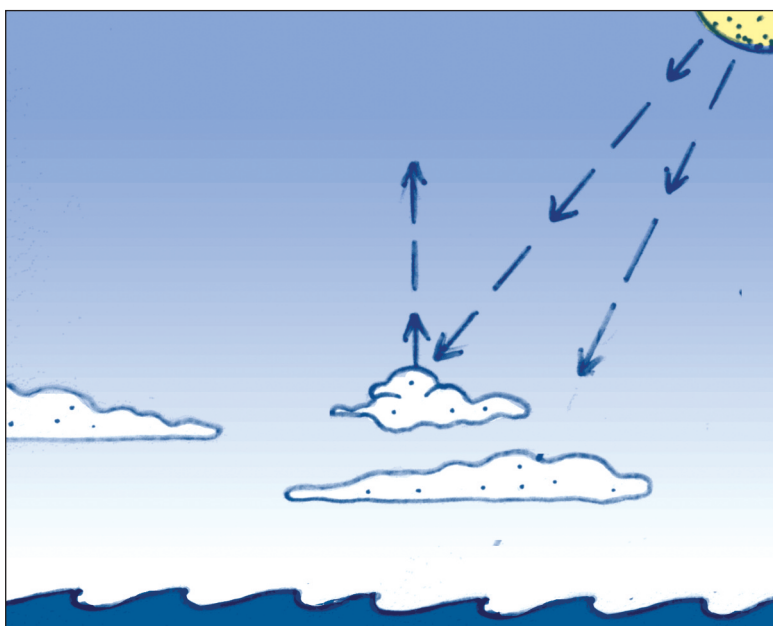


Marine Cloud Brightening or Cloud Reflectivity Enhancement

Description and purpose of the technology

Marine Cloud Brightening (MCB) is a theoretical solar geoengineering technique that aims to create whiter clouds in order to reflect more sunlight back to space. The brightening of the clouds is to be attained by enhancing the concentration of smaller cloud droplets. To achieve this, MCB proponents suggest shooting large amounts of tiny particles, such as sea salt aerosols, into marine clouds. These particles would act as cloud condensation nuclei: molecules of water vapour would gather around these condensation nuclei to form tiny cloud droplets. And how should the particles reach the clouds? The proposals suggest injecting salty aerosols into marine cloud layers by spraying seawater from vessels with nozzles able to turn saltwater into tiny particles.¹

Brighter clouds could theoretically diminish the solar radiation reaching the Earth's surface and would therefore reduce the temperature of the atmosphere and oceans because they absorb less solar energy. However, MCB would not reduce the concentration of greenhouse gases in the atmosphere and, like all solar geoengineering techniques, could have impacts on weather patterns with potentially calamitous ecological impacts on entire regions. Who would decide where to inflict potential droughts or floods caused by large-scale cloud brightening?

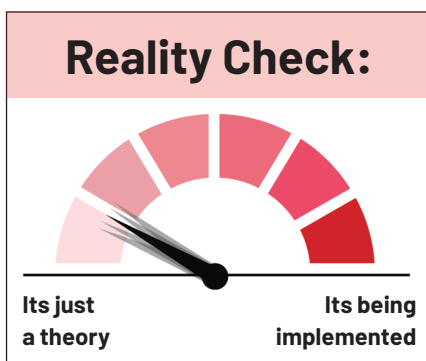


This approach aims to brighten clouds with smaller, but denser droplets - with the goal of reflecting more sunlight back into space.

Actors involved

MCB is researched and modelled at universities and research institutions. The first known open-air trial was conducted in 2011, off the coast of Monterey, California, as part of the "Eastern Pacific Emitted Aerosol Cloud Experiment" (E-PEACE). The project was financed by the U.S. National Science Foundation and led by the University of California San Diego. During the twelve-day trial, salt aerosols were released from an aircraft as well as smoke and exhaust gas from a research vessel and a container ship. Afterwards, an aircraft measured research parameters, aiming to collect data on cloud-aerosol interactions for modelling MCB.²

Point of Intervention:  



In March 2020, another open-air MCB experiment was performed in Australia. The project claimed to conduct the trials as a mean to protect the Great Barrier Reef, but MCB is clearly unable to address the principal threats for the reef – ocean acidification and water pollution in coastal areas.

A four-day trial to test MCB technology from a vessel, led by the Southern Cross University and the Sydney Institute of Marine Science, was conducted in a southern part of the Great Barrier Reef under a program called Australian Reef Restoration and Adaptation Program (RRAP). The tested prototype machine pumped sea water through a filter and sprayed it out of small nozzles, producing minuscule water droplets. A fan propelled the microscopic droplets into the atmosphere. Larger-scale trials, aiming to cover an area of 400 km², were announced. A global coalition of nearly 200 environmental groups protested against the experiment.

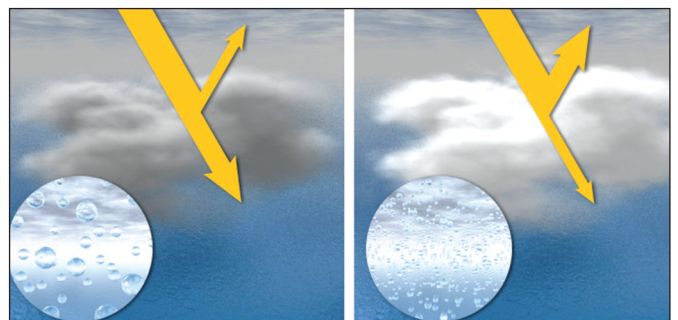
The project is connected to the US-based Marine Cloud Brightening Project and several project leaders research and model geoengineering for a decade, e.g. researchers based at the University of Sydney. The crisis of the Great Barrier Reef provided them with a platform to try to overcome public resistance to the use of geoengineering.³ The Great Barrier Reef Foundation, who conducts a study on solar geoengineering as part of the governmental RRAP, has close ties to Australia's largest greenhouse gas emitter BHP and further major emitters from both the mining and aviation industries. These investments suggest a keen interest in avoiding the costs of greenhouse gas reductions and their ability to continue business as usual.⁴

Further field experiments, among them the international VAMOS Ocean-Cloud-Atmosphere-Land Study Regional Experiment, studied the impacts of aerosols on clouds and became a key source of data for modelling MCB. Modelling studies aim to study the effectiveness, side effects, risks and economic implications of MCB and can be seen as an intermediate step in preparing outdoor trials, although the quality and significance of the modelling results is highly questionable.

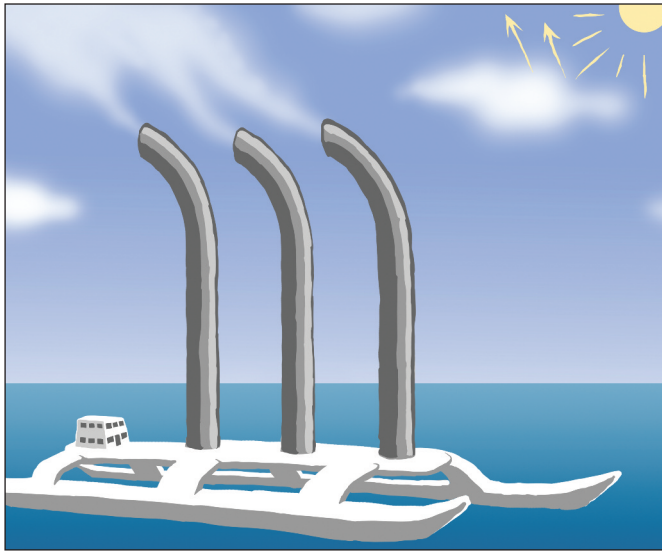
// MCB would not reduce the concentration of greenhouse gases in the atmosphere and could have impacts on weather patterns with potentially calamitous ecological impacts on entire regions. Who would decide where to inflict potential droughts or floods caused by large-scale cloud brightening? //

MCB modelling is, inter alia, conducted within GeoMIP, the “Geoengineering Model Intercomparison Project”, a collaboration between climate modelling centres throughout the world or at the British University of Leeds. The University of Eastern Finland and the pan-European IMPLICC project concluded research and modelling studies on solar geoengineering, including MCB, in 2012 and 2014.⁵

John Latham, a retired computer science professor at the University of Manchester, was among the first to propose MCB. Together with Stephen Salter, an engineering professor at the University of Edinburgh, he developed and modelled the idea to launch several hundred wind-powered vessels, each at a cost of £ 2.5 million, to shoot salt water droplets into the sky. Salter also proposed a ship-based MCB programme to protect sea ice by producing clouds in the Arctic region during Arctic summers.⁶



MCB could make clouds whiter, with smaller but more dense droplets Illustration from NASA



Ships with special nozzles aim to spray saltwater droplets into the sky.

Further research and modelling activities are conducted by a joint team consisting of staff from the Pacific Northwest National Laboratory (PNNL) and the U.S. National Oceanic and Atmospheric Administration (NOAA). The output of the model simulations run by the PNNL-NOAA research team contributes to the Marine Cloud Brightening Project (MCBP), a project financially supported by the Bill Gates-backed FICER fund. The MCBP, a collaboration of Washington University and PNNL, developed a technology to generate aerosolized salt mist from sea water and spray it into clouds.

After modelling, lab-scale and indoor experiments, various open-air tests were announced, among them a coastal dispersion test at Moss Landing, California and cloud spraying tests at additional coastal sites. A proposed large-scale test would affect an area of 10,000 km² in the North East Pacific. MCBP changed its name twice: a decade ago large-scale field trials had already been planned under the names Silver Lining Project and Silver Lining Inc., but were cancelled due to public protests and lack of funding.

In 2019, the U.S. government allocated US\$ 4 million of funding to NOAA to conduct research on solar geoengineering techniques, MCB is among the approaches NOAA is going to explore.⁷

Impacts of the technology

While modelling results predict that MCB could reduce average global temperatures, they also show that it would have considerably varied and potentially detrimental impacts in different parts of the world.⁸ For example, global mean precipitation is modelled to decrease along with temperatures – one study shows that precipitation could decrease up to 2.3%. South America is predicted to become warmer and dryer with MCB.⁹ Substantial rainfall reduction over the Amazon basin is predicted, which would be an ecological disaster due to severe consequences for the rainforest.¹⁰ Another study predicts a massive 7.5% increase in runoff over land, primarily due to increased precipitation in the tropics, even though global mean precipitation decreases.¹¹

While researchers have optimistically suggested that precipitation changes “could be circumvented by not seeding in a particular area,”¹² these studies show the extent to which geoengineering is likely to have major unintended consequences, and how poorly understood those consequences still are.

The models also show that once you start cooling the Earth with MCB (and indeed all other solar geoengineering approaches), you must do even more of it to keep achieving the same effect. For MCB, this would mean further cloud modification, in terms of increasing both the regions where clouds were modified and the amount by which they were modified. The problems created by a sudden termination of the geoengineering, e.g. a rapid increase in temperatures, would therefore only worsen as time went on.¹³ A recent study has highlighted how sudden termination of solar geoengineering would significantly increase the threats to biodiversity from climate change, owing to these rapid and unprecedented temperature changes.¹⁴

Researchers have also pointed out the vulnerability of MCB to physical attack, given that spray vessels would be in the open oceans. If many or all the cloud-spraying vessels were prevented from operating, there would be a rapid rise in global temperature, with all the accompanying changes in weather patterns and other adverse consequences.¹⁵ If we can imagine a dystopian future where geoengineering is widely deployed, then the threat of conflict over its deployment and its impacts does not seem far-fetched.

Reality check

MCB is a theoretical concept, and research into its effects is almost completely limited to climate modelling. But modelling can push this dangerous technology and open-air tests forward – sporadic outdoor experiments have been announced and may be conducted in the near future given sufficient funding.

Public opposition is also a factor. In Australia, a coalition of nearly 200 environmental groups from 45 countries formed against open-air experiments after the tests in Australia's Great Barrier Reef.

The Australian RRAP's own public perception survey showed that the public opposes MCB. According to the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) Indigenous coastal communities have the right under Free,

Prior and Informed Consent (FPIC) requirements to give or withhold consent to a project that may affect them or their territories.¹⁶

Further reading

ETC Group and Heinrich Böll Foundation, "**Geoengineering Map**".
<https://map.geoengineeringmonitor.org/>

Endnotes

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- 12 Latham, et al. (2012)
- 13 Jones, et al. (2010)
- 14 Christopher Trisos, et al. (2018) Potentially dangerous consequences for biodiversity of solar geoengineering implementation and termination, in Nature Ecology & Evolution, Vol. 2:475 - 482, <https://doi.org/10.1038/s41559-017-0431-0>
- 15 Latham, et al. (2012)
- 16 Friends of the Earth Australia (2020); Reef Restoration and Adaptation Program (2019) The RRAP Investment Case and Concept Feasibility Study reports, accessed: Sept. 2020, <https://www.gbrrestoration.org/reports#technical-reports>; United Nations (2016) Free Prior and Informed Consent - An Indigenous Peoples' right and a good practice for local communities - FAO, published: October 14, 2016, <https://www.un.org/development/desa/indigenouspeoples/publications/2016/10/free-prior-and-informed-consent-an-indigenous-peoples-right-and-a-good-practice-for-local-communities-fao/>