



Arctic Amplification

For Prelims: Arctic Amplification, Polar Amplification, Green House Gas, Global Warming, Permafrost Thawing, Climate Change.

For Mains: Consequences of Arctic Amplification and its Impact on India.

Why in News?

Recently, some studies were published on Arctic Amplification, which suggested that the **region is fast changing and that the best of climate models may not be able to capture the rate of changes** and predict it accurately.[II](#)



What are the Findings of these Studies?

- The Arctic is heating four times faster than the rest of the planet.
- The warming is more concentrated in the Eurasian part of the Arctic, where the Barents Sea north of Russia and Norway is warming at an alarming rate — seven times faster than the global average.

What do Previous Studies Say?

- The Arctic was warming twice the global rate prior to the beginning of the 21st century.
- Arctic surface air temperature has increased by more than double the global average over the last two decades as per a 'Special Report on the Ocean and Cryosphere in a Changing Climate' in 2019 by the [Intergovernmental Panel on Climate Change \(IPCC\)](#).
- In May 2021, the [Arctic Monitoring and Assessment Programme \(AMAP\)](#) warned that the Arctic has warmed three times quicker than the planet, and the chance of the sea ice completely disappearing in summers is 10 times greater, if the planet is warmer by two degrees Celsius above the pre-industrial levels.
 - The report also said that the average annual temperature in the region increased by 3.1 degree Celsius compared to 1 degree Celsius for the planet.
- Mean Arctic amplification saw steep changes in 1986 and 1999, when the ratio reached 4.0, implying four times faster heating than the rest of the planet.

What is Arctic amplification?

- Polar amplification happens **when changes to the earth's atmosphere led to a larger difference in temperature near the north and south poles** than to the rest of the world.
- This phenomenon is measured against the **average temperature change of the planet**.
- These changes are **more pronounced at the northern latitudes** and are known as the **Arctic amplification**.
- It occurs when the **atmosphere's net radiation balance is affected by an increase in greenhouse gases**.

What causes the Arctic Amplifications?

- The ice-albedo feedback, lapse rate feedback, water vapour feedback (Change in Water Vapour amplify or weaken temperature range) and ocean heat transport are the primary causes.
- **Sea ice and snow have high albedo** (measure of reflectivity of the surface), implying that they are capable of reflecting most of the solar radiation as opposed to water and land.
 - As the sea ice melts, the Arctic Ocean **will be more capable of absorbing solar radiation, thereby driving the amplification**.
- The lapse rate or the rate at which the **temperature drops with elevation decreases with warming**.
 - Studies show that the **ice-albedo feedback and the lapse rate feedback** are responsible for 40% and 15% of polar amplification respectively.

What are the consequences of Arctic Warming?

- **Thinning of Greenland Ice Sheet:**
 - The Greenland ice sheet is melting at an alarming rate, and the rate of accumulation of sea ice has been remarkably low since 2000, marked by young and thinner ice replacing the old and thicker ice sheets.
 - The unusual summer temperatures resulted in a melt of 6 billion tonnes of ice sheet per day, amounting to a total of 18 billion tonnes in a span of three days, enough to cover West Virginia in a foot of water.
- **Rise in Sea Level:**
 - The Greenland ice sheet **holds the second largest amount of ice**, after Antarctica, and therefore it is crucial for maintaining the sea level.
 - In 2019, this was the single biggest cause for the rise in the sea level, about 1.5 metres.
 - If the **sheet melts completely**, the sea level would rise by seven metres, capable of **subsuming island countries and major coastal cities**.
- **Impact on Biodiversity:**
 - The warming of the Arctic Ocean and the seas in the region, the acidification of water, changes in the salinity levels, is impacting biodiversity, including the **marine species and the dependent species**.
 - The warming is also **increasing the incidence of rainfall which is affecting the availability and accessibility of lichens** to the reindeer.
 - The Arctic amplification is causing widespread **starvation and death among the Arctic fauna**.
- **Thawing of Permafrost:**
 - The permafrost in the Arctic is thawing and in turn **releasing carbon and methane** which are among the major greenhouse gases responsible for global warming.
 - Experts fear that the thaw and the melt will also release the **long-dormant bacteria and viruses that were trapped in the permafrost and can potentially give rise to diseases**.
 - The best-known example of this is the permafrost thaw leading to an **anthrax outbreak in Siberia in 2016**, where nearly 2,00,000 reindeer succumbed.

What is its Impact on India?

- In recent years, scientists have pondered over the **impact the changing Arctic can have on the monsoons** in the Indian subcontinent.
- The link between the two is growing in importance **due to the extreme weather events India faces**, and the heavy reliance on rainfall for water and food security.
- In 2021 a study (A possible relation between Arctic Sea ice and late season Indian Summer Monsoon Rainfall extremes) **was published**, which found that the **reduced sea ice in the Barents-Kara Sea region can lead to extreme rainfall events in the latter half of the monsoons** — in September and October.
 - The changes in the atmospheric circulation due to diminishing sea ice combined with the warm temperatures in the Arabian Sea contribute to enhanced moisture and drive extreme rainfall events.
- According to the World Meteorological Organization's report in 2021 (State of Global Climate in 2021) sea level along the Indian coast is rising faster than the global average rate.
 - One of the **primary reasons for this rise is the melting of sea ice in the polar regions**, especially the Arctic.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. Which of the following statements is/are correct about the deposits of 'methane hydrate'? (2019)

1. Global warming might trigger the release of methane gas from these deposits.
2. Large deposits of 'methane hydrate' are found in Arctic Tundra and under the sea floor.
3. Methane in atmosphere oxidizes to carbon dioxide after a decade or two.

Select the correct answer using the code given below.

- (a) 1 and 2 only
 (b) 2 and 3 only
 (c) 1 and 3 only
 (d) 1, 2 and 3

Ans: (d)

Exp:

- Methane hydrate is a crystalline solid that consists of a methane molecule surrounded by a cage of interlocking water molecules. It is an "ice" that only occurs naturally in subsurface deposits where temperature and pressure conditions are favourable for its formation.
- Regions with suitable temperature and pressure conditions for the formation and stability of methane hydrate— sediment and sedimentary rock units below the Arctic permafrost; sedimentary deposits along continental margins; deep-water sediments of inland lakes and seas; and, under Antarctic ice. Hence, statement 2 is correct.
- Methane hydrates, the sensitive sediments, can rapidly dissociate with an increase in temperature or a decrease in pressure. The dissociation produces free methane and water, which can be triggered by global warming. Hence, statement 1 is correct.
- Methane is removed from the atmosphere in about 9 to 12-year period by oxidation reaction where it is converted into Carbon Dioxide. Hence, statement 3 is correct.
- **Therefore, option (d) is the correct answer.**

Mains

Q. How do the melting of the Arctic ice and glaciers of the Antarctic differently affect the weather patterns and human activities on the Earth? Explain. (2021)

Q. What are the economic significances of discovery of oil in Arctic Sea and its possible environmental consequences? (2015)

[Source: TH](#)

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