# Ocean Circulation and Climate Change

Source: SD

## Why in News?

Recently, a study published in Nature Communications has gained attention for its unexpected findings about the **ocean's role in** climate change.

- The study reveals that a **weaker ocean circulation might increase atmospheric $CO_2$** levels, contrary to previous assumptions.

## What is the Relation Between Climate Change and Ocean Circulation?

- **The Role of Overturning Circulation:** Ocean overturning circulation acts as a global conveyor belt, moving water and nutrients across the ocean. It is a two-fold process.
  - As **surface waters absorb CO2 and cool,** they become denser and sink into the deep ocean, **transporting carbon away from the atmosphere.**
  - **Deep waters upwell, bring nutrients and carbon** back to the surface, where they **support marine life** and help regulate atmospheric CO2 levels.
- **Traditional Views on Ocean Circulation and Climate Change:** As climate change progresses, scientists predict a weakening of ocean overturning circulation due to various factors.
  - **Melting Ice Sheets:** Particularly around Antarctica, melting ice sheets add freshwater to the ocean, disrupting circulation patterns.
  - **Temperature Changes:** Global warming affects ocean temperature gradients, further impacting circulation.
  - The traditional view is that weaker circulation would mean **less carbon is stored in the deep ocean,** but the ocean's carbon sink effect would **stay balanced due to less carbon coming back up.**
- **New Insights from Research:** New research reveals a **complex feedback mechanism involving ocean circulation,** iron availability, microorganisms, and ligands, showing that weaker ocean circulation could increase atmospheric CO2 levels contrary to previous beliefs.
  - **Ligands are organic molecules** that bind with iron to keep it soluble and accessible for phytoplankton growth, but their **availability can limit the effectiveness** of iron fertilization efforts globally.
- **Implications for Climate Change Mitigation:** The study highlights the need to **reconsider the ocean's role in climate change mitigation,** as weaker ocean circulation could reduce carbon sink effectiveness, leading to higher atmospheric CO2 and exacerbating global warming.

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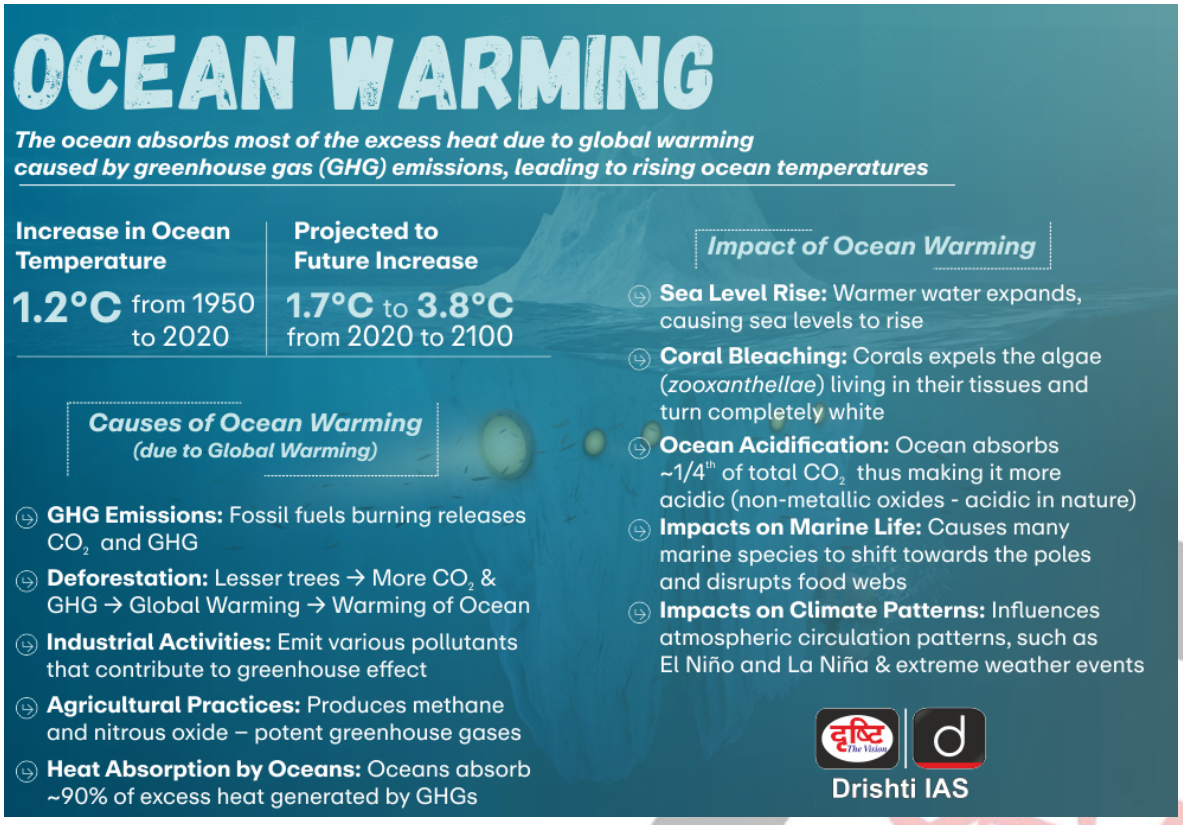
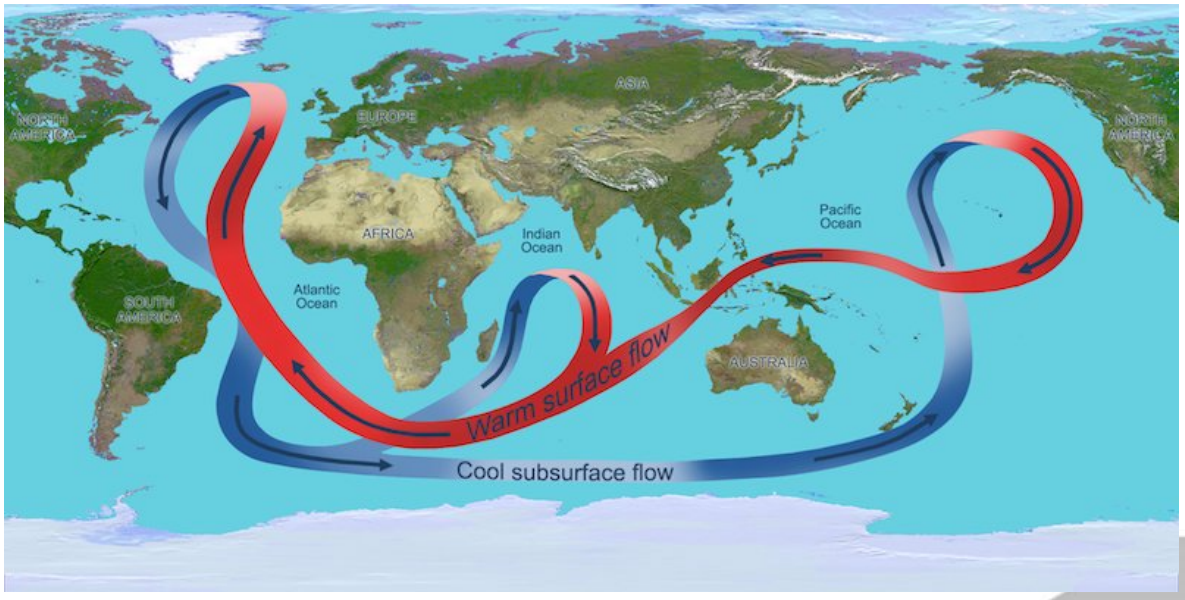



## What is Meridional Overturning Circulation (MOC)?

- **Definition:** The Meridional Overturning Circulation (MOC) is a **crucial component of global ocean circulation**, moving water, heat, salt, carbon, and **nutrients primarily in the north-south direction** within and between ocean basins. It plays a **vital role in regulating the Earth's climate.**
- **Mechanism:**
  - **Northward Flow:** In the Atlantic Ocean, warm and salty surface water is transported from the South Atlantic **towards the Nordic Seas** (near Greenland, England, and Northern Canada). Here, it **cools, becomes denser,** and sinks to **form deep water currents** that flow southwards towards Antarctica.
  - **Antarctic Contribution:** Near Antarctica, **even denser waters are formed.** These waters flow north along the seafloor into the North Atlantic, where they**rise and mix with other waters** before flowing back to the south.
- **Significance:**
  - The MOC is responsible for about two-thirds of the oceanic **northward heat transport,** making it essential for climate regulation.
  - Changes in the MOC influence regional and global heat distribution, **affecting climate and weather patterns.**
- **Cycle Duration:** The entire circulation cycle of the MOC, also known as the**oceanic conveyor belt, is extremely slow.** It takes approximately **1,000 years** for a parcel (any given cubic meter) of water to complete its journey along the belt.




## UPSC Civil Services Examination, Previous Year Question (PYQ)

### ***Prelims:***

**Q. At the national level, which ministry is the nodal agency to ensure effective implementation of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act,2006? (2021)**

**(a)** Ministry of Environment, Forest and Climate Change

**(b)** Ministry of Panchayati Raj

**(c)** Ministry of Rural Development

**(d)** Ministry of Tribal Affairs

**Ans: (d)**

**Q. Stiglitz Commission established by the President of the United Nations General Assembly was in the international news. The commission was supposed to deal with (2010)**

**(a)** The challenges posed by the impending global climate change and prepare a road map

**(b)** The workings of the global financial systems and to explore ways and means to secure a more sustainable global order

**(c)** Global terrorism and prepare a global action plan for the mitigation of terrorism

**(d)** Expansion of the United Nations Security Council in the present global scenario

**Ans: (b)**

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### ***Mains:***

**Q**. Assess the impact of global warming on the coral life system with examples. **(2019)**