



Marine Cloud Brightening

For Prelims: [Marine cloud brightening](#), [Coral bleaching](#), [Global warming](#), [Great Barrier Reef](#), [Intergovernmental Panel on Climate Change](#).

For Mains: Mechanism of Marine Cloud Brightening and Related Challenges and Risks, Environmental Pollution & Degradation, Conservation

[Source: TH](#)

Why in News?

The concept of [marine cloud brightening](#) is gaining prominence recently as a tactic for **addressing extreme ocean heat** and as a way to **reduce coral bleaching and safeguard marine ecosystems**.

What is Marine Cloud Brightening?

▪ About:

- The concept of **cloud brightening** traces back to British cloud physicist John Latham, who **proposed this idea in 1990** as a **means to control [global warming](#)** by altering the Earth's energy balance.
- Latham's calculations suggested that **brightening clouds over vulnerable ocean regions could counteract the warming** caused by a doubling of pre industrial atmospheric carbon dioxide.

▪ Mechanism of Marine Cloud Brightening:

- In **clean maritime air**, clouds primarily form from **sulfates and sea salt crystals**, which are **relatively scarce**, leading to **larger droplets with lower light reflection**.
- **Marine cloud brightening (MCB)** seeks to boost marine cloud reflectivity (albedo), **making clouds whiter and brighter**.
 - It involves using **water cannons or specialized vessels to release fine sea water droplets** into the atmosphere.
 - As these droplets evaporate, **they leave behind salt particles**, serving as cloud condensation nuclei that foster the formation of denser, brighter clouds.

Note

Warm clouds consist of numerous small suspended water droplets. These droplets form around **tiny airborne particles known as "aerosols,"** which can be natural (like dust, sea salt, pollen, ash, and sulfates) or human-made (from activities like burning fossil fuels and manufacturing).

- A cloud of many small droplets is **brighter than one with fewer large droplets** even if both clouds contain the same amount of water overall.

▪ Potential Benefits:

- MCB has the **potential to lower sea surface temperatures** in targeted areas, potentially **reducing the frequency and severity of coral bleaching events**.
 - This could **provide a lifeline for corals**, enabling their survival and recovery while the world transitions away from fossil fuels.
- Researchers are exploring the viability of MCB for the Great Barrier Reef through modeling studies and small-scale experiments.
 - The [Great Barrier Reef](#), a [UNESCO World Heritage Site](#), has been particularly vulnerable to coral bleaching, experiencing mass bleaching events in recent years.

Note

Surprisingly, humanity is already unintentionally engaged in cloud brightening. The [Intergovernmental Panel on Climate Change](#) estimates humanity's unintentional **release of aerosols** offsets around **30% of the warming effect due to [greenhouse gases](#)**.

- **Sulphates in ship** exhaust are such a potent source of aerosols for droplet formation, the passage of ships leaves cloud trails called **ship tracks**.
- **Challenges and Risks Associated with MCB:**
 - **Technical Feasibility:** MCB involves the large-scale spraying of seawater into the atmosphere at significant altitudes, which presents **engineering complexities in terms of design, cost, maintenance**, and operation of the spraying devices.
 - **Environmental Impacts:** Alterations in cloud patterns and precipitation due to MCB could **affect regional climate and hydrological cycles**, potentially causing unintended consequences like droughts or floods.
 - **Ethical Issues:** MCB raises **ethical dilemmas about human intervention in natural processes** and the governance and decision-making processes surrounding its implementation.
 - **Moral Hazard:** MCB might lead to **complacency among policymakers and the public**, diminishing their commitment to reducing greenhouse gas emissions and adapting to climate change.

What is Coral Bleaching?

- **Coral bleaching** is a phenomenon where corals, **typically vibrant and colorful**, lose their color and turn white due to stress, often caused by elevated sea temperatures.
 - This occurs when the **corals expel the symbiotic algae** living within their tissues, which provide them with nutrients and color.
- **Coral bleaching weakens the corals**, making them more susceptible to disease, and can lead to their death if the stress continues.

Conclusion

MCB is still in the early stages of research and development, requiring additional studies to assess its **feasibility, efficacy, impacts, risks, and governance**. It is essential to recognize that **MCB is not a standalone solution but a potential complementary measure** to help coral reefs confront extreme heat stress in the short term. MCB should be integrated into a comprehensive approach that includes **conservation, restoration, adaptation, and innovation to safeguard coral reefs from the impacts of [climate change](#)**.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. 1 "Biorock technology" is talked about in which one of the following situations?

- (a) Restoration of damaged coral reefs
- (b) Development of building materials using plant residue
- (c) Identification of areas for exploration/extraction of shale gas
- (d) Providing salt licks for wild animals in forests/protected areas

Ans: (a)

Q.2 Consider the following statements: (2018)

1. Most of the world's coral reefs are in tropical waters.
2. More than one-third of the world's coral reefs are located in the territories of Australia, Indonesia and Philippines.
3. Coral reefs host far more number of animal phyla than those hosted by tropical rainforests.

Which of the statements given above is/are correct?

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

Ans: (d)

Q.3 Which of the following have coral reefs? (2014)

1. Andaman and Nicobar Islands
2. Gulf of Kachchh
3. Gulf of Mannar
4. Sunderbans

Select the correct answer using the code given below:

- (a) 1, 2 and 3 only
- (b) 2 and 4 only
- (c) 1 and 3 only
- (d) 1, 2, 3 and 4

Ans: (a)

Mains

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