

January 2026

Prepared by SRM360

SRM & Corals

Corals face a bleak outlook as climate change and ocean acidification worsen. Could emerging technologies to cool the planet help?

Key messages

Vital ecosystems

Coral reefs are vitally important ecosystems, relied upon by millions of people and a quarter of marine species.

Existential threats

They face increasing threats from climate change and ocean acidification and are being pushed towards irreversible collapse.

Part of the response?

Protecting corals will take many measures, which could include sunlight reflection methods to help limit temperatures, though these cannot address ocean acidification.

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A school of fish swim above a finger coral colony as it grows on the Great Barrier Reef (Reuters/Lucas Jackson)

What are corals?

Corals are marine organisms that live in colonies (connected structures). They're formed of many thousands of individual polyps, which are small cylinder-shaped animals with tentacles for defence and gathering food. These typically host algae within their tissues, which provide food as part of a mutually beneficial relationship between the two organisms.

There are two types of corals: soft and hard. Hard corals have rigid skeletons and can form massive reefs in warm waters, such as the Great Barrier Reef - the largest living structure on Earth.¹

■ Warm-water coral reefs



Sources: UNEP World Conservation Monitoring Centre (UNEP-WCMC) and the WorldFish Centre

Coral reefs are vitally important ecosystems. They support at least 25% of marine species, providing habitats that offer shelter, food, and breeding grounds.² Healthy coral reefs help supply fisheries that millions of people rely on.³ They also protect coastlines from storms and support local tourism.³ Estimates for their global economic value range from tens to hundreds of billions of dollars per year.⁴

Corals under threat

Corals face local threats such as overfishing and dredging, which can physically damage corals and disrupt the balance of their ecosystems.⁵ Toxic pollutants can also harm corals' health and reproduction, while other pollutants can smother corals directly or by promoting the rapid growth of algae.⁵

Climate change poses a broader and more serious threat. Higher temperatures can cause corals to expel their symbiotic algae, leaving them white, vulnerable to disease, and without their main source of food.⁶ This process, known as coral bleaching, can kill corals if hot conditions persist for weeks.⁷



A field of bleached staghorn coral is seen in a shallow reef with a large school of fish. (Getty Images/Sirachai Arunrugstichai)

Ocean acidification, mainly caused by the ocean absorbing carbon dioxide emissions, also threatens corals. More acidic seawater weakens coral skeletons and limits their growth.⁸

Ocean surface temperatures have increased by 0.5°C since the 1980s,⁹ and the ocean is more acidic than it has been for millions of years.¹⁰ Under these stresses, global coral coverage has halved since the 1950s.³ Researchers have also found that coral reefs are crossing a tipping point, risking irreversible losses and potential collapse.¹¹

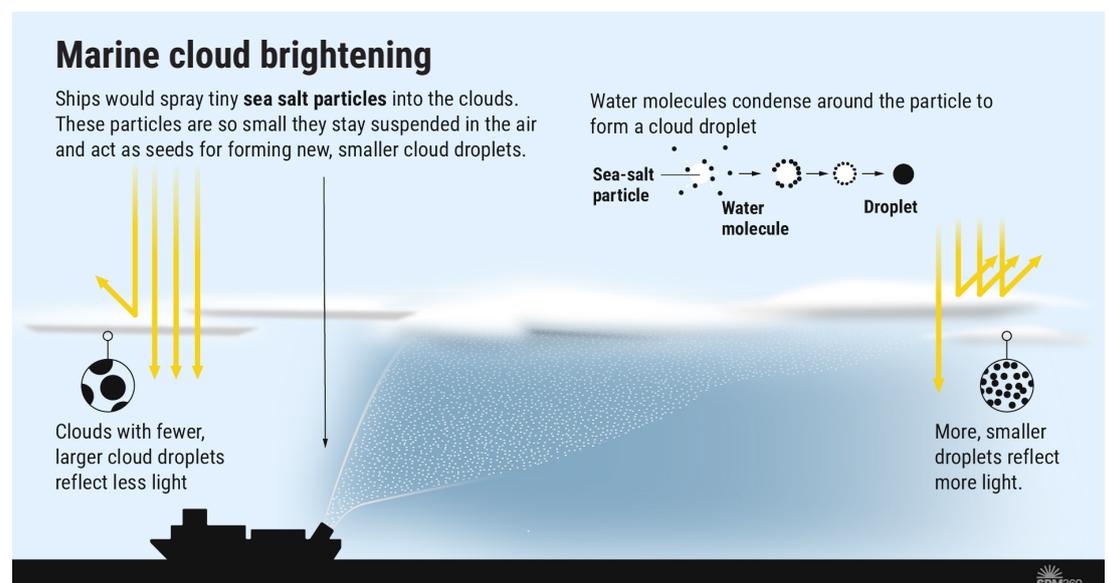
Potential interventions

Cutting carbon dioxide emissions will be essential for limiting further ocean warming and acidification in the long term. However, past emissions have already committed the world to a hotter and more acidic ocean over the coming centuries.¹²

Scientists are therefore looking into an array of additional measures to help protect coral reefs. For example, the Australian Government is funding research into several new approaches to help protect the Great Barrier Reef through the Reef Restoration and Adaptation Program (RRAP).¹³ This includes ideas to selectively breed more resilient corals and to restore damaged reefs by introducing new young corals.

Marine cloud brightening for temporary regional cooling

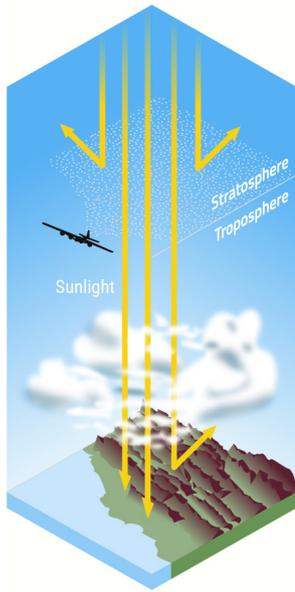
One approach being explored is marine cloud brightening (MCB), which is one of several potential approaches to cool the planet known as sunlight reflection methods (SRM) or solar geoengineering. MCB would involve a fleet of ships spraying precisely sized sea-salt particles into low-lying ocean clouds to make them more reflective, providing temporary regional cooling.



Studies suggest that MCB deployment could decrease the heat stress faced by corals, significantly reducing coral bleaching.^{1,14} This could be applied regionally or intermittently in response to bleaching forecasts.¹⁵

However, the technical feasibility of deployment remains uncertain,¹⁶ and concerns have been raised that MCB may be less effective or even counterproductive in some cases.¹⁷

How would SAI affect corals?



Stratospheric aerosol injection (SAI) is the most researched SRM approach.¹⁶ It would involve using a fleet of specially designed high-flying jets to create a global layer of tiny particles in the upper atmosphere to reflect a small fraction of sunlight.

Researchers are confident that this would be technically feasible, but it would have several side effects and would present significant governance challenges.¹⁶

This table outlines how three key factors for corals could be affected by SAI compared to future climate change.

What impacts would climate change have?

What impacts would SAI have?

Heat stress

Global warming will make marine heatwaves more intense, more frequent, and longer-lasting.¹⁸

Most corals may suffer bleaching events on an annual basis later this century.²⁰

Carefully deployed SAI could reduce temperatures around the world.¹⁹

SAI's cooling effect could significantly reduce coral bleaching.²¹

Ocean acidification

Even under optimistic scenarios, ocean acidification is projected to worsen as the ocean continues to absorb carbon dioxide.¹²

This will harm the health of corals, but the effects are expected to be small compared to those of increasing heat stress.¹⁸

SAI would not address ocean acidification.²²

Its cooling effect would have indirect impacts on ocean acidification, though the overall effect is expected to be small.²³

Collapse

Warming of 2-2.5°C, which is less than what's expected under current policies this century, would irreversibly eliminate over 99% of reef-building corals.²⁰

SAI could reduce the risk of coral reefs collapsing by limiting the main cause: higher ocean temperatures.²⁴

Issues and challenges

While SRM could reduce many climate impacts, it raises several concerns, including side effects and governance challenges.

Physical effects

- SAI could reduce the rainfall changes expected under climate change overall, but could worsen them in some places.²⁵ Deployed unevenly, SRM could produce substantial shifts in rainfall patterns.
- SAI could delay the recovery of the ozone hole and add a little to air pollution, though these risks may be small compared to the benefits of reduced heat.²⁶

Sociopolitical concerns

- There is a concern that advancing SRM would undermine efforts to cut emissions, known as mitigation displacement or moral hazard.²⁷
- SRM deployment would have impacts across the world and countries might not cooperate to make decisions fairly or effectively.²⁸
- The benefits and risks of SRM would be uneven, which could increase tensions between countries.²⁹ The attribution of SRM's impact may also be contested, which could pose further geopolitical risks.²⁸
- Large-scale SRM would need to be reliably maintained, as an abrupt and long-lasting stop would cause a “termination shock” – a rapid increase in temperature with devastating effects for the planet.³⁰

Additional reading

Learn more about sunlight reflection methods at [SRM360.org](https://srm360.org).

Check out our introductory guides: <https://srm360.org/guide/why-consider-srm/>

View this and other primers on our site [here](#).



About SRM360

SRM360 is a non-profit knowledge broker dedicated to informing people about sunlight reflection methods – or solar geoengineering – so they can contribute to critical decisions about its research, development, and governance.

Endnotes

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