

**Briefing Note on Solar Radiation Modification as addressed in the
Intergovernmental Panel on Climate Change Sixth Assessment Report
Working Group III: Mitigation of Climate Change**

The IPCC AR6 Working Group III (WG-III) reportⁱ published on 4th April 2022 focuses on climate change mitigation, assessing methods for reducing greenhouse gas emissions, and removing greenhouse gases from the atmosphere. This briefing summarizes how solar radiation modification (SRM) is addressed in the reportⁱⁱ (Part I) and identifies some key policy implications developed by C2G (Part II).ⁱⁱⁱ The final AR6 Synthesis Report, which will cover the findings of all three Working Group reports, is expected in September 2022.

Part I: Summary of key findings on SRM from the WG-III report

SRM and related information can be found in different parts of the [WG-III report](#) but was not included in the Summary for Policymakers. A detailed assessment of SRM approaches was included in Chapter 14 of the report in ‘Cross-Working Group Box 4: Solar Radiation Modification (SRM)’ and section ‘14.4.5.1 Global governance of solar radiation modification and associated risks’. SRM is also mentioned in the [Technical Summary](#). Part I includes extracts from these sources.

Technical Summary

The technical summary makes a reference to the failure of international cooperation to address transboundary issues associated with SRM.

“International cooperation will need to be strengthened in several key respects in order to support mitigation action consistent with limiting temperature rise to well below 2°C in the context of sustainable development and equity (high confidence). (...) International cooperation is emerging but so far fails to fully address transboundary issues associated with solar radiation modification and carbon dioxide removal.” {14.2, 14.3, 14.4, 14.5, 14.6, Cross-Working Group Box 4 in Chapter 14}

Underlying Scientific-Technical Assessment

The Scientific-Technical Assessment examines in some depth the potential risks and benefits of SRM as one possible climate response option, as well as related global governance considerations.

In Chapter 3, the section on sectoral emissions strategies and the timing of net zero explains that “in the context of mitigation pathways, only a few studies have examined solar radiation modification (SRM), typically focusing on Stratospheric Aerosol Injection. These studies find that substantial mitigation is required to limit warming to a given level, even if SRM is available. SRM may reduce some climate impacts, reduce peak temperatures, lower mitigation costs, and extend the time available to achieve mitigation; however, SRM does not address ocean acidification and may involve risks to crop yields, economies, human health, or ecosystems. There also are significant uncertainties surrounding SRM, including uncertainties on the costs and risks, which can substantially alter the amount of SRM used in modelled pathways. Furthermore, the degree of international cooperation can influence the amount of SRM deployed in scenarios, with uncoordinated action resulting in larger SRM deployment and consequently larger risks/impacts from SRM. Bridging research and governance involves consideration of the full range of societal choices and ramifications.”

Cross-Working Group Box 4: Solar Radiation Modification (SRM)

The cross-working group box (which is also included in the WGII report) “*assesses SRM proposals, their potential contribution to reducing or increasing climate risk, as well as other risks they may pose (categorised as risks from responses to climate change in the IPCC AR6 risk definition in 1.2.1.1), and related perception, ethics and governance questions.*” {CWGB SRM} The bullets below identify some key findings to illustrate the aspects being covered by Cross-Working Group Box 4 (with text in italics as direct quotes) {CWGB SRM}:

- *"SRM contrasts with climate change mitigation activities, such as emissions reductions and carbon dioxide removal, as it introduces a 'mask' to the climate change problem by altering the Earth's radiation budget, rather than addressing the root cause of the problem, which is the increase in greenhouse gas concentrations in the atmosphere" ... "There is high agreement in the literature that for addressing climate change risks SRM cannot be the main policy response to climate change and is, at best, a supplement to achieving sustained net zero or net negative CO₂ emission levels globally". (See more in box section on ‘Proposed Solar Radiation Modification Schemes’)*
- *"In the context of reaching the long-term global temperature goal of the Paris Agreement, there are different hypothetical scenarios of SRM deployment" presenting "different levels and distributions of SRM benefits, side effects." ... "If emissions reductions and CDR are deemed insufficient, SRM may be seen by some as the only option left to ensure the achievement of the Paris Agreement's temperature goal by 2100". (See more in box section ‘Which scenarios’)*
- Recent studies suggest that it is conceptually possible to meet multiple climate objectives through optimally designed SRM strategies. However, SRM approaches introduce a range of new risks to people and ecosystems, including risks to crops, human health, biodiversity, as well as risks for international collaboration and peace. Due in part to limited research, the risks to crop yields, economies, human health, or ecosystems are not well understood and large uncertainties and knowledge gaps are associated with the potential of solar radiation modification approaches to reduce climate change risks. (Content of this bullet was compiled from a number of paragraphs. For reference see box section ‘SRM risks to human and natural systems and potential for risk reduction’)
- *“Most studies [on public perception] have been limited to Western societies with some exceptions. Studies have repeatedly found that respondents are largely unaware of SRM.” (See more in box section ‘Public perception’)*
- *"There is concern that publicly debating, researching and potentially deploying SAI could involve a 'moral hazard', with potential to obstruct ongoing and future mitigation efforts, while empirical evidence is limited and mostly at the individual, not societal level" ... "There is low agreement whether research and outdoors experimentation will create a 'slippery slope' toward eventual deployment, leading to a lock-in to long-term SRM, or can be effectively regulated at a later stage to avoid undesirable outcomes" ... "SRM research has been conducted predominantly by a relatively small number of experts in the Global North, and that more can be done to enable participation from diverse peoples and geographies..." (See more in box section ‘Ethics’)*
- *"Currently, there is no dedicated, formal international SRM governance for research, development, demonstration, or deployment..." and "...the lack of robust and formal SRM governance poses risks." ... "Co-evolution of SRM governance and research provides a chance for responsibly developing SRM technologies with broader public participation and political legitimacy, guarding against potential risks and harms relevant across a full range of scenarios". (See more in box section ‘Governance of research and of deployment’).*

Chapter 14, section 14.4.5.1: Global governance of SRM and associated risks

Chapter 14 of the Working Group III report also includes a whole section dedicated to the global governance of SRM and associated risks.

- *“Solar Radiation Modification, in the literature also referred to as ‘solar geoengineering’, refers to the intentional modification of the Earth’s shortwave radiative budget, such as by increasing the reflection of sunlight back to space, with the aim of reducing warming. Several SRM options have been proposed, including Stratospheric Aerosol Injection (SAI), Marine Cloud Brightening (MCB), Ground-Based Albedo Modifications, and Ocean Albedo Change (OAC). SRM has been discussed as a potential response option within a broader climate risk management strategy, as a supplement to emissions reduction, carbon dioxide removal and adaptation, for example as a temporary measure to slow the rate of warming or address temperature overshoot. SRM assessments of potential benefits and risks still primarily rely on modelling efforts and their underlying scenario assumptions.”*
- *“Stratospheric aerosol intervention (SAI) – the most researched SRM method – poses significant international governance challenges since it could potentially be deployed uni- or minilaterally and alter the global mean temperature much faster than any other climate policy measure, at comparatively low direct costs. While being dependent on the design of deployment systems, both geophysical benefits and adverse effects would potentially be unevenly distributed. Perceived local harm could exacerbate geopolitical conflicts, not the least depending on which countries are part of a deployment coalition, but also because immediate attribution of climatic impacts to detected SAI deployment would not be possible. Uncoordinated or poorly researched deployment by a limited number of states, triggered by perceived climate emergencies, could create international tensions. An additional risk is that of rapid temperature rise following an abrupt end of SAI activities.”*
- *“While there is room for national and even sub-national governance of SAI – for example on research (differentiating indoor from open-air) and public engagement – international governance of SAI faces the challenge that comprehensive institutional architectures designed too far in advance could prove either too restrictive or too permissive in light of subsequent political, institutional, geophysical and technological developments. Views on governance encompass a broad range, from aiming to restrict to wanting to enable research and potentially deployment; in between these poles, other suggest authors stress the operationalization of the precautionary approach: preventing deployment until specific criteria regarding scientific consensus, impact assessments and governance issues are met. Many scholars suggest that governance arrangements ought to co-evolve with respective SRM technologies, including that it stay at least one step ahead of research, development, demonstration, and—potentially—deployment. With the modelling community’s increasing focus on showing that, and in what ways, SAI could help to minimise climate change impacts in the Global South, the SRM governance literature has come to include considerations of how SAI could contribute to global equity.”*
- *“Given that risks and potential benefits of SRM proposals differ substantially and their large-scale deployment is highly speculative, there is a wide array of concrete proposals for near-term anticipatory or adaptive governance. Numerous authors suggest a wide range of governance principles; encapsulate most of these in suggesting a list of four: (1) Guard against potential risks and harm; (2) Enable appropriate research and development of scientific knowledge; (3) Legitimise any future research or policymaking through active and informed public and expert community engagement; (4) Ensure that SRM is considered only as a part of a broader, mitigation-centred portfolio of responses to climate change. Regarding international institutionalisation, options range from formal integration into existing UN bodies like the UNFCCC or the Convention on Biological Diversity (CBD) to the creation of specific, but less formalised global fora to forms of club governance. Recent years have also seen the emergence of transnational non-state actors focusing on SRM governance, primarily expert networks and NGOs.”*
- *“Currently, there is no targeted international law relating to SRM, although some multilateral agreements—such as the Convention on Biological Diversity, the UN Convention on the Law of the*

Sea, the Environmental Modification Convention, or the Vienna Convention on the Protection of the Ozone Layer and its Montreal Protocol—contain provisions applicable to SRM.”

- Finally, Table 14.4 ‘Effects of international cooperation on sectoral mitigation efforts’ points to lack of cooperative mechanisms addressing risks and benefits of SRM and suggests “*there is room for international cooperation to more explicitly address transboundary issues associated with Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM).*”

Part II: C2G Analysis and Potential Policy Implications

This part presents potential issues arising from C2G’s analysis for consideration in relation to the governance^{iv} of solar radiation modification in light of the new findings presented in the IPCC AR6 WG-III report.

- **Knowledge gaps** – The report notes that while SRM may potentially be able to offset warming and alleviate some climate hazards as a supplement to the main climate response options (i.e., mitigation and adaptation) their potential to reduce risks or introduce novel risks remains poorly understood. **Policymakers may wish to consider whether and how to strengthen understanding and address knowledge gaps around SRM, to inform any potential considerations or decision making in the future while addressing issues related to moral hazard. Strengthening transdisciplinary knowledge of SRM risks and impacts could help inform risk-risk analysis to compare the relative risks of deploying – or not deploying - SRM in future scenarios in which the world exceeds or overshoots the agreed temperature goals or significant global climate tipping points.** Such comparative risk analysis may become increasingly important for policymakers. Such analysis could also provide important inputs for strengthening governance relating to SRM.
- **Governance of research** – The report highlights the growth, but current paucity, of SRM research and lack of formal international research governance, which are also contributing factors to, inter alia, the particular challenges concerning outdoor experiments where the distinction between research and deployment may be less clear. **Policymakers may wish to consider how more formal, dedicated international governance around such research may be important and how it could be implemented in practice, including how to best address the issue of moral hazard.** One potential approach highlighted in the report suggests to “*legitimise any future research or policymaking through active and informed public and expert community engagement [...and] ensure that SRM is considered only as a part of a broader, mitigation-centred portfolio of responses to climate change.*” **Policymakers may also wish to address concerns that researching SRM could distract, delay or downplay the critical need for transformative emission reductions, removals and adaptation (moral hazard of doing research). They may also wish to weigh these concerns against the risks of not knowing whether, or not, SRM might be scientifically, societally, operationally, and politically viable as a possible additional climate response option (moral hazard of not doing research).**
- **Governance gaps** – The report highlights the current lack of dedicated, formal international SRM governance for research, development, demonstration, or deployment. It also assesses that “*there is high agreement in the literature that for addressing climate change risks, SRM cannot be the main policy response to climate change and is, at best, a supplement to achieving sustained net zero or net negative CO₂ emission levels globally*”. With no comprehensive international frameworks to provide space to exchange views on; to learn about the risks, benefits, and governance challenges of; and eventually to enable decision-making about SRM, this leaves a governance vacuum that is itself a global risk. **Policymakers may wish to consider:**
 - a. **Whether, how and where to organize the needed inclusive, transparent, global discussions so that countries can together assess and then decide whether or not the risks and benefits of using SRM outweigh the risks and benefits of not using it;**

- b. **Whether and how the world might minimize risks (both known and unknown) and maximize gains related to any potential use of SRM; and,**
 - c. **Whether and how to deal with the implications of including – or excluding – SRM from the list of potential responses to manage climate risks.**
- **Societal appraisal** – Inclusive discussions with globally diverse audiences, including the voices and views of climate-vulnerable communities and drawing on multiple disciplines, could help to address the high level of complexity associated with any policy position on SRM. In addition, such discussions could improve understanding of varying levels of risk tolerance and build a greater common understanding of the evidence base. **Policymakers may wish to consider whether and how to encourage and support such activities.**
 - **Multilateral discussions**, such as within the UN, could raise awareness and broaden understanding of the potential role of SRM – if any – as part of climate response options. Global discussions, knowledge sharing and reviews of SRM by processes like the UN Environment Assembly as well as assessments of the latest science by the IPCC could be helpful. An initial consideration by the UN General Assembly could provide high level guidance to multilateral discussions and identify follow-up actions to enhance the understanding of the role – if any – SRM could play in addressing scenarios in which global temperatures exceeded (overshoot) agreed temperature goals or climate-induced global tipping points. **Policymakers may wish to consider whether and how to advance consideration of these issues in relevant intergovernmental processes and fora both informally as well as formally.**

*Further information on SRM and the IPCC reports is available on the C2G website at:
<https://www.c2g2.net/intergovernmental-panel-on-climate-change/>*

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ⁱ See: https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_FullReport.pdf

ⁱⁱ A separate briefing note on how SRM is addressed in the WG-I and WG-II reports are available from the C2G website here: <https://www.c2g2.net/intergovernmental-panel-on-climate-change/>

ⁱⁱⁱ More detailed information about emerging approaches to altering the climate and their governance is available on the C2G website: www.c2g2.net in addition, the [C2G Glossary](#) may provide useful information for those new to this topic.

^{iv} A comprehensive and inclusive concept of the full range of means for deciding, managing, implementing, and monitoring policies and measures ([IPCC SR15 Glossary](#), p550).