SRM & Extreme Heat

Climate change is worsening extreme heat and emissions cuts are falling short. This primer introduces an emerging set of ideas to cool the planet – sunlight reflection methods (SRM) – and outlines how they might address extreme heat, as well as the risks they could pose.

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Prepared by SRM360

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Extreme heat causes a shimmer effect in Phoenix, Arizona, during a 2023 heatwave. (Photo by Mario Tama/Getty Images)

The hazards of extreme heat

Global average temperatures have risen about 1.4˚C and will increase further in coming decades. This change is uneven, with temperatures rising faster on land and temperature extremes rising faster still. This makes dangerous heat more common and more severe, leading to a host of serious consequences.

A growing health crisis

Extreme heat can have acute and lasting effects on health as the body strains to keep itself cool.[1] Almost half a million heat-related deaths occur each year and this is expected to increase substantially.[2] As climate change continues, some regions may cross thresholds of heat beyond human survivability.[3]

Disruptions to work and education

Outdoor physical labour becomes increasingly dangerous with extreme heat, leading to restrictions on working hours in some places.[4] School closures also become more common, and children are less able to learn in overly hot classrooms.[5] These disruptions place a strain on economies and communities, impacting livelihoods and future opportunities.

Filipina student Marjorie answers learning modules at home in May 2024. A record heatwave led to school closings with students reverting to remote learning. (Photo by Ezra Acayan/Getty Images)

Unequal impacts

The impacts of extreme heat will not fall evenly. The elderly, young children, and people with underlying health conditions are particularly vulnerable.[1] Low-latitude countries are already more exposed to heat and urban areas tend to be substantially hotter than rural areas.[6] Given these factors and limited access to cooling, the urban poor in the Global South are particularly exposed and vulnerable to extreme heat.

Why consider reflecting sunlight?

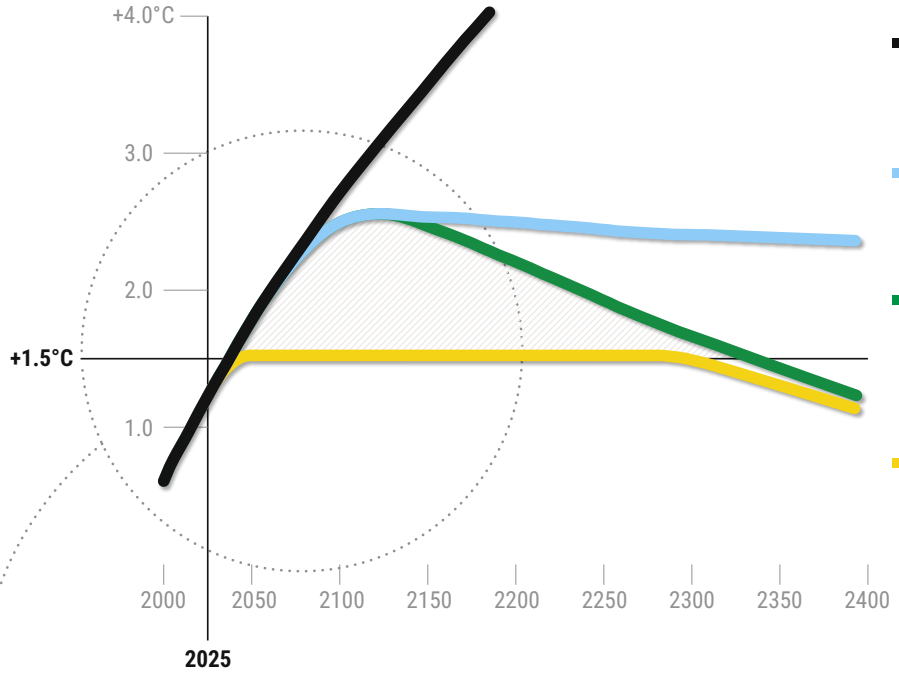
The impacts of global warming are being felt in every country and every community around the world, but especially in the Global South. With limited progress on emissions cuts and risks mounting, there is increasing interest in options for addressing near-term risks.[7]

Sunlight reflection methods (SRM) – a set of theoretical approaches to increase how much sunlight the Earth reflects – might offer a way to reduce the impacts of global warming, but they would also pose new risks and challenges.

Tackling climate change could take centuries

The primary strategy to prevent further warming is to stop burning fossil fuels and reduce other sources of greenhouse gas emissions. But eliminating emissions will only stop global warming getting worse; it will not reverse it.[8] To return temperatures to safer levels, the world must also remove hundreds of billions of tonnes of carbon dioxide already in the atmosphere – this will be costly and could take over a century.[9]

GLOBAL TEMPERATURE INCREASE



NO EMISSIONS CUTS
Temperatures would continue to rise.

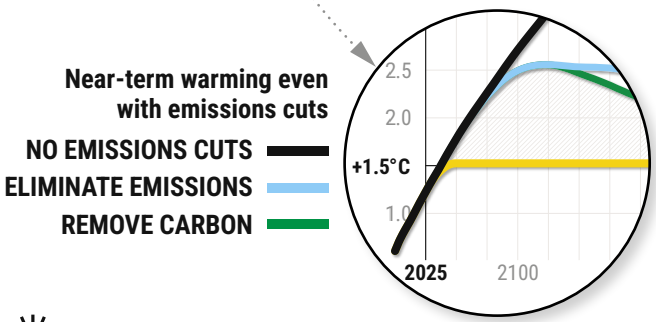
ELIMINATE EMISSIONS
This would stop global warming, but not reverse it.

REMOVE CARBON
Carbon dioxide removal could then slowly lower temperatures.

REFLECT SUNLIGHT
SRM could offset global warming while emissions fall and carbon is removed.

SRM could lower temperatures in years

Current emissions policies put the world on track for at least another 1˚C of warming.[10] Even with much greater efforts to cut emissions, global temperatures will keep rising for decades, raising risks around the world. Adaptation will play an important role in reducing some harms, but its effectiveness and potential are limited – particularly for ecosystems and lower-income populations in the Global South.[11]



SRM could offer a way to cool the world fast, potentially reducing otherwise unavoidable impacts of climate change. Reflecting just 1% of incoming sunlight would be enough to prevent the next 1˚C of global warming.[12]

SRM could limit near-term warming

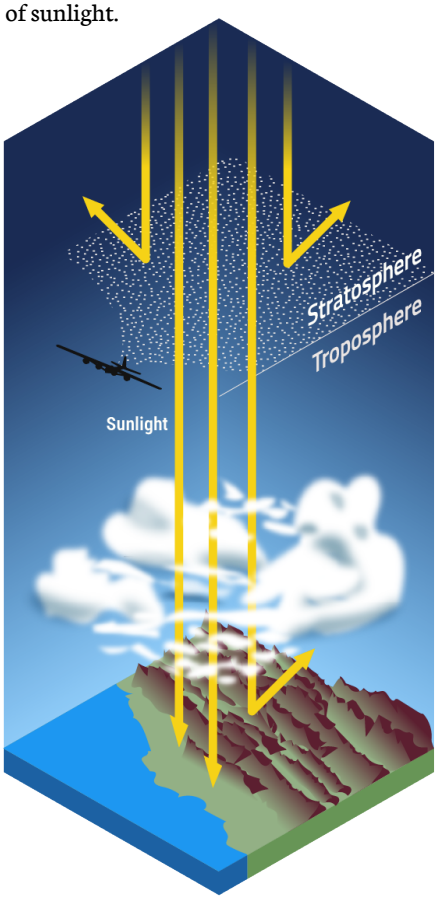
REFLECT SUNLIGHT

What are sunlight reflection methods?

SRM may sound like science fiction, but there are hundreds of studies exploring the potential of tiny particles known as aerosols to help counter rising temperatures. These ideas remain theoretical, but two approaches stand out as potentially feasible and effective.

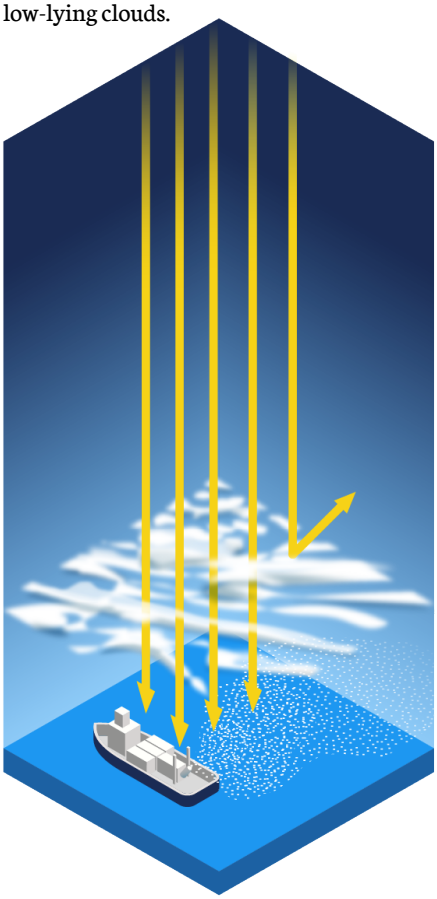
Stratospheric aerosol injection (SAI)

Tiny particles released in the stratosphere would directly reflect a small fraction of sunlight.



Marine cloud brightening (MCB)

Sea-salt particles would be sprayed from ships to enhance the reflectivity of low-lying clouds.



SCALE OF INTERVENTION	**Global**	**Regional**
HOW IT COULD WORK	Using high-flying jets, SAI could create a global layer of tiny particles that would reflect light and cool the planet. Researchers are confident that this idea could technically work and cool the Earth substantially for a few tens of billions of dollars per year.[13,14]	By spraying sea-salt from ships, MCB could offer a way to make ocean clouds more reflective, providing regional cooling. Significant uncertainties and engineering challenges remain so it is not yet clear whether this idea is feasible.[13]
POSSIBLE OUTCOMES	SAI could not offset all the effects of climate change and would have side effects, but by lowering temperatures it might reduce many of the risks of climate change.	MCB might help tackle local risks, e.g., cooling the great barrier reef,[15] or it might be scaled up to produce a global cooling. However, the patchy nature of its cooling effect could lead to substantial shifts in rainfall patterns.[16]

Could SRM help?

Cutting emissions and removing carbon will be essential to addressing climate change, but even with ambitious efforts the world faces a growing threat from extreme heat. Could SRM help, and what new risks could it bring?

Less warming, less extreme heat

SAI appears to be both technically feasible and capable of lowering temperatures around the world.[13] By lowering temperatures, it could offset most of the increase in the severity and frequency of extreme heat expected with climate change.[17]

For MCB, the climate response would depend on which ocean regions were cooled.[16] This cooling effect would generally spread to other parts of the world, reducing the risks of extreme heat. However, in some cases it might raise extreme heat risks in a minority of places.[18]

Dawnsha Johnson cools her son Javon with a portable fan during a July 2022 heatwave in Houston, Texas. (Photo by Brandon Bell/ Getty Images)

Trade-offs and challenges

SAI would come with side effects, such as adding to air pollution and delaying the recovery of the ozone hole. One study found that the benefits of reducing extreme heat would significantly outweigh these particular harms, though there are large uncertainties.[19] SRM approaches could also shift rainfall patterns, which could have uneven effects across regions.[20]

SRM might have the potential to greatly reduce climate risks caused by rising temperatures, but it faces significant public controversy and poses serious governance challenges.[21] Could SRM heighten international tensions? Might it undermine efforts to cut emissions? Could it be reliably maintained for the decades or centuries needed to keep global temperatures in check?

Key messages

- Extreme heat is a serious and growing threat to lives and livelihoods around the world, and the greatest impacts will be felt by the urban poor in the Global South.
- By lowering temperatures, SRM could reduce extreme heat, but it could not address all climate risks, would have side effects, and raises significant governance challenges.
- While emissions cuts, carbon removals, and adaptation are essential, the risks and potential benefits of SRM are important to consider. This will require thoughtful engagement by researchers, policymakers, and stakeholders across society.

Appendix

Learn more about sunlight reflection methods at SRM360.org.

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

Endnotes

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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.