

Marine Cloud Brightening Explained

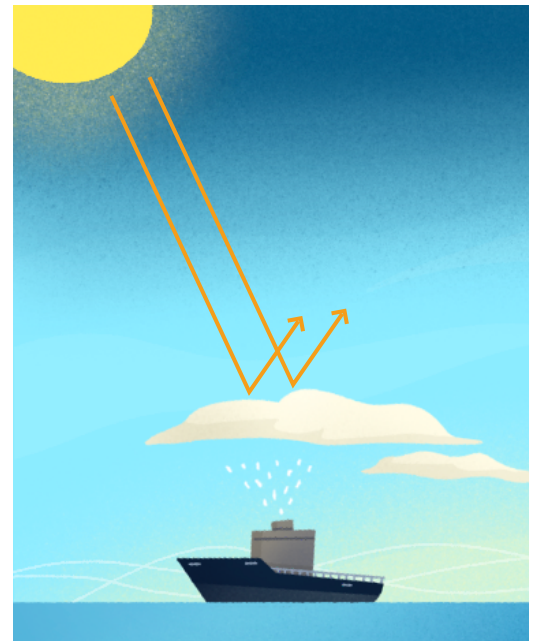
Marine cloud brightening (MCB) is a proposed solar geoengineering technique that aims to cool the Earth by enhancing the reflectivity of low-lying marine clouds over oceans. The idea is to spray tiny sea salt particles into these clouds, increasing the density of cloud droplets and making the clouds brighter. Brighter clouds reflect more sunlight back into space, reducing the amount of solar energy absorbed by the planet. By increasing cloud albedo (reflectivity), MCB could help reduce regional temperatures, potentially mitigating some of the effects of climate change. Cost estimates for MCB are limited and uncertain but are generally in the range of billions to tens of billions per year, depending on scale.

How Does MCB Work?

MCB leverages natural cloud formation processes:

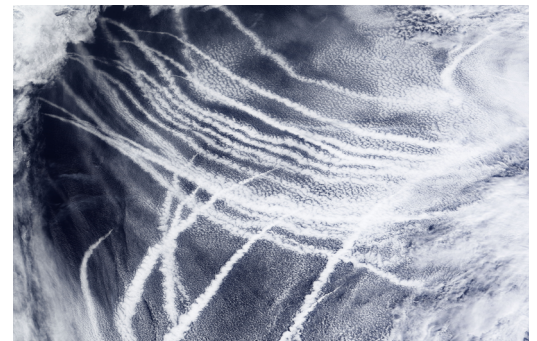
- Over oceans, clouds form as water vapor condenses around particles, such as sea salt, acting as cloud condensation nuclei.
- By spraying additional sea salt particles into the atmosphere, MCB encourages more cloud droplets to form. This increases cloud density and reflectivity, enhancing the cooling effect.
- Specialized equipment, such as ships or aircraft, could be used to spray seawater into the air, creating fine droplets that remain suspended for extended periods.

MCB would likely target specific regions, such as the Arctic or coastal areas, where localized cooling could protect vulnerable ecosystems or slow the impacts of extreme warming.



Ship Tracks: A Real-World Analogue

“Ship tracks” offer a real-world example of MCB in action. These narrow, reflective cloud formations occur when aerosols from ship exhaust serve as cloud condensation nuclei, increasing cloud reflectivity over oceans. While ship tracks illustrate how aerosols can enhance cloud albedo, they also highlight the complexities of aerosol-cloud interactions, which remain not fully understood.



Potential Benefits of MCB

- 1. Regional and Flexible Cooling:** MCB [could be applied](#) in specific areas to address localized warming, such as protecting coral reefs or slowing Arctic ice loss.
- 2. Adjustability:** The intensity and frequency of MCB applications could be adjusted based on research findings and climate conditions, offering a degree of control over its effects.

Risks and Challenges of MCB

- 1. Scientific Uncertainty:** The long-term impacts on cloud behavior, marine ecosystems, and atmospheric chemistry [are not well understood](#), and the precise nature of the scope and impacts remain uncertain.
- 2. Weather Pattern Disruption:** By altering cloud properties, available light, and ocean temperature, some models predict that MCB could unintentionally [disrupt](#) regional precipitation patterns, affecting agriculture and water supplies, while others predict that MCB [could potentially](#) impact fisheries and marine food webs.
- 3. Regional Inequities:** Effects [may not be evenly](#) distributed—for example, while some regions might benefit, others could experience unintended climate changes, such as reduced rainfall or drought.
- 4. Scalability:** MCB may only potentially work for certain types of clouds and has scaling limitations. It may also cause a bigger disruption if used at a scale to impact global temperatures.
- 5. Temporary Solution:** Like other solar geoengineering techniques, MCB does not address greenhouse gas emissions. If stopped, its cooling effects would quickly dissipate, leading to rapid warming (a “termination shock”).

Research Efforts

In Australia, researchers [have been exploring](#) MCB since 2020 as a potential tool to protect the Great Barrier Reef from coral bleaching. By spraying fine sea salt particles into the atmosphere, the project aims to enhance cloud reflectivity and lower ocean temperatures, potentially reducing heat stress on the reef. While early trials [have shown promise](#), the long-term ecological and climatic effects remain under study. Meanwhile, in Alameda, California, the University of Washington’s Marine Cloud Brightening Project [sought to conduct](#) an experiment to assess MCB’s feasibility. However, in June 2024, the city of Alameda [voted to end](#) the research due to environmental and ethical concerns, reflecting broader debates about geoengineering governance and risks.

Marine cloud brightening offers a scientifically plausible way to temporarily cool specific regions of the planet, but it remains highly experimental. While it could provide rapid, localized cooling, its long-term impacts on weather, ecosystems, and atmospheric conditions are uncertain. As with other geoengineering approaches, MCB does not address the root cause of climate change—greenhouse gas emissions—and should not be considered a standalone solution.