, and nutrients across the world's oceans**.

- In Antarctica, it involves the **sinking of dense, oxygen-rich water from the surface, its spread along the [sea floor](#), and slow rise in distant regions.**
- **Process:**
 - In polar regions, the surface water cools due to **low temperatures and exposure to frigid air masses.**
 - The cooling leads to the formation of **sea ice, which extracts freshwater from the surrounding seawater.** This process increases the **salinity and density of the remaining water.**
 - The high salinity and density cause the **surface water to become denser, making it more likely to sink.**
 - The dense water sinks to deeper layers, forming what is known as **bottom water.**
 - The sinking of dense water drives the deeper limb of the **overturning circulation.** It flows towards the equator, while at the same time, warmer surface water from lower latitudes moves towards the poles.
 - As the deep-water travels, it gradually mixes with surrounding water masses, **exchanging heat, carbon, and nutrients.** Eventually, the upwelling of this modified water occurs in other regions, completing the overturning circulation.
- **Importance:**
 - Overturning circulation plays a crucial role in maintaining **climate stability on Earth.**
 - It facilitates the **transport of heat, carbon, and nutrients, influencing the planet's climate system.**
 - Additionally, it **ensures the supply of oxygen to the deep ocean, supporting marine life and its ecosystems.**
- **Impact of Slowdown in Overturning Circulation:**
 - The observed slowdown of deep ocean currents in Antarctica, occurring earlier than anticipated, raises concerns about climate stability.
 - A reduced flow of bottom water results in a **decline in oxygen supply** to the deep ocean, impacting **oxygen-dependent organisms.**
 - Lower oxygen levels may lead to **behavioral changes, migrations, and disruptions in the marine food chain.**
 - Moreover, the slowdown amplifies **global warming** as the ocean's **capacity to store carbon dioxide and heat diminishes**, intensifying the **greenhouse effect.**
- **Melting Antarctic Ice and its Contribution:**
 - Melting Antarctic ice disrupts the formation of **Antarctic bottom water**, making **surface waters fresher and less dense, impeding their sinking.**
 - This disruption weakens the overturning circulation, further diminishing the oxygen supply to the deep ocean.
 - The replacement of bottom water with warmer, oxygen-depleted waters exacerbates the **decline in oxygen levels.**
 - Additionally, melting ice contributes to rising sea levels through thermal expansion as warmer water occupies more space.

What are the Key Highlights about Antarctica?

- Antarctica is **uninhabited except for those manning the nearly 40 permanent stations** established by several countries, including India, for carrying out scientific research.
 - India maintains **two research stations on the continent:** 'Maitri' (commissioned in 1989) at Schirmacher Hills and 'Bharati' (2012) at Larsemann Hills.
 - It has also **launched 41 scientific expeditions every year** thus far. Together with **'Himadri' station in Svalbard**, above the Arctic circle, India is among an **elite group of countries with multiple research** in the polar regions.
- Antarctica is **Earth's southernmost continent.** It contains the **geographic South Pole** and is situated in the **Antarctic region of the Southern Hemisphere.**
- At 14,000,000 square kilometres, it is the **fifth-largest continent.**
- The **Indian Antarctic Programme** is a multi-disciplinary, multi-institutional programme under the control of the National Centre for Antarctic and Ocean Research, Ministry of Earth Sciences.
- India officially **acceded to the Antarctic Treaty System in August 1983.**



UPSC Civil Services Examination Previous Year Question (PYQ)

Q. How do ocean currents and water masses differ in their impacts on marine life and coastal environment? Give suitable examples. **(2019)**

Q. What are the forces that influence ocean currents? Describe their role in fishing industry of the world. **(2022)**

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