



Marine Cloud Brightening

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

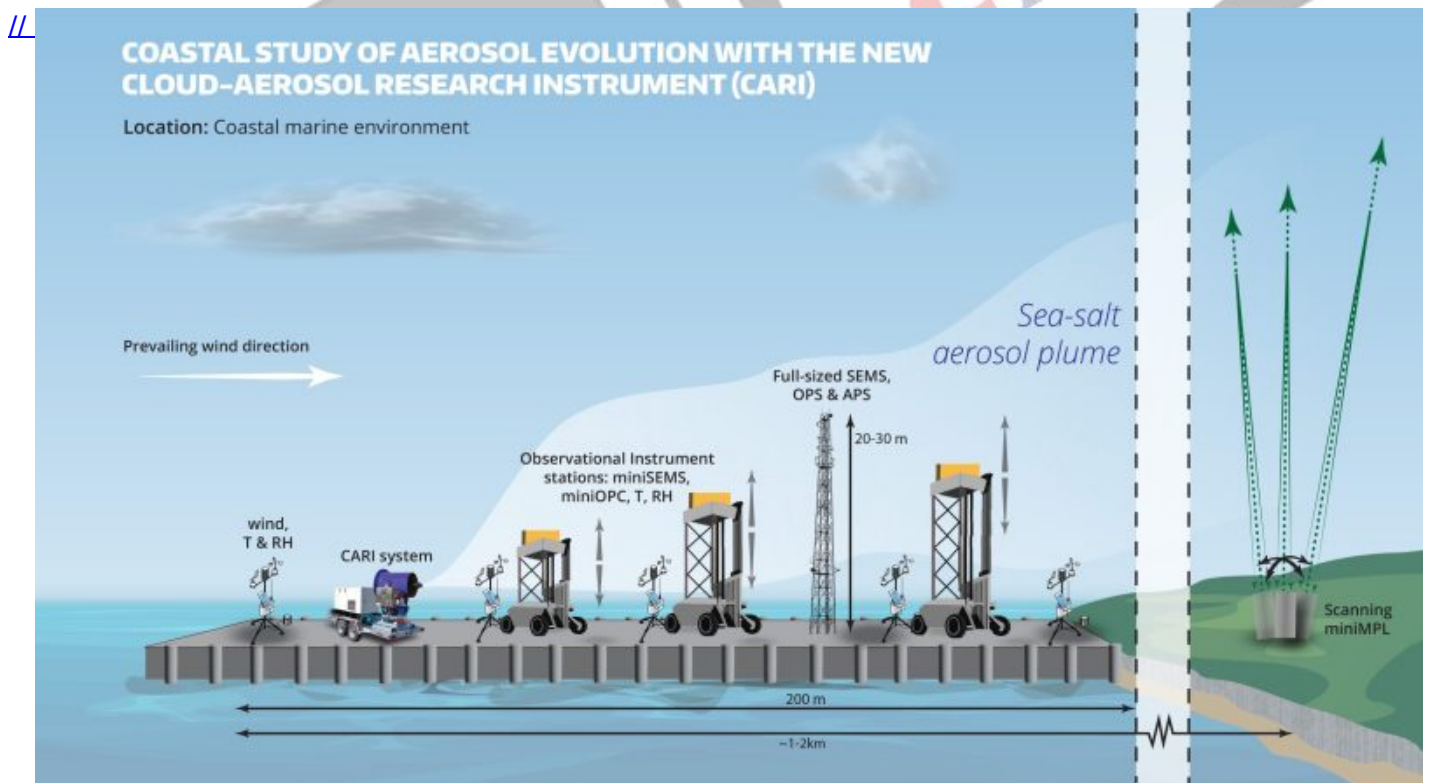
For Mains: Mechanism of Marine Cloud Brightening and Related Challenges and Risks, Environmental Pollution & Degradation, Conservation

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.

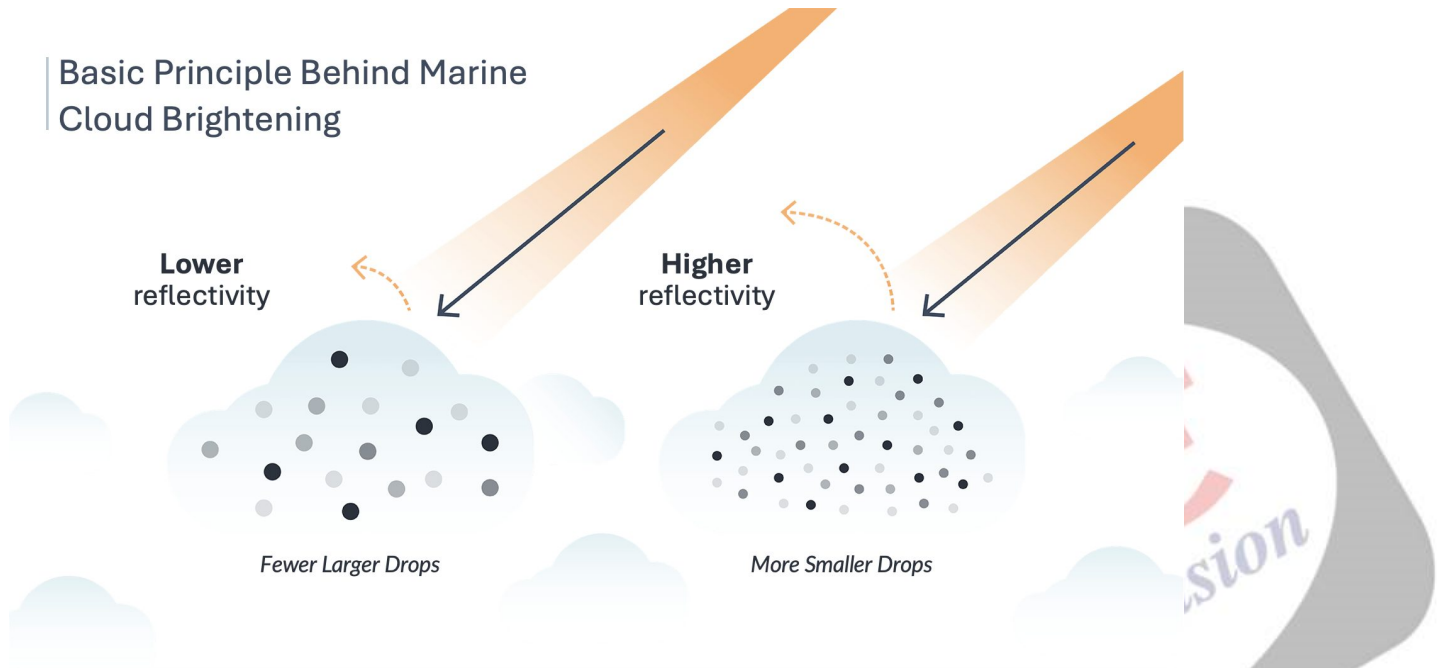


What is Marine Cloud Brightening?

▪ **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 ₂ Capture	Industrial Process	Minimal	High technical feasibility
Fertilization of the ocean	Increased CO ₂ 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 defectors 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)