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SRM & Security

As the climate continues to warm, geopolitical and security risks are likely to increase as well. Sunlight reflection methods (SRM), or solar geoengineering, may be an effective way to reduce the global average temperature, but it comes with its own set of security dynamics.

Key messages

Climate change as a threat multiplier

Climate change has long been considered a threat to global security, acting as a threat multiplier and potentially creating new areas of security risk or conflict.

Positive or negative impacts?

SRM has the potential to lower global average temperatures, which could lessen some of the climate impacts that raise security risks, but might introduce or amplify tensions among countries regarding its use, impacts, and outcomes.

Understanding security dynamics is crucial

A better understanding of the potential security dynamics of SRM will be crucial to effectively manage these issues as SRM moves out of the lab and towards potential usage.

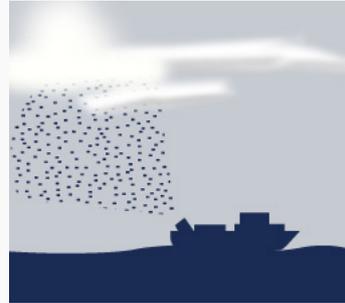
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*A military team practises an aerial operation in Alaska, US.
(IMAGO/piemags via Reuters Connect)*

Differentiating the technologies

Cloud seeding and SRM are sometimes confused; this figure lays out the key differences between the main approaches.



CLOUD SEEDING

MARINE CLOUD BRIGHTENING (MCB)

STRATOSPHERIC AEROSOL INJECTION (SAI)

WHAT'S THE IDEA?

Planes, drones, or ground-based cannons add tiny particles to clouds to encourage local rain or snowfall.

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

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

IS IT BEING DONE?

Yes, more than **50 countries** have either commercial or governmental cloud seeding programmes.¹

No, but there have been a limited number of small-scale outdoor experiments that have had little to no environmental impact.²

No, but as with MCB, a few small, environmentally negligible outdoor experiments have been conducted.²

SCALE OF EFFECTS?

Cloud seeding is intended to increase precipitation or sometimes reduce hail damage on a **local level**.¹

MCB is intended to produce a **regional cooling**, but could have remote effects or, if scaled up, global impacts.³

SAI would produce a **global cooling effect**, altering the climate around the world.⁴

COULD IT WORK?

Growing evidence suggests cloud seeding can have a limited effect on local rainfall.⁵

It is **unclear** whether MCB is feasible, as developing effective sprayers is technically challenging and the cloud response is uncertain.⁶

There is **no doubt** that SAI could produce a large, global cooling effect, and it appears feasible to do with specially designed, high-altitude jets.⁶

SIDE EFFECTS?

Limited research suggests minor changes in precipitation outside of the intended area.⁵

If MCB produced a large enough regional cooling, there would be shifts in rainfall and other weather patterns in remote regions.³

SAI could reduce many effects of global warming, but would change rainfall patterns and have other side effects, such as adding to acid rain.⁷

Weaponisation and secrecy

Could SRM be used as a weapon?

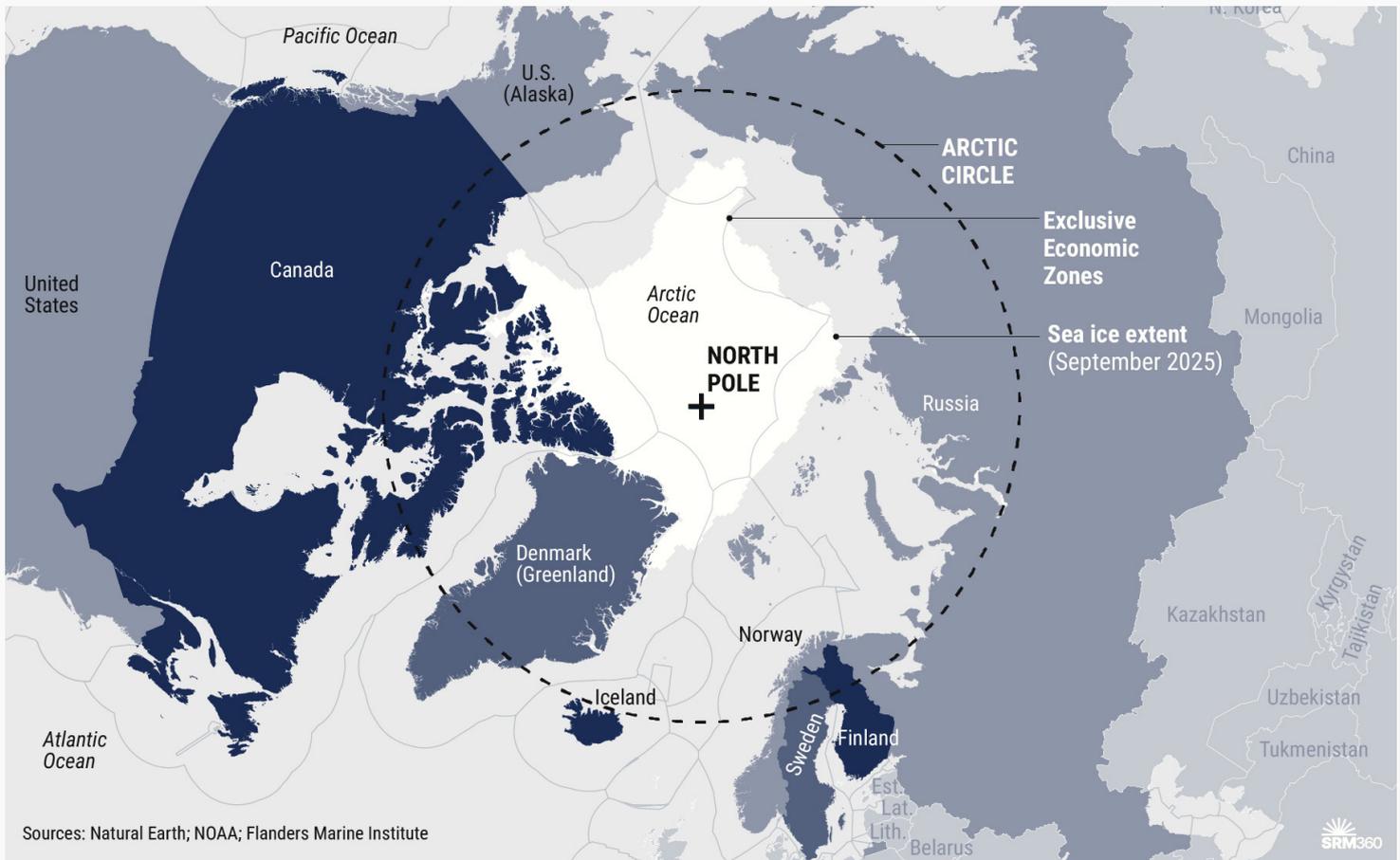
- Cloud seeding carries at least some history and threat of weaponisation. With Operation Popeye, the US military seeded clouds during the Vietnam War in an effort to hinder enemy movements or otherwise disrupt their operations. This led to the adoption of what's known as the ENMOD treaty, a ban on environmental modification for hostile or military uses.⁸
- Sunlight reflection methods like MCB and SAI are not suited to being used as direct weapons. They would change the climate (the long-term statistics of weather) and are too imprecise to target individual countries or areas.⁹
- Countries could deploy SRM carelessly, or without concern for its impacts on neighbours or the broader global community. There is also a possibility that SRM could be used as a tool of general disruption,¹⁰ though it would still be a complicated and expensive way to disrupt or destabilise enemies. These possibilities could clearly present security challenges.

Could SRM deployment be done in secret?

- Large-scale SAI of the sort that could affect global temperatures would be fairly easily detectable, both in terms of the infrastructure involved¹¹ - new types of planes flying the same unusual sorties over and over, new or repurposed airbases with unusual ground equipment, among other things - as well as in terms of the atmospheric effects of the deployment.¹² Satellites and other technology now continuously monitor atmospheric concentrations of a number of gases, aerosols, and pollutants,¹³ and the millions of tonnes of sulphate particles required for SAI would not go undetected.
- The same would be true of MCB, which would involve fleets of ships patrolling patches of the open ocean - which again should be readily detectable.¹⁴
- It would also be relatively easy to spot a secretive unilateral SAI programme well before it actually deployed. Much like how a country needs to spend years enriching uranium and developing infrastructure before it is capable of building a nuclear weapon, a major SAI programme would involve a number of steps leading up to deployment that the rest of the world could observe - and, if it really came to it, interrupt.

Climate change, SRM, and security risks

Climate change itself is likely to lead to security risks and geopolitical tensions.¹⁵ Rising temperatures, changes to precipitation patterns, sea level rise, and more can induce climate-related migration, increase food and water stress, destroy critical infrastructure, cause or exacerbate disasters, and more.



Climate change is reshaping security dynamics in the Arctic, with implications for how SRM deployment may play out in the future.

SRM, if deployed, might reduce some of those risks by lowering global average temperatures and reducing many impacts of climate change. However, it could raise some risks in some places, by altering weather patterns or through other side effects.

SRM deployment could also introduce new security challenges beyond its direct environmental effects. The possibilities for how SRM could affect the relations between nations could unfold in many ways, imagining some of those scenarios may help plan for potential futures.

Here are two ways this might play out...

Scenario one



ZUMA Press Wire via Reuters Connect

Refreezing the Arctic

In the 2030s in the far north, where climate change has already altered the landscape in dramatic ways, a coalition of several countries including the US, Canada, and China launch an SAI programme. The new bases from which planes fly daily missions require a military presence for protection – and Russia objects, both to the encroachment of militaries into the Arctic and to the refreezing of sea ice itself. Other Arctic countries including Norway and Denmark are caught in the middle, having rejected participation in the SRM programme but still militarily aligned against Russia.

- What is the potential for a hot war to materialise in this situation?
- What risks might be introduced by attempts at sabotage, cyberwarfare, or other destabilising attacks?
- Would there be a way to ease tensions as the world cools?

Scenario two



REUTERS

South Asian drought

In the 2040s, with climate change impacts becoming unbearable in many places, a broad coalition of countries begin an SAI programme. As expected, global temperature increases were halted - but a few years into the programme, an unprecedented drought hits Northern India and Pakistan, and geopolitical tensions rise.

The affected countries blame the drought on the SAI deployment. Two nuclear-armed powers, traditionally at odds, join to denounce the global programme and demand its cessation as well as compensation for their growing agricultural and other losses.

- How might the scientific and political challenges of attributing climate impacts play out if both the SAI deployment and the intensity of drought are without historical analogues?
- What would the impact of “weaponised” accusations and the lack of firm scientific conclusions be?
- If the SAI programme was yielding positive results elsewhere in the world - reduced polar melting, calmer wildfire seasons, and so on - how might such a global standoff be resolved?

Moving the security conversation forward

There are clearly many more ways an SRM deployment could unfold, but these scenarios illustrate some of the security challenges it could present. The scientific facts will matter, but when it comes to the security dynamics, how SRM research and any potential deployment are carried out and perceived will be crucial. As such, a few points are important moving forward:

- A thorough understanding of SRM security dynamics will require factoring in scientific as well as geopolitical, sociopolitical, and other inputs.
- Gaming out potential scenarios for SRM deployment may be useful as discussions progress, in addition to ongoing computer modelling and other research to better understand the outcomes and impacts.
- Building trust and transparency into all SRM activities, in ways that are inclusive to a wide array of stakeholders, may help reduce political tensions as discussions proceed into the future.

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/>

Read more from The Center for Climate and Security: <https://councilon-strategicrisks.org/2025/09/22/a-dose-of-realism-geopolitical-and-security-dimensions-of-solar-radiation-modification/>

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.

About The Center for Climate and Security

The Center for Climate and Security is a solutions-oriented, bridge-building research institute focused on tackling systemic climate and ecological security risks.