

Briefing note on Solar Radiation Modification

What does the Intergovernmental Panel on Climate Change (IPCC) tell us?

Key Messages

- According to the Intergovernmental Panel on Climate Change's (IPCC) most recent sixth assessment (AR6), the current speed and scale of global emissions reductions, removals and adaptation efforts is now almost certainly insufficient for meeting the Paris Agreement temperature goal of 1.5–2°C.
- An important new insight in AR6 was that even with the most rapid and deep efforts resulting in the lowest greenhouse gas emission scenarios, it is now more likely than not that global warming will exceed 1.5°C.
- In addition to deep and rapid climate mitigation and adaptation efforts, an additional approach – known as solar radiation modification (SRM) – is being explored to temporarily limit global warming by enhancing the Earth's reflectivity. Researching, developing, or potentially deploying SRM poses multiple potential risks – both known and unknown – as well as benefits. However, overshooting the Paris Agreement temperature goals also entails risks for both humanity and the ecosystems we depend on for survival.
- There is currently no dedicated, formal international framework or fora to guide and connect governance processes for SRM research, development, demonstration, or deployment. The absence of such governance poses risks given, for example, that SRM would affect every country on the planet, but not necessarily equally.
- The IPCC, at the request of governments, assessed what is currently known about SRM and its governance and this was presented in the AR6 reports published in 2021/22.

Context

- Our planet is getting hotter and human-induced climate change has already caused widespread adverse impacts and poses additional severe risks if global warming exceeds 1.5°C.¹
- Inadequate progress in reducing global greenhouse gases means that even with the deepest emissions reductions and removals scenarios assessed by the IPCC, it is now more likely than not that warming will exceed 1.5°C.² Almost half the people on the planet (and the ecosystems on which life depends) are already highly vulnerable to climate change³ and despite some progress with adaptation, many gaps exist⁴ and adaptation will reach limits with increased warming.⁵
- In addition to the primary focus on deep and rapid climate mitigation and adaptation, another approach – known as solar radiation modification (SRM) – is being explored to temporarily limit global warming (for example, if 1.5°C is exceeded), by enhancing the Earth's reflectivity.⁶ SRM is coming under increasing scientific and public scrutiny. Further research could help contribute to a better understanding of the relative risks - with or without SRM - in a rapidly warming world. Some governments and non-state actors are investing into SRM research⁷.

What does the IPCC tell us about Solar Radiation Modification (SRM)?

- The IPCC is the United Nations body responsible for providing policymakers with regular assessments of the science of human-induced climate change. The IPCC convened its first expert meeting covering SRM over a decade ago.⁸ It was subsequently assessed in the IPCC's fifth assessment (AR5)⁹ and a special report on 1.5°C Global Warming.¹⁰ The IPCC's most recent, sixth assessment (AR6), involved over 780 authors, was reviewed and approved by governments and presented in reports published in 2021/22 by each of the IPCC's three Working Groups.¹¹ At the request of governments, AR6 also assessed the research and science relating to SRM, including its governance.
- AR6 assessed how the climate would respond to five illustrative future emissions scenarios resulting in global levels of greenhouse gas emissions ranging from very high to very low. In the near term (2021-2040) global warming levels of 1.5°C were assessed to be very likely (>90% chance) to be exceeded in the very high emissions scenario and likely (>66% chance) in the high and intermediate emissions scenarios. Warming of 1.5°C was assessed as more likely than not (>50% chance) to be exceeded in the low emissions scenario, and more likely than not (>50% chance) to be reached even in the very low emission scenario, followed by overshoot and then a return below 1.5°C toward the end of the Century.¹² Consequently, the faster and deeper international emissions reduction and removal efforts are undertaken, the less pressure there will be in the future for potentially risky new approaches such as SRM.
- According to the IPCC, addressing climate change risks cannot rely on SRM as the main policy response to climate change. SRM is, at best, a supplement to achieving, globally, sustained net zero or net negative CO₂ emission levels.¹³ SRM contrasts with climate change mitigation activities, such as emission reductions and removals, as it introduces a 'mask' to the climate change problem – by seeking to reflect sunlight back into space to reduce temperatures – rather than attempting to address the root cause, which is the increase in greenhouse gases in the atmosphere.¹⁴
- Some responses to climate change that are intended to reduce risks can result in new impacts and risks, including risks from maladaptation and adverse side effects of some emissions reduction and carbon dioxide removal measures.¹⁵
- While SRM approaches have the potential to offset warming and reduce some climate hazards, there are large uncertainties and knowledge gaps around their potential to reduce climate change risks (i.e., the potential adverse consequences resulting from the combination of climate hazards, exposure and vulnerability). In addition, if SRM were to be implemented, it would introduce a widespread range of new risks to people and ecosystems, which are not well understood.^{16,17}
- Different hypothetical scenarios of SRM deployment presents different levels and distributions of SRM benefits, side effects and risks.¹⁸ The more SRM deployed, the larger is the likelihood for the risks of side effects and environmental risks, which differ depending on the SRM option deployed.¹⁹
- Stratospheric aerosol injection– the most researched SRM method – poses significant international governance challenges since it could potentially be deployed uni- or mini-laterally and alter the global mean temperature much faster than any other climate policy measure, at comparatively low direct costs.²⁰
- Currently, there is no dedicated, formal international SRM governance for research, development, demonstration, or deployment. Some multilateral agreements exist that indirectly and partially cover SRM, but none is comprehensive. The lack of SRM governance poses risks.²¹

Notes and references

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- ¹ IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Available from: www.ipcc.ch/report/ar6/wg2/
- ² In the very low emissions scenario, the IPCC assess that it is more likely than not (>50% chance) that global surface temperature would decline back to below 1.5°C toward the end of the 21st century, with a temporary overshoot of no more than 0.1°C above 1.5°C global warming. See: IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3–32. Available from: <https://www.ipcc.ch/report/ar6/wg1/> (SPM B.1.3)
- ³ IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Available from: www.ipcc.ch/report/ar6/wg2/ (SPM B.2)
- ⁴ IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Available from: www.ipcc.ch/report/ar6/wg2/ (SPM C.1) See also: UNEP Adaptation Gap Report (2021) <https://www.unep.org/resources/adaptation-gap-report-2021>
- ⁵ IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Available from: www.ipcc.ch/report/ar6/wg2/ (SPM C.3)
- ⁶ SRM refers to proposals to increase the reflection of shortwave radiation (sunlight) back to space to counteract anthropogenic warming and some of its harmful impacts. A number of SRM options have been proposed, including: Stratospheric Aerosol Injection (SAI), Marine Cloud Brightening (MCB), Ground-Based Albedo Modifications (GBAM), and Ocean Albedo Change (OAC). For more detail, see: IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).
- ⁷ C2G (2022). Status of global activities relating to solar radiation modification and its governance. 17 May 2022. Carnegie Climate Governance Initiative (C2G). Carnegie Council for Ethics in International Affairs. New York. Available from: https://bit.ly/GlobalSRM_TB (Accessed on: 07 July 2022).
- ⁸ IPCC (2012). Meeting Report of the Intergovernmental Panel on Climate Change Expert Meeting on Geoengineering [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, C. Field, V. Barros, T.F. Stocker, Q. Dahe, J. Minx, K. Mach, G.-K. Plattner, S. Schlömer, G. Hansen, M. Mastrandrea (eds.)]. IPCC Working Group III Technical Support Unit, Potsdam Institute for Climate Impact Research, Potsdam, Germany, pp. 99 https://archive.ipcc.ch/pdf/supporting-material/EM_GeoE_Meeting_Report_final.pdf
- ⁹ IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. <https://www.ipcc.ch/assessment-report/ar5/>
- ¹⁰ IPCC (2018). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press. <https://www.ipcc.ch/sr15/>
- ¹¹ IPCC (2021). Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Available from: www.ipcc.ch/report/ar6/
- ¹² IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY. pp.3–32. Available from: <https://www.ipcc.ch/report/ar6/wg1/> (SPM B.1.3)

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- ¹³ IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).
- ¹⁴ IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).
- ¹⁵ IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Available from: www.ipcc.ch/report/ar6/wg2/ (SPM B.5)
- ¹⁶ IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Available from: www.ipcc.ch/report/ar6/wg2/ (SPM B.2)
- ¹⁷ Although there have been hundreds of climate modelling studies that have simulated the effects of SRM on climate hazards, many fewer studies have examined SRM risks – the potential adverse consequences to people and ecosystems from the combination of climate hazards, exposure and vulnerability – or the potential for SRM to reduce risk. It is also important to note that assessments of potential benefits and risks of SRM still primarily rely on computer modelling and their underlying scenario assumptions. See: IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).
- ¹⁸ IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).
- ¹⁹ IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).
- ²⁰ IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).
- ²¹ IPCC (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: www.ipcc.ch/report/ar6/wg3/ (Chapter 14 Cross Working Group Box 4).

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