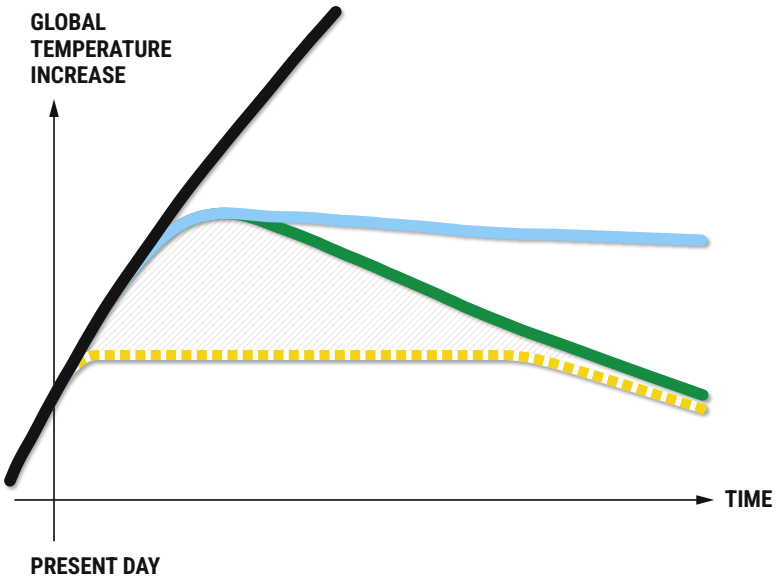
How could solar radiation modification affect Brazil?

The world is nearing 1.5˚C of warming and Brazil is experiencing worsening impacts of climate change, including, among others, the increase in extreme weather events, the degradation of the Amazon, and reduced agricultural productivity.

With risks mounting, there is growing interest in a set of technologies to cool the planet known as solar radiation modification (SRM) – also called solar geoengineering. What are these technologies, and what could they mean for Brazil and the planet?

Could reflecting sunlight "buy time" for decarbonisation?

This illustrative diagram explores the potential contribution of different climate strategies.



NO EMISSIONS CUTS
Temperatures would continue to rise.

REACH NET ZERO EMISSIONS
This would stop further global warming, but not reverse it.

REMOVE CARBON
Carbon dioxide removal could then slowly lower temperatures.

REFLECT SUNLIGHT?
Could SRM offset global warming while emissions fall and carbon is removed?

It is important to emphasise that the main strategy for limiting further global warming is to end the dependence on fossil fuels and to reduce all other sources of greenhouse gas emissions.

Reaching net zero CO_2 emissions is needed to stop further global warming, but it will not reverse it.[1] To return temperatures to safer levels, the world must also remove billions of tonnes of CO_2 from the atmosphere.[2] This will be extremely costly and could take more than a century.

Current emissions policies put the world on a trajectory of around 2.5˚C to 3˚C of average global warming, resulting in devastating impacts on ecosystems and society.[3]

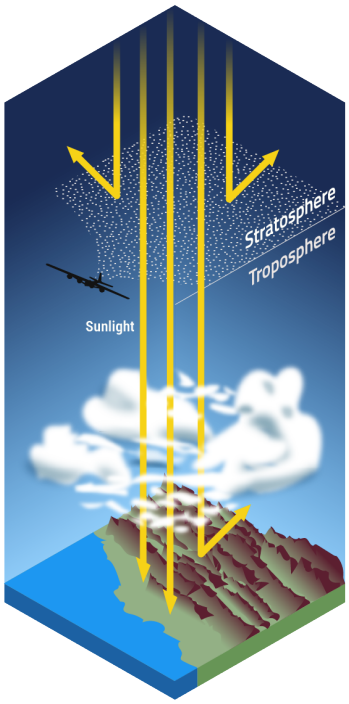
Could reducing the flow of solar radiation with SRM offer temporary relief while emissions cuts and increased removals are implemented?

What are the SRM technologies?

SRM refers to a set of potential technologies to cool the planet by increasing the amount of sunlight the Earth reflects back to space. This may be able to significantly reduce the impacts caused by global warming.

However, because they do not address the root cause of the problem – rising greenhouse gas emissions – SRM cannot replace the need for substantial emissions cuts to limit warming. In addition, it entails new risks and geographically uneven challenges that require further study. Nevertheless, two technologies have received particular attention.

SAI is the method that has attracted the most attention and research so far.[4] Major volcanic eruptions demonstrate that tiny particles in the upper atmosphere can cool the planet substantially. By mimicking this effect, SAI has the potential to cool the planet rapidly and at a relatively low deployment cost.[5]



Stratospheric aerosol injection (SAI)

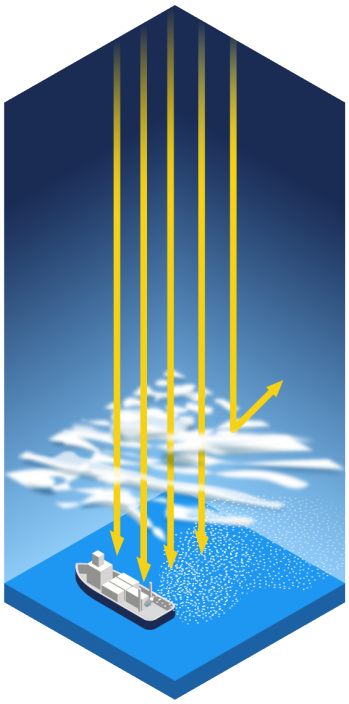
A global intervention

HOW COULD IT WORK?

Using high-flying jets, SAI could create a global layer of tiny particles in the atmosphere that would directly reflect a small fraction of sunlight back to space, resulting in a reduction in the planet's temperature.

POSSIBLE OUTCOMES

SAI could produce a global cooling effect, reducing some of the effects of climate change. However, it would only mask the warming effects of greenhouse gases and would not address many important issues, such as ocean acidification.[6] SAI would also have significant side effects and alter rainfall patterns.[7] Since it is not possible to ensure a uniform effect of SRM across the planet, the risks and impacts of the measure are expected to affect regions differently.



Marine cloud brightening (MCB)

A regional intervention

The idea of this method is to inject tiny aerosols at the base of marine clouds, thereby increasing their albedo – the fraction of solar radiation that is reflected into space – and cooling the lower atmosphere.

HOW COULD IT WORK?

By spraying sea-salt from ships, MCB could make ocean clouds more reflective, providing regional cooling that could potentially be scaled up to a global level if large areas could be used.

POSSIBLE OUTCOMES

It is not yet clear whether this idea is feasible.[4] Its patchy, regional cooling effect could substantially shift rainfall patterns.[8]

How might SAI affect Brazil?

Brazil is one of the most vulnerable countries to climate change and faces many challenges. The table below highlights four possible risks. The question is: could SAI reduce or increase risks for Brazil.

How climate change may affect Brazil

How stratospheric aerosol injection may affect Brazil

The Amazon

The Amazon rainforest is vital for global biodiversity, climate regulation, and the livelihoods of millions of people. Its carbon stock is critical to the planet's climate future.

How climate change may affect Brazil	How stratospheric aerosol injection may affect Brazil
Rising temperatures and more intense droughts threaten the Amazon.[9]	Some stresses such as extreme heat would be greatly reduced, but the impact on the hydrological cycle is uncertain.[7]
Exacerbated wildfires also pose a threat.[9]	One study finds SAI would have little effect on western Amazon wildfires.[10]
These and other factors like deforestation could push the Amazon towards a potential collapse.[9]	The impact of SAI on the potential collapse of the Amazon is highly uncertain.[11]

Agricultural production

As one of Brazil's most significant economic activities, agriculture is crucial to both the country's economy and the world's food supply.

How climate change may affect Brazil	How stratospheric aerosol injection may affect Brazil
Rising temperatures threaten agricultural production and increase pest prevalence.[12]	The cooling effect would benefit agricultural production.[13]
More intense extreme rainfall and droughts are impacting production.[12]	Its impacts on rainfall could have a small effect on agricultural productivity.[13]
Rising CO_2 levels could increase agricultural productivity, but studies disagree on the overall effects.[12]	Overall, it is expected that crop yields would benefit.[13]

Water scarcity

A reliable water supply is essential for Brazil's agriculture, hydropower, and people's well-being.

How climate change may affect Brazil	How stratospheric aerosol injection may affect Brazil
Climate change is projected to reduce water security in Brazil.[14]	Limited evidence suggests that SAI would not be able to reverse this trend.[15]
Both droughts and floods become more frequent and more intense, disrupting water supplies.[16]	The potential impacts on droughts over Brazil are uncertain.[7]

Heatwaves

Extreme heat threatens Brazilians' health, especially vulnerable groups like the elderly and those with health conditions.

How climate change may affect Brazil	How stratospheric aerosol injection may affect Brazil
Heatwaves become more frequent and more intense.[17]	The severity and frequency of heatwaves would be greatly reduced.[18]
Heatwaves are killing hundreds of Brazilians per year and this rate is increasing.[19]	Most of the increase in deaths from heatwaves could be avoided.[20]

Issues and challenges

While SAI or MCB could significantly reduce some climate harms, they raise several critical concerns – including side effects and governance challenges.

- Global SAI could reduce the rainfall changes expected under climate change overall, but could worsen them in some places.[21] Deployed in an uneven way, SAI or MCB could produce major changes 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.[20]

- SAI would need to be maintained for decades to centuries as it only masks the warming effect of greenhouse gases. If ended abruptly, it could cause a termination shock, with a rapid increase in temperature and devastating effects for the planet.[22]

- The benefits and risks of SAI and MCB would be uneven, which could create tensions between countries.[23] Attribution of SRM's impact may also be contested, posing risks to its continuation.[24]

- Some people are concerned that SRM could be used as a justification to delay essential emissions cuts. This concern is known as moral hazard.[25]

Key messages

Not a substitute

SRM would only mask the warming effect of greenhouse gases and cannot replace emissions cuts. However, if applied alongside reduction and removal, it may be useful.

Weighing risk vs risk

SRM would likely reduce some risks but would also introduce new ones. These must be carefully weighed against the impacts of climate change without the use of SRM.

Difficult decisions

There are no risk-free options. Brazil needs to address this issue to help shape outcomes that will affect its people, ecosystems, and critical resources.

Additional reading

Learn more about SRM in SRM360's introductory guide at **SRM360.org/guide/why-consider-srm/**

For the online version of this primer, including references, visit **SRM360.org/brazil-primer**

Endnotes

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