

- mitigate the risks associated with SRM.
- Global collaboration: Efforts are being made to include researchers from the Global South (preferably referred to as The Global Majority) in SRM studies to ensure diverse perspectives and equitable consideration of impacts.
- Governance frameworks: Developing international guidelines and oversight mechanisms for SRM research and potential deployment.

GLOBAL GOVERNANCE & POLICY CHALLENGES

Current landscape

- No specific international laws govern SRM
- Discussions primarily occurring in academic and scientific forums
- Attempts have been made to address SRM at the United Nations Environment Assembly (UNEA), but no formal resolutions have been adopted

Challenges

- Lack of consensus on whether and how to proceed with research or potential deployment
- Differing perspectives between developed and developing nations
- Integrating SRM into existing climate change frameworks like the Paris Agreement

NEED FOR REGULATORY FRAMEWORKS

Research governance

- Guidelines for responsible conduct of experiments
- Protocols for sharing data and results internationally
- Mechanisms for science communication, public engagement and transparency

Risk management

- Liability and compensation mechanisms for potential negative impacts
- Insurance and indemnification policies for large-scale interventions
- Emergency response plans for unintended consequences

Ethical oversight

- Frameworks for addressing equity and justice concerns
- Processes for obtaining informed consent from affected populations
- Guidelines for balancing current and future generations' interests

Monitoring and enforcement

- Global system for monitoring atmospheric changes and impacts
- Mechanisms to ensure compliance with agreed-upon protocols
- Sanctions or consequences for unauthorized SRM activities

THE FUTURE OF SOLAR GEOENGINEERING

Research priorities

- Balancing research on different SRM approaches (e.g., SAI vs. MCB)
- Integrating social sciences and humanities into SRM research
- Increasing global research capacity, particularly in the Global South

Feasibility and effectiveness

- Assessing the technical feasibility of large-scale deployment
- Evaluating the potential effectiveness in mitigating climate change impacts
- Discussing the limitations and uncertainties of current models

Risk assessment

- Evaluating potential environmental and societal risks
- Developing methodologies for comprehensive risk analysis
- Debating acceptable levels of risk given the climate crisis
- Comparing risks of SRM implementation against risks of climate change without intervention

Ethical implications

- Discussing the moral aspects of intentionally altering the global climate
- Debating researchers' responsibilities in advancing potentially risky methods
- Considering the ethics of not pursuing SRM research given climate threats
- Ensuring equitable representation in decision-making processes

Governance challenges

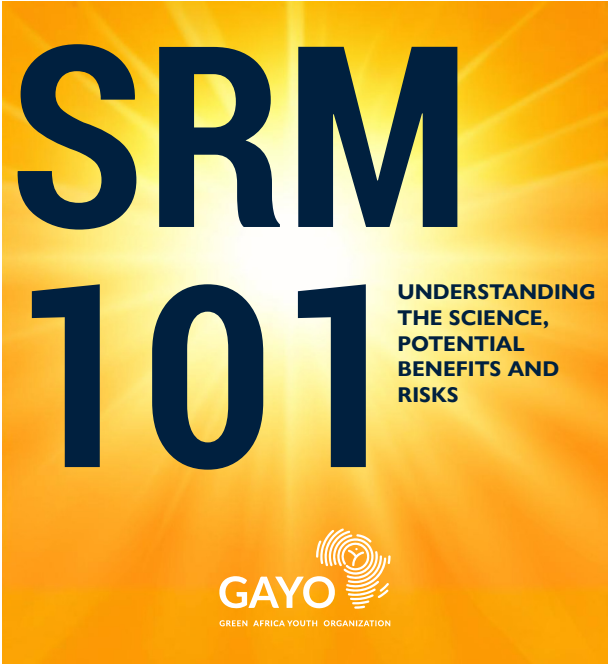
- Debating appropriate frameworks for international oversight
- Discussing how to ensure equitable decision-making and implementation
- Developing mechanisms for inclusive global participation in SRM governance

Future Directions

- Advocating for increased global research capacity, particularly in the Global South
- Promoting equity and inclusion in SRM research and governance discussions
- Developing interdisciplinary approaches to address the complex challenges of SRM
- Exploring potential synergies between SRM and other climate change mitigation strategies

Remember: Solar geoengineering is a rapidly evolving field. Always check for the most recent and peer-reviewed information.

Scan the QR code for further information



WHAT IS SOLAR RADIATION MANAGEMENT?

Solar Radiation Management (SRM), also known as Climate Intervention, refers to a proposed set of methods aimed at reducing global warming by reflecting a small portion of sunlight back into space. **This approach doesn't address the root cause of climate change—greenhouse gas emissions—but instead attempts to counteract some of its effects by altering the Earth's radiation balance.**

KEY APPROACHES

Stratospheric Aerosol Injection (SAI)	Marine Cloud Brightening (MCB)
Involves dispersing reflective particles into the stratosphere These particles form aerosols through chemical reactions Mimics the cooling effect of large volcanic eruptions Potentially the most effective and widely studied SRM technique	Proposes increasing the reflectivity of low-lying clouds over the ocean Achieved by spraying sea salt particles into the air, acting as cloud condensation nuclei Aims to make clouds whiter and more reflective

Cirrus Cloud Thinning	Space-Based Reflectors
Focuses on reducing high-altitude cirrus clouds that trap heat	Involves placing reflective structures in Earth's orbit
Could potentially allow more heat to escape into space	Would deflect a small percentage of incoming sunlight
Note: Unlike SAI and MCB, CCT doesn't provide cooling by enhancing reflectivity	Currently considered impractical due to high costs and technical challenges

HOW IT WORKS

SRM methods like SAI and MCB work on the principle of increasing Earth's albedo (reflectivity) to reduce the amount of solar radiation absorbed by the planet. The basic steps for these methods are:

- Intervention: Reflective particles or substances are introduced into the atmosphere or clouds.
- Reflection: These particles reflect a small fraction of incoming sunlight back into space.
- Reduced heat absorption: Less solar energy reaches and is absorbed by the Earth's surface.
- Cooling effect: The reduced absorption of solar energy leads to a cooling of the global temperature.

SAI mimics natural phenomena like volcanic eruptions, which can cause temporary global cooling by ejecting particles that form reflective aerosols in the stratosphere. MCB is inspired by the brightening of marine clouds that occurs due to their interaction with pollution particles emitted by ships.

Cirrus Cloud Thinning works differently, aiming to reduce the heat-trapping effect of high-altitude clouds rather than increasing reflectivity.

POTENTIAL GLOBAL COOLING EFFECTS

- Temperature reduction: Models suggest that well-implemented SRM could potentially lower global average temperatures by 0.3°C to 1.5°C, depending on the scale of deployment.
- Rapid action: Unlike greenhouse gas reduction, which takes decades to show effects, SRM could potentially produce cooling within months to a few years of implementation.
- Regional variations: The cooling effect may not be uniform globally. Some regions might experience more pronounced cooling than others.
- Impact on weather patterns: Altering the Earth's energy balance could affect precipitation patterns, wind systems, and other climate dynamics.
- Oceans and ice: Cooling could potentially slow sea level rise by reducing thermal expansion of oceans and slowing ice melt in polar regions. This might help preserve ice sources such as glaciers.
- Temporary nature: The cooling effect would likely be temporary, lasting only as long as the SRM efforts are maintained.

- Avoiding tipping points: Lower temperatures provided by SRM may help ecosystems avoid passing tipping points that would release large amounts of greenhouse gases into the atmosphere.

CURRENT RESEARCH

- SCoPEx (Stratospheric Controlled Perturbation Experiment)**
- Led by Harvard University researchers
 - Aims to release small amounts of calcium carbonate into the stratosphere
 - Currently in planning stages, with initial test flights focusing on equipment functionality
 - More information: (<https://www.keutschgroup.com/scopex>)
- SPICE (Stratospheric Particle Injection for Climate Engineering)**
- UK-based project that explored the feasibility of injecting particles into the stratosphere
 - Included plans for a balloon-and-hose experiment (canceled due to governance concerns)
 - Project details: (<http://www.spice.ac.uk/>)
- Marine Cloud Brightening Project**
- Based at the University of Washington, focusing on spraying sea salt to brighten clouds
 - Conducted small-scale land-based experiments in Monterey Bay, California
 - Notable for including Global South activists and researchers in their study design
 - Project website: (<https://atmos.uw.edu/faculty-and-research/marine-cloud-brightening-program/>)

- GeoMIP (Geoengineering Model Intercomparison Project)**
- International collaboration to assess impacts of SRM using climate models
 - Provides standardized experiments for consistent comparison across different models
 - More information:(<https://climate.envsci.rutgers.edu/GeoMIP/>)

POTENTIAL BENEFITS

- Quick temperature reduction: SRM could potentially lower global temperatures within months to years, much faster than emissions reduction strategies.
- Emergency response: Could be deployed as a rapid intervention in case of severe climate tipping points or unforeseen warming acceleration.
- Buying time: Might provide a temporary “cooling buffer” while long-term emissions reduction and carbon removal strategies take effect.
- Polar ice preservation: Rapid cooling could help slow the melting of Arctic sea ice and glaciers, potentially avoiding irreversible changes.

It's important to note that these benefits are based on theoretical models and limited experiments. The full global impact of large-scale implementation remains uncertain, and potential risks and side effects must be carefully considered alongside these potential benefits.

RISKS AND CONTROVERSIES

- Environmental concerns:
- Ozone depletion: Some proposed aerosols could potentially damage the ozone layer, increasing UV radiation at Earth's surface.
- Altered precipitation patterns: Changes in global temperature gradients could disrupt monsoon systems and regional rainfall patterns.
- Ocean acidification: While cooling the planet, SRM doesn't address rising CO2 levels, which would continue to acidify oceans.
- Ecosystem disruption: Rapid changes in temperature and sunlight could stress ecosystems adapted to current conditions.
- Unknown long-term effects: The full environmental impact of sustained SRM is difficult to predict and could lead to unforeseen consequences.

GEOPOLITICAL IMPLICATIONS

- Global governance challenges: Implementing and controlling SRM on a global scale would require unprecedented international cooperation.
- Potential for conflict: Disagreements over deployment, intensity, or uneven effects could lead to international tensions or conflicts.
- Unilateral action risks: A single nation or group might attempt to implement SRM without global consensus.
- Dependency and termination shock: If started, abrupt cessation of SRM could lead to rapid warming, potentially worse than if it had never been implemented.
- Disproportionate impacts: Effects may vary regionally, potentially benefiting some nations while harming others.

ETHICAL CONSIDERATIONS

- Moral hazard: The prospect of a “technical fix” might reduce motivation to cut greenhouse gas emissions.
- Intergenerational ethics: Implementing SRM commits future generations to its continued use or consequences of termination.
- Informed consent: It's challenging to obtain consent from all affected populations for a global intervention.
- Justice and equity: Questions arise about who decides to implement SRM and who bears the risks.
- Playing “God” with the climate: Some argue that intentionally altering the global climate crosses an ethical boundary.
- Dual-use concerns: Methods developed for SRM could potentially be weaponized.
- Risk-risk tradeoffs: Considering the ethics of not pursuing SRM research given the risks of climate change.

MITIGATING RISKS & ADDRESSING UNKNOWN

- Increased research capacity: There is a growing call for expanded research to better understand and potentially