Geoengineering the stratosphere: Funding for high-altitude geoengineering research is increasing massively

February 23, 2026

This update on Stratospheric Aerosol Injection (SAI) summarises the latest developments on the Geoengineering Monitor Map, highlighting new trends for civil society and climate justice movements to follow in their efforts to oppose geoengineering globally.

*This update is Part Four of a four-part series on solar geoengineering, where we cover Solar Radiation Management projects at all distances between the Earth and the Sun: from the Earth's surface, through the clouds, into the stratosphere, and into outer space. It was researched and written by **Anja Chalmin**, and published with the support of the Geoengineering Monitor team.*

Critical developments covered in this update

- Funding for solar geoengineering research, particularly Stratospheric Aerosol Injection, is increasing rapidly despite the huge risks and uncertainties surrounding its deployment—**overall funding for SRM jumped almost three-fold in 2025**.
- Israeli and US for-profit start-up Stardust Solutions has **raised US$60 million to conduct outdoor SAI experiments**, the **largest ever funding round for SRM research**.
- US-based Make Sunsets has announced that it will **allow royalty-free use of its patented SAI technology and continues to sell "cooling credits"** following its balloon releases.
- **Corporate driven funding led by tech and finance billionaires has recently reached new highs**, led by grants awarded by the **Simons Foundation** which has launched a US$50 million fund, the **Quadrature Climate Foundation**, and **Reflective**.
- The Degrees Initiative has **published more studies modelling SAI deployment against a backdrop of worst-case greenhouse gas emission scenarios**, which is often not transparently disclosed and may lead to a biased perception of the technology.
- **Public funding for solar geoengineering also grew significantly in 2025**, led by the UK's **Advanced Research & Invention Agency's (ARIA)** £57 million SRM research fund and **Natural Environment Research Council's (NERC)** five-year study programme.
- **Avoiding climate tipping points is increasingly being used to justify the use of SRM**. However, this risk-risk framing does not consider the full range of environmental, social, economic and geopolitical challenges that would accompany it.
- The 20th meeting of the AMCEN, a leading African environmental body, and numerous African youth organisations, have **made their opposition to SRM clear** due to the significant ecological, ethical and geopolitical risks it poses.

Introduction: Funding for SAI and SRM in general took off in 2025

Stratospheric Aerosol Injection (SAI) is the most prominent Solar Radiation Management (SRM) approach. It involves spraying large quantities of tiny, reflective particles, such as sulphate aerosols, into an upper layer of the Earth's atmosphere to reflect sunlight back into space.

SAI is associated with significant potential risks and uncertainties, including damage to human health, ecosystems and the ozone layer, reduced agricultural yields and significant changes to rainfall patterns. Other unintended consequences of the deployment of the technology cannot be ruled out because climate models are not able to capture the full complexity of atmospheric interactions and processes. This is partly because many of these interactions and processes are not yet fully understood.

Another major risk of SAI is the so-called termination shock. In order to mask the warming effects of greenhouse gases, SAI deployment would require particle concentrations to be maintained through regular injections. However, abruptly terminating SAI deployment would result in rapid temperature increase and changes in precipitation, causing major impacts to ecosystems.

Ultimately, SAI will undermine real solutions to the climate crisis by encouraging climate mitigation efforts to focus on technological quick-fixes rather than genuine, deep emissions reductions.

This Technology Update outlines the commercial development of SAI, addressing the growing volume of funding, particularly from the private sector. It also analyses research priorities, including those of The Degrees Initiative, and highlights the growing number of research projects focusing on preparing for the deployment of SAI. It notes that tipping points are becoming an increasingly important driver for SAI research.

Our research shows that overall funding for SRM, of which SAI is the major component, increased almost three-fold in 2025 compared to 2024, with public funding accounting for the vast majority of the increase. This data is analyzed in detail in the subsequent sections of this article.

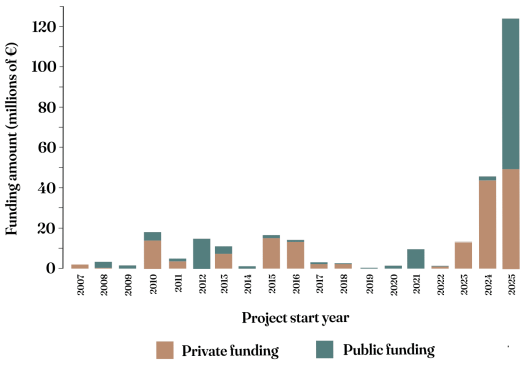

Figure 1: Total annual funding awarded to SRM projects. This figure is based on German Federal Environment Agency (2024) data covering 2007-2024. Data for 2025 has been added by Geoengineering Monitor, and includes the following sources of funding (converted to €): ARIA (€62.48 million), NERC (€11.55 million), Stardust Solutions (€50.4 million), ACtIon4Cooling (€0.08 million), and the Swiss National Science Foundation (€2.28 million).

For-profit deployment of SAI: Solar geoengineering

as a business model

US-Israeli company Stardust Solutions completes largest ever funding round for solar geoengineering experiments

Stardust Solutions is an investor-funded for-profit start-up founded in 2023 by Israeli researchers Yanai Yadov, a former deputy chief scientist at the Israeli Atomic Energy Commission, Amiad Spektor and Eli Waxman. The for-profit company is incorporated in Delaware, USA. Its headquarters are located outside Tel Aviv in Israel.

The researchers have been conducting indoor trials since 2022 and testing SAI hardware outdoors since 2024. Starting in 2026, the company intends to conduct SAI field trials by releasing its proprietary reflective particles from aircraft flying at around 18 kilometers above sea level. The exact location of the trials has not yet been publicly disclosed.

Stardust claims to have developed a new type of reflective particle for SAI and is seeking to patent it. The nature of these particles has not yet been revealed, but the company announced that it would publish its key findings in early 2026. The company raised US$60 million in venture capital in October 2025 for its field trials – the largest funding round ever for an SRM company. Since its foundation, Stardust has raised a total of US$75 million. Major investors include the Israeli-Canadian Awz Ventures, a capital fund with strong ties to Israeli military and intelligence agencies, Lowercarbon Capital, led by tech billionaire, venture capitalist and former Google executive Chris Sacca; the Dutch holding company Exor; former Facebook executive Matt Cohler; and the US firms Future Positive, Future Ventures, Never Lift Ventures, Starlight Ventures, Nebular and Lauder Partners. Other investors include the British groups Attestor, Kindred Capital, Orion Global Advisors, and the early-stage venture capital fund Earth.Now. In the future, Stardust intends to pursue government contracts for SAI deployment.

US-based Make Sunsets allows royalty-free use of patented SAI technology

Make Sunsets Inc. is at the forefront of efforts to commercialise SAI technology. It aims to create reflective clouds in the stratosphere by releasing sulphur dioxide (SO_2) particles. Balloons filled with hydrogen gas and carrying ~1.7 kilograms of SO_2 are released at ground level and rise into the stratosphere, where they are expected to burst at an altitude of 20 kilometers or higher due to the decrease in air pressure, releasing the SO_2 particles.

The company sells 'cooling credits' based on this approach, claiming that one gram of SO_2 released offsets the warming effect of one tonne of CO_2 for one year, yet it does not provide any scientific evidence to support this claim. It also claims that it can "*create sufficient cooling to offset this year's new warming*" with US$7 million worth of SO_2 and deployment costs of US$23 million. Again, there is no scientific evidence to support this assertion.

In 2022, the US company conducted its first test flights from Baja California, Mexico, without the consent of the Mexican government or the local communities. Following the disclosure of these experiments, the Mexican government announced its intention to ban further balloon launches, prompting Make Sunsets to relocate subsequent experiments to the US. The Mexican government cited evidence that SRM techniques do not reduce GHG emissions and have unequal environmental, health, and community impacts as the reasons for the ban.

In April 2025, the US Environmental Protection Agency (EPA) requested information from Make Sunsets, stating that it would evaluate whether the company's activities were subject to the Clean Air Act. This was in response to concerns about pollution and the need for regulatory oversight. SO_2 is a regulated pollutant under the Clean Air Act, because exposure to it can irritate the lungs and contribute to environmental issues such as acid rain. The requested information is mainly technical and legal in nature. The EPA is still reviewing Make Sunsets' response.

As of November 2025, the company claims to have launched over 200 balloons and sold more than 200,000 'cooling credits' to around 1,000 customers, over 70% of which were sold to two undisclosed clients. The balloon launch sites are located in Nevada and California, but most have not been disclosed to the public.

In December 2025, Make Sunsets announced that it had been awarded its first U.S. patent. The patent covers a balloon-based system designed to transport a refillable SO_2 container from a ground station to the stratosphere. Once there, the liquid SO_2 is intended to evaporate and disperse. The system can be operated from multiple ground stations. The container can hold and release pressurised liquid, and can be refilled. An elevation adjustment system and steering thrusters enable the container to be raised or lowered between ground stations

and the stratosphere.

Make Sunset grants companies free use of the technology as long as they release less than one tonne of SO_2 into the stratosphere per year. Companies wishing to release more than one tonne per year must purchase a licence from the company. As well as releasing balloons, other proposed methods of deployment include aircraft with a four-tonne payload capacity, and skytubes tethered at ground level and reaching into the stratosphere.

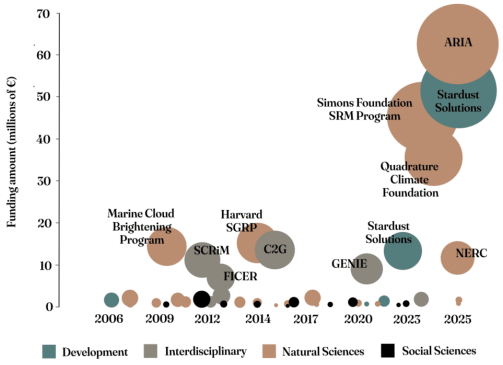

Figure 2: SRM project size in terms of funding. This figure is based on German Federal Environment Agency (2024) data covering 2007-2024. Data for 2025 has been added by Geoengineering Monitor, and includes the following sources of funding (converted to €): ARIA (€62.48 million), Quadrature Climate Foundation (€36.9 million), NERC (€11.55 million), Stardust Solutions (€50.4 million), ACtIon4Cooling (€0.08 million), and the Swiss National Science Foundation (€2.28 million).

Corporate-funding for SAI research growing by leaps and bounds

The Simons Foundation has awarded US$50 million to fund SRM research

In 2024, the Simons Foundation, founded by mathematician and hedge fund manager James Simons and partner Marilyn Simons, awarded 14 grants in support of SRM, providing up to US$10 million per year until 2029, a sum that was unmatched (see Fig. 2) throughout the entire 2007-2023 period. The grants support ten SAI research projects as well as research into mixed-phase and cirrus cloud thinning. Researchers at

- Washington University will investigate the use of calcite and aluminum oxide aerosols for SAI;
- Washington University aim to strengthen existing models of SAI plume evolution;
- Harvard University aim to identify alternatives to sulphuric acid for SAI;
- ETH Zurich will model and experimentally study the atmospheric processes involved in SAI, including alternatives to sulphuric acid;
- Columbia University will use an aerosol flow tube to investigate proposed SAI aerosols at stratospheric temperatures;
- The University of Cape Town in South Africa will investigate alternative aerosols for use in SAI, including crushed diamonds, dust, calcite and other candidates;
- McGill University in Canada will study the microphysical properties of aerosol particles under stratospheric conditions in a laboratory;
- The Physical Meteorological Observatory Davos / World Radiation Center in Switzerland will investigate the chemical processes associated with alternative SAI aerosols;
- The National Center for Atmospheric Research will investigate alternative aerosols for use in SAI and their impact on ozone and ice cloud formation;

- Princeton University will model a novel SRM strategy that aims to alter stratospheric temperatures and compare the results with SAI.

The Quadrature Climate Foundation (QCF) provides €37 million for SRM research

QCF, established in 2019, is funded through profits from the hedge fund Quadrature Capital, which has stakes worth US$170 million in fossil fuel firms. In 2024, QCF announced plans to provide €37 million for SRM research over the next three years, which accounts for less than 5% of its US$930 million funding portfolio.

In May 2025, the University of Chicago's Climate Systems Engineering initiative (CSEI) received a $5 million grant from the QCF to support research into SRM. The grant will enable researchers from the University of Chicago, Colorado State University, Harvard University, the University of Hawaii, the University of Illinois at Urbana-Champaign, and partners at key engineering firms to research SAI. The research topics include:

- Aircraft options for delivering aerosol into the stratosphere using both established and novel technologies, retrofitting existing aircraft, and examining the logistics of sulphur handling and transport.
- Modelling to reduce uncertainty surrounding how aerosol particles form in the wake of aircraft.
- Exploring ways to increase the world's ability to monitor aerosols in the stratosphere.
- Evaluating the efficacy of SAI and its possible consequences.

QCF is also supporting The Degrees Initiative, the University of Exeter (£0.75 million in 2024), research on the response of climate metrics in SAI scenarios and the growing conditions for luxury crops after SAI deployment.

The US-based Reflective funds research modelling SAI deployment near the poles

Reflective is a philanthropically funded research organisation based in the San Francisco Bay Area, California. Its mission is "*to radically accelerate the pace of SAI research and technology development, such that the world is equipped with the data and tools needed to make informed decisions about SAI*." Reflective considers SAI to be an effective means of mitigating the impact of climate change and avoiding tipping points. This stance is unsurprising, given that the organisation's Scientific Advisory Board includes the SAI researcher David Keith. Keith initiated the Stratospheric Controlled Perturbation Experiment (SCoPEx), which modelled SAI and planned to conduct an SAI field experiment, which was cancelled due to protests.

Reflective is funded by the Renaissance Philanthropy Fund through its Advanced Research for Climate Emergencies (ARC) programme, which also supports the development of other geoengineering approaches. Several other of the project's funders, including the Cohler Charitable Fund, the LAD Climate Fund, Open Philanthropy, and Outlier Projects, have a history of providing financial support for SRM.

In 2025, Reflective selected eight grantee teams and provided them with funding to model lower-altitude SAI deployment near the poles. The company has also developed an SAI simulator designed to enable non-specialists to understand and explore SAI, claiming that "*the scenarios we've run consistently show that SAI does have the potential to cool the planet*". This shows a clear bias towards SAI deployment, despite the company's stated aim being to equip the world with data and tools in order to make an informed decision.

The Degrees Initiative continues to prioritise research into SAI deployment

The **DE**veloping country **G**overnance **RE**search and **E**valuation for **S**RM (Degrees) Initiative's stated aim is to facilitate the participation of countries in the Global South in research relating to the deployment and governance of SRM. The Initiative is predominantly funded by foundations run by technology and finance billionaires based in the Global North, some of which also fund open-air experiments and the commercialisation of geoengineering technologies.

In 2024, Geoengineering Monitor published a briefing examining the Initiative's funding, research agenda, and

Global North bias. The information in this article serves as an update to that briefing, and reinforces its comprehensive findings.

Registered in the UK, the Initiative supports SRM research through two funds. The Degrees Modelling Fund (DMF) aims to investigate the impact of SRM on climate conditions in the Global South, whereas the Degrees Socio-Political Fund (SPF) aims to investigate the social and political implications of SRM in these regions. The Initiative is currently funding 35 research teams, including nine SPF teams, and has recently selected four new DMF research teams in Cabo Verde, Jordan, Morocco, and the Republic of the Congo, which are due to begin work in January 2026.

The DMF research teams predominantly model the deployment of SAI. Of the 54 peer-reviewed studies published by DMF teams at the time of writing, over 95% (52 studies) modelled SAI deployment. Twelve of these studies also modelled the G6solar scenario, which is a hypothetical SRM scenario involving a uniform decrease in incoming solar radiation to cool the planet. Of the remaining studies, two modelled space-based geoengineering, one modelled the deployment of marine cloud brightening, one modelled the effects of SRM on hydrological cycles, and another reviewed the potential climate impacts of SAI, MCB and CO_2 removal.

At first glance, the modelled impacts of SAI deployment appear to be diverse, and have included changes to the West African monsoon, cocoa production, malaria risk, marine heatwaves and storm track development. However, all of the modelling has ultimately followed the same structure:

- One or more climate models and IPCC climate scenarios were selected and used to compare how the climate scenario evolved with and without the use of SAI; high greenhouse gas emissions pathways were most frequently chosen, and a low emissions pathway has never been considered;
- The modelling analysed the influence of SAI on temperature and/or precipitation;
- Conclusions were drawn based on these temperature and precipitation trends, for example, on the impacts on cocoa cultivation, marine heatwaves or the conditions for the spread of malaria.

Of the 51 DMF-funded modelling studies that are based on IPCC climate scenarios, 44 are based on high to intermediate IPCC scenarios and 16 studies are based on the IPCC SSP5-8.5 climate scenario, which is the worst-case scenario with the highest greenhouse gas emissions. The most frequently chosen IPCC scenario, chosen 22 times, is RCP8.5, which assumes no mitigation efforts and a CO_2 concentration four times higher than pre-industrial levels. Best-case scenarios, such as the low greenhouse gas emissions scenarios SSP1-2.6 and RCP2.6, have never been used in DMF-funded modelling studies. Half of the DMF studies modelling SRM deployment are based solely on a worst-case climate scenario, in other words, the pathway with the highest greenhouse gas emissions and no climate mitigation action.

Scenarios with very high radiative forcing such as RCP8.5 and SSP5-8.5 lead to larger temperature increases and hence more significant climate impacts due to more severe changes in the climate system. The modelling results are therefore influenced by the choice of scenario, as higher temperatures increase the likelihood that the theoretical cooling effect of SRM techniques will be modelled more favorably.

Due to these factors, the IPCC climate scenario being used in the modelling studies should be communicated transparently, but this is not always the case. Only 26 of the 37 DMF-funded publications based on the RCP8.5 or SSP5-8.5 scenarios state in their abstracts which scenario is being used. This obscures the fact that the modelling does not represent the full range of IPCC climate scenarios, nor does it reflect the most likely scenarios or the path we are currently on. This may lead to a biased perception of SAI, whereby policymakers may view these studies as evidence that solar geoengineering is a viable alternative to urgent emissions reductions.

This flawed perception of SAI could be reinforced further by the fact that more recent Degrees publications are now referring to the results of earlier Degrees studies. However, in doing so they do not make it clear that these studies are largely based on worst-case scenarios.

The Degrees Initiative states that it is "*impartial on SRM: on whether it should ever be used and how it should be governed*". However, its approach to research and the way in which it presents the results of the research it funds plays a key role in normalising and legitimising solar geoengineering as a viable mitigation strategy. In doing so it is acting as a stepping stone to open-air SRM experiments. Further evidence of this is provided by the fact that the

Degrees Global Forum in Cape Town in 2025 focused largely on SAI deployment and deployment technologies.

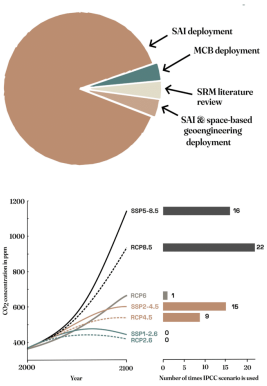

Figure 3: Top: Focus of the 54 Degrees Modelling Fund (DMF)-funded studies published as of October 2025. SRM = Solar Radiation Management, MCB = Marine Cloud Brightening, SAI = Stratospheric Aerosol Injection. Bottom: IPCC RCP and SSP climate scenarios and the number of times they are modelled in DMF studies. Source: Own research.

Publicly-funded SAI research is also increasing rapidly

The UK's Advanced Research and Innovation Agency (ARIA) has awarded funding to five SAI projects

ARIA is a UK government research funding agency. Its £57 million "Climate Cooling" research programme is funding research into a number of geoengineering technologies which have been covered in other articles in this series, including space-based schemes, solar geoengineering in the lower atmosphere such as MCB, and SAI. Five of the 22 research teams are investigating SAI-related issues:

- The PULSE project (Public Understanding, Leadership, and Social Ethics in the Governance of Earth Cooling Technologies in Communities Impacted by Volcanic Activity in the Philippine Context), is based at the University of the Philippines, Los Baños, has received £0.15 million and runs from 2025 to 2027. It aims to explore public opinion and ethical considerations relating to SAI and SRM, and to recommend governance structures for decision-making processes.
- The TRUSS project (Toward Robust and Unbiased validation of SAI Simulations), is based at the Institut Teknologi Sepuluh Nopember in Indonesia and has received £0.35 million. It runs from 2025 to 2028 and seeks to refine climate intervention models to enhance the reliability of SAI modelling outputs and impact assessments. Its aim is to quantify and reduce uncertainties in SAI simulations.
- Defining the minimum scale of an SAI test: a fundamental first step towards an outdoor large scale experiment, is a project based at Cornell University in the US which runs from July 2025 to July 2027, and has received £0.5 million. It aims to determine the scope of a field experiment that would be necessary to meaningfully limit uncertainties when deploying SO_2 from an aircraft, such as the movement of air plumes. To this end, a hypothetical experiment will be conducted that is as realistic as possible, enabling the conclusions to be applied to real-life scenarios.
- The StratoGuard project (Global Monitoring of Geoengineering using Micro High-Altitude Balloons), is being conducted by Voltitude Limited, in Farnborough, UK. It runs from 2025 to 2028 and has received £0.6 million. It aims to develop core technologies for a global sensor system for solar-powered micro-altitude balloons (mHABs), which will be deployed primarily in the stratosphere and is intended to serve as a basic monitoring tool for SRM. The project will demonstrate an optimised mHAB, incorporating technical developments such as the integration and demonstration of a particle counter probe.

- The Novel Materials for Stratospheric Aerosol Injection project is based at Cambridge University in the UK. It runs from June 2025 to June 2028 and has received £5.5 million. It aims to expand knowledge of various Alternative SAI Materials (ASAIMs) by combining field experiments, laboratory work and modelling. The chemical and optical properties of the particles will be investigated using stratospheric balloon and aeroplane flights, but no substances will be released into the stratosphere during these flights. The dispersion and dispersal of the aerosols will be measured in laboratory tests and the climate impact of the ASAIMs will be modelled.

In addition to these five SAI-focused projects, The Degrees Initiative has received £2 million in funding from ARIA for its GRID-CC (Global to Regional Impacts Downscaling for Climate Cooling) project. The project plans to create a freely accessible repository of detailed climate data for the Global South, which will be hosted at the University of Cape Town in South Africa. This data is intended to enable high-resolution climate projections to facilitate global and regional modelling. The impacts of SRM will be compared with those of climate change, with a focus on preventing tipping points. This kind of problematic risk-risk framing is discussed in other sections of this article.

The UK's Natural Environment Research Council (NERC) is funding a five-year study into the climate impacts of SAI and MCB

NERC's Marine CLOUD Brightening (MACLOUD) and Evaluation of Climate Intervention through novel Potential Strategies (ECLIPSE) research programmes aim to model the potential impacts of implementing SRM techniques on a large scale. The five-year programme runs from 2025 to 2030 and has a budget of £10.5 million and will not include field experiments. It will examine the climate impacts of SAI and MCB using natural analogues, such as volcanic eruptions and changes in shipping emissions, as well as reviewing existing data. It will also examine lesser-studied SRM techniques, including the use of cellulose nanocrystals for SAI. Project partners include the British universities of Birmingham, Cambridge, Edinburgh, Exeter, Leeds, Manchester, Oxford, Reading, andImperial College London, and the Center for International Climate and Environmental Research in Norway. The studies form part of NERC's Modelling environmental responses to SRM programme.

Research projects funded by the European Space Agency seek to minimise uncertainties in climate models

The Aerosol Cloud Interactions for Cooling (ACtIon4Cooling) project, funded by the European Space Agency (ESA), aims to assess the feasibility and risks of SRM, as well as providing input for governance, research and a potential deployment framework. To this end, the project seeks to improve the understanding of aerosol-cloud interactions (ACIs), thereby reducing uncertainties in climate models and enabling more accurate evaluation of SRM approaches, including SAI, Marine Cloud Brightening (MCB) and Cirrus Cloud Thinning (CCT). ACI investigations include satellite and ground-based observations and data acquisition, as well as the evaluation of measurements of volcanic aerosols, marine clouds affected by ship-track emissions and aviation-relevant cirrus clouds. This data will be processed to inform global and regional climate simulations. The results will also be used to facilitate "*the development of monitoring and attribution requirements for a dedicated SRM satellite mission"*. The project is led by the German Aerospace Center, in collaboration with the National Observatory of Athens in Greece and the University of Leipzig in Germany.

The Satellite and Model Data to Inform Solar Radiation Modification Techniques (STATISTICS) project is funded by the ESA and aims to improve the accuracy of climate models by combining climate modelling with satellite-based Earth observation. The project argues that most SRM studies rely on climate modelling and make limited use of real-world observations. STATISTICS deals with SAI, MCB, CCT and Mixed-phase Cloud Thinning. It investigates ACI by examining natural and anthropogenic analogues, such as volcanic eruptions and industrial emissions. The project's goal is to draw conclusions about the climatic impacts of SRM, such as SAI, by comparing observational studies with climate model results. The thinning of cirrus and mixed-phase clouds will be reassessed by comparing observational studies with climate model results. Furthermore, the verifiability of SRM field experiments and deployment based on natural analogues will be investigated. STATISTICS is led by GRASP SAS (Generalised Retrieval of Aerosol and Surface Properties) in France, in collaboration with the following institutions: CNRS-LOA (Laboratoire d'Optique Atmosphérique) and CNRS-IPSL (Institut Pierre-Simon Laplace) in France; the Max Planck Institute for Meteorology in Germany; the University of Oslo in Norway; the Davos Physical Meteorological Observatory and Perspectives Climate Research in Switzerland.

The STATISTICS project is collaborating with three EU-funded projects: CERTAINTY, CleanCloud and Co-CREATE. CERTAINTY aims to improve our understanding of the interactions between aerosols and clouds, and their impact on the Earth system. To this end, long-term satellite data will be evaluated to enhance forecast models and provide insights into climate mitigation and adaptation. The consortium has, among other things, examined the influence of dust on weather and climate, and modelled sea spray emissions from leads in the Arctic to map their influence on ACIs more accurately. CleanCloud also aims to enhance the understanding of ACIs, thereby improving short- and long-term climate predictions. The Co-CREATE project (Conditions for Responsible Research of SRM – Analysis, Co-Creation, and Ethos) aims to develop guidelines and principles to reduce uncertainties surrounding the conditions and governance arrangements of experimental SRM research. These guidelines and principles are intended to facilitate decision-making for the relevant authorities.

In June 2025, the STATISTICS and the ACtIon4Cooling project, both funded by the European Space Agency (ESA), conducted a workshop on SRM techniques and concluded that "*small-scale field experiments may eventually become necessary to resolve key scientific uncertainties that cannot be addressed by model experiments, natural analogues or laboratory studies alone*".

Tipping points as a driver for SRM research and deployment

The IPCC defines a tipping point as a threshold beyond which a system reorganizes itself and does not revert to its original state, even if the initial cause is removed. In the context of the climate system, the term refers to a critical threshold at which the climate changes from one stable state to another, either globally or regionally.

Examples of tipping points include thawing permafrost, which would release huge quantities of methane into the atmosphere, and the Amazon forest dieback, where precipitation levels reduce to the extent that the ecosystem is no longer able to sustain itself. The idea of avoiding tipping points is increasingly being used as an argument for further research into the deployment of SRM:

- The Global Tipping Point Report 2025, for example, recommends a moratorium on SRM deployment and large-scale experiments in order to assess both the risks and potential benefits of it. The report is published by the University of Exeter, whose work on solar geoengineering is supported by ARIA and the Quadrature Climate Foundation, among others.
- Reflective considers SAI to be an effective means of mitigating the impact of climate change and avoiding tipping points.
- Mengying Zhao, et al., researchers at Nanjing University and Zhejiang University in China, and at Cornell University in the US,claim that the SAI strategies they considered would mitigate the risks associated with many tipping elements. Their funders include the Quadrature Climate Foundation and the US National Science Foundation. The latter has supported SRM research, modelling and field trials for more than 15 years, including GLENS,GeoMIP,E-PEACE,VOCALS-REX, and SRM research at Rutgers University and the University of California.
- Mark Symes, one of ARIA's programme directors, said in an interview with The Guardian in April 2025, that "*the looming threat of climate tipping points was a strong reason to research solar geoengineering*".
- Gideon Futerman, et al., researchers from Great Britain, the USA and China, also cite the avoidance of tipping points as a key advantage of SRM and conclude that "*when temperature is a key driver of tipping, well-implemented, homogenous, peak-shaving SRM could be at least partially effective at reducing the risk of hitting most tipping points examined relative to the same emission pathway scenarios without SRM.*"

This line of reasoning is a form of "risk-risk" framing that geoengineering proponents seek to introduce into the political discourse surrounding SRM. In an attempt to normalise the discussion around the use of SRM, the risks of its deployment are increasingly being compared to the risks of reaching a tipping point. However, the risks being compared are often deliberately limited to those related to climate change. Deploying SRM would, however, entail a much broader range of environmental, social, economic and geopolitical challenges.

Robert E. Kopp, et al., researchers at the University of Bristol, "*critique the 'tipping point' framing for oversimplifying the diverse dynamics of complex natural and human systems and for conveying urgency without fostering a meaningful basis for climate action.*" They conclude that "*the deep uncertainty and perceived abstractness of climate tipping points render them ineffective for triggering action and setting governance goals.*"

Duncan P. McLaren published an article in the European Journal of Risk Regulation in which he discusses the risks associated with raising hopes that SRM can avert some of the otherwise unavoidable risks of climate change. He found that:

- "*most references to such* (risk-risk) *analysis appear primarily as rhetorical efforts to argue for continued SRM research*";
- "*a detailed review of the leading methodological proposal reveals serious practical and ethical shortcomings arising in both the framing and current methodologies of risk-risk analysis*";
- "*the shortcomings mean ethical questions are not resolved, interaction effects between possible responses are downplayed and other potential exceptional responses ignored*";
- He concludes that "*rather than identifying possible risk-superior pathways, in this case risk-tradeoff analysis – embedded in a technocratic risk management repertoire – seems likely to encourage excessive reliance on SRM.*

Leading African environmental body and youth organisations make their opposition to SRM clear

At the 20th African Ministerial Conference on the Environment (AMCEN-20) in July 2025, the rejection of SRM was reaffirmed. AMCEN-19 had called for a global governance mechanism to ensure the non-use of solar radiation management technologies. SRM was deemed unacceptable due to the significant ecological, ethical and geopolitical risks it poses. Not only did Africa's leading ministerial body for environmental issues make their opposition clear, but African youth did too. In October 2025, youth organisations across Africa working within climate justice networks, community development projects and research-based advocacy platforms clearly stated that they oppose SRM as a climate policy option because it directly threatens Africa's environmental and development interests, distracting the world from real, people-centred solutions and creating new threats with devastating consequences. Rather than gambling with planetary systems, these youth movements are calling for "*a science-grounded and justice-led redirection toward proven socio-technical pathways. These include community-owned renewable energy, agroecology for food sovereignty, climate-resilient water systems, and locally driven adaptation grounded in indigenous and traditional knowledge*".