



## Marine Cloud Brightening

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

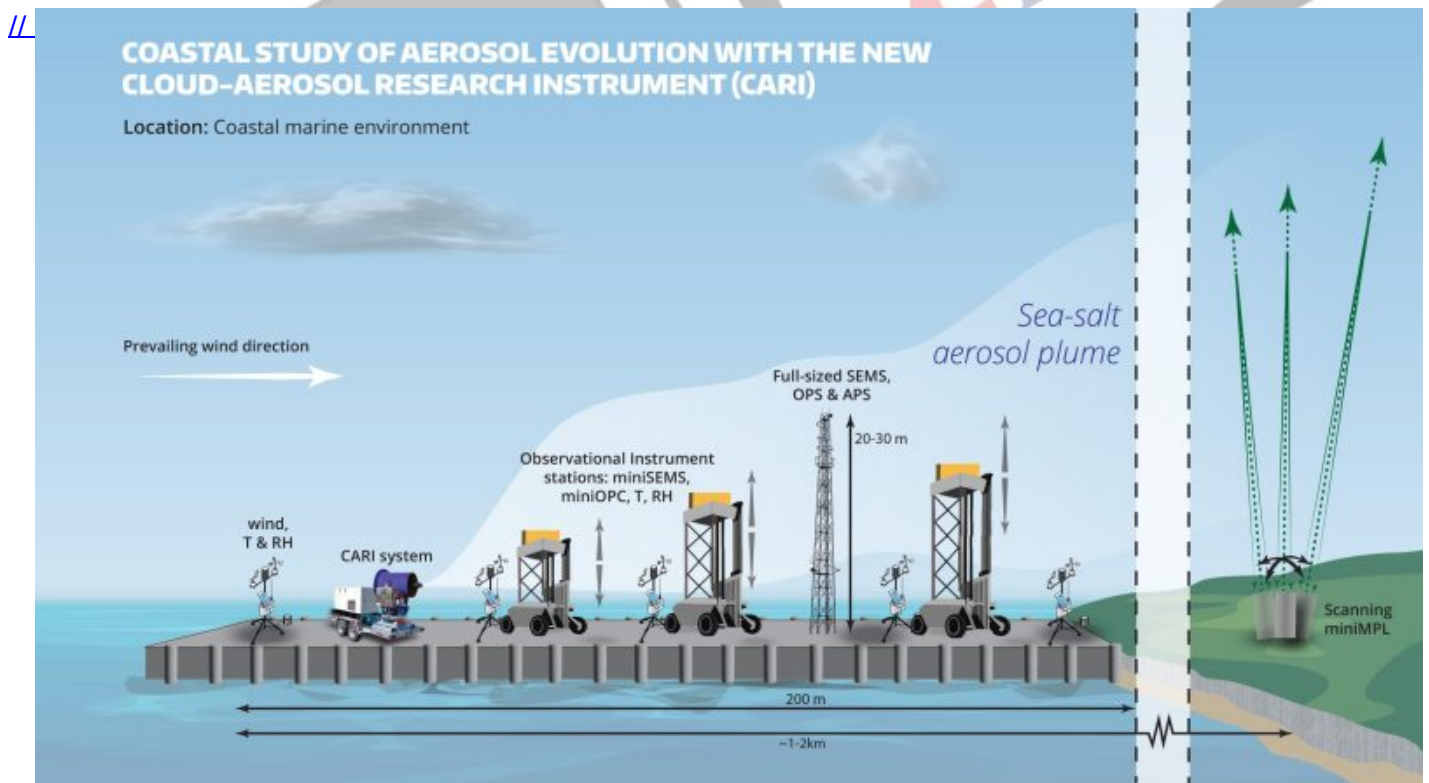
**For Mains:** Mechanism of Marine Cloud Brightening and Related Challenges and Risks, Environmental Pollution & Degradation, Conservation

**Source:** [ST](#)

### Why in News?

Recently, scientists are testing a **geoengineering technique called marine cloud brightening**.

- This method involves using machines **to inject tiny saltwater particles into marine stratocumulus clouds**, aiming to increase their reflectivity and cool the Earth.

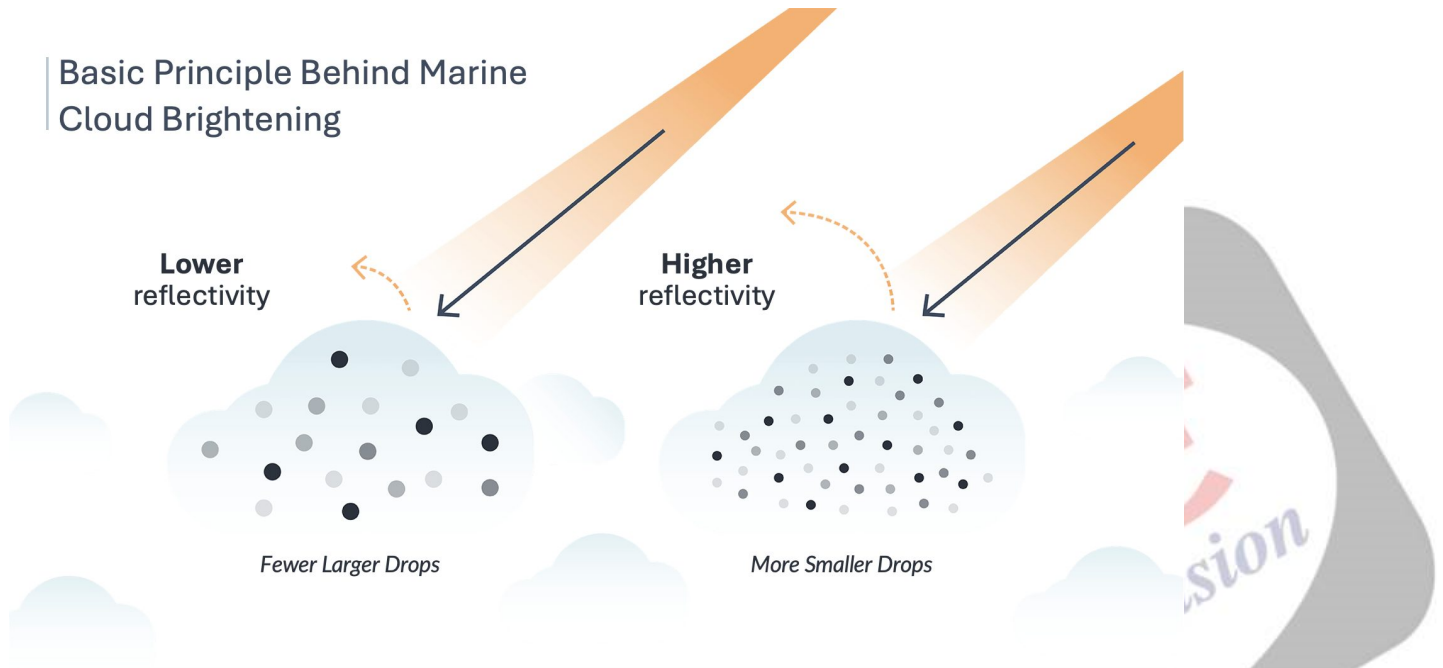


### What is Marine Cloud Brightening?

▪ **About:**

- **Marine cloud brightening** is a scientific initiative that explores how **altering atmospheric particles (aerosols)** can **impact cloud reflectivity**.
- By releasing tiny **aerosol particles** into the atmosphere, researchers aim to enhance cloud brightness, leading to **increased sunlight reflection**.
- Aerosols of the **right size and concentration** could significantly **increase the reflectivity** of specific types of clouds.
- This phenomenon is visible in satellite images of clouds brightened by **ship emissions** (known as “ship tracks”).

Basic Principle Behind Marine Cloud Brightening



▪ **Goals of the Marine Cloud Brightening Program:**

- Better understanding of the present-day effects of **pollution aerosols** on clouds.
- Investigate whether aerosol particles made from **sea salt** could be used to intentionally reduce near-term climate warming while **greenhouse gas** concentrations are brought down to safer levels.
- Understand the **benefits, risks, and efficacy of the intentional use of aerosols** to reduce warming through different implementations of marine cloud brightening.

**Aerosol and Climate Effect:**

- **Aerosol concentration is declining** due to expanding **air quality regulations**, leading to fewer particles in the atmosphere.
- Most aerosol particles have a **cooling effect on climate**, so their reduction adds to **global warming**.
- Scientists estimate that aerosols from human emissions are offsetting 0.5°C of global warming, but the **actual cooling effect** could range from 0.2°C to 1.0°C.
- Uncertainty about aerosol effects on clouds contributes to uncertainty in future warming projections.

**What are the 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.**

- Changes in clouds **over broad regions affect the circulation of the atmosphere, weather, and precipitation.**
- Both marine cloud brightening (**MCB**) and **pollution aerosols can change clouds**, which in turn **affects regions** both nearby and far from where the brightening occurs.
- **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.



# GEO-ENGINEERING



Geoengineering means manipulating the earth's climate to lower its temperature to counter global warming

## TYPES OF GEO-ENGINEERING

### CARBON DIOXIDE REMOVAL

| Technology/ Method Proposed                        | Proposed Effects/actions                                       | Potential Side Effects                  | Feasibility/Cost Effectiveness                                     |
|--|--|---|--|
| Land Use Management                                | Afforestation/ Reforestation                                   | Minimum Side Effects                    | High feasibility, Low Cost   |
| Bio-energy with carbon capture and storage (BECCS) | Biomass harvested and used as fuel                             | Potential land use conflict             | Comparatively expensive  |
| Direct CO <sub>2</sub> Capture                     | Industrial Process   | Minimal                                 | High technical feasibility   |
| Fertilization of the ocean                         | Increased CO <sub>2</sub> absorption by promoting algae growth | High potential for adverse side effects | Feasible but not cost-effective                                    |
| Accelerated Weathering                             | Pulverization of silicate rocks                                | Potential respiratory health impact     | Could be combined with crop production, a feasible option at scale |

### SOLAR RADIATION MANAGEMENT

|                                 |   |   |   |
|---------------------------------|---|---|---|
| Stratospheric aerosol Injection | For reflecting sunlight back into space                                     | Likely impact on the hydrological cycle | Feasible and potentially highly effective |
| Marine cloud brightening        | Seeding of marine clouds with seawater aerosol                              | Likely impact on precipitation pattern  | Low to medium cost and feasible at scale  |
| Giant deflectors in outer space | Mirror placed in near earth orbit   | Regional climate effects                | Capital-intensive and long gestation      |
| Surface albedo approaches       | Painting the roof of the building bright white, Installing desert reflector | Major Impact on Desert Ecosystem        | High labor and maintenance cost           |

### REGULATION

- ↘ No specific international or Indian regulations on geoengineering.

### INDIA'S EFFORTS

- ↘ **Department of Science and Technology:**
  - ◆ Geoengineering climate-modelling research programme (since 2013)

### IISc:

- ◆ Initiative to understand the implications of solar geoengineering for developing countries
- ◆ Scientists simulated injecting 20 million tonnes of sulphate aerosols into the Arctic stratosphere



Drishti IAS

## Conclusion:

- Marine Cloud Brightening (MCB), a **cutting-edge climate intervention**, remains in its **early research and development** stages. Scientists are diligently exploring its feasibility, efficacy, and potential impacts.
- **Sustainable human adaptation** is considered the sole novel approach among various geoengineering methods **to mitigate global warming and address climate change**, with acknowledgment of associated risks and uncertainties

**Drishti Mains Question:**

Q. Discuss the various geoengineering techniques proposed to mitigate climate change and their potential impacts on global climate systems. How does sustainable human adaptation stand out as a unique approach in this context?

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

**Prelims**

**Q. In the context of which of the following do some scientists suggest the use of cirrus cloud thinning technique and the injection of sulphate aerosol into stratosphere? (2019)**

- (a) Creating the artificial rains in some regions
- (b) Reducing the frequency and intensity of tropical cyclones
- (c) Reducing the adverse effects of solar wind on the Earth
- (d) Reducing the global warming

**Ans: (d)**

**Q. Consider the following statements: (2012) Chlorofluorocarbons, known as ozone-depleting substances, are used**

1. in the production of plastic foams
2. in the production of tubeless tyres
3. in cleaning certain electronic components
4. as pressurizing agents in aerosol cans

**Which of the statements given above is/are correct?**

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

**Ans: (c)**

**Mains:**

**Q. Bring out the relationship between the shrinking Himalayan glaciers and the symptoms of climate change in the Indian subcontinent. (2014)**