Solar Geoengineering: Protecting Democratic Deliberations in a Contested Information Environment

Trish Lavery

Keywords—*climate interventions, stratospheric aerosol injection, solar radiation modification, hybrid threat, strategic communication, NATO, disinformation, foreign information manipulation and interference (FIMI)*

About the Author
Dr Trish Lavery is an internationally recognised academic and policy leader who integrates futures thinking, behavioural psychology, and structured analytic techniques into the design of future-ready and resilient policy and communication strategies. Trish has led significant projects on disinformation in both domestic and international contexts, including during her time as Strategic Foresight Counsellor and Senior Strategic Analyst at the OECD, and as part of her role as Senior Fellow of Futures and Human Behaviour at the Sympodium Institute of Strategic Communications. She is currently on secondment from Australia's Department of the Prime Minister and Cabinet to the National Security College, Australia, where she is working on an international project that examines possible futures of decision-making pathways for the governance of solar geoengineering.

Abstract
Solar geoengineering interventions are designed to reflect sunlight and reduce the impacts of climate change. These are attracting increased

DOI 10.30966/2018.RIGA.16.3

research and policy attention while simultaneously being targets for disinformation campaigns and conspiracy theories. The technical complexity, scientific uncertainties, and governance controversies of climate cooling technologies create ideal conditions for information manipulation, making them vulnerable to exploitation by malign actors. Influence operators have already demonstrated sophisticated capabilities in exploiting weather modification and climate change narratives for strategic advantage. This establishes a precedent that could see solar geoengineering disinformation used as a hybrid threat and an inevitable focus of future influence campaigns. This article analyses the implications of solar geoengineering disinformation, demonstrates how malign actors could exploit scientific and governance uncertainty for geopolitical advantage, and introduces a strategic communications framework to guide policymakers, researchers, and communications professionals on mechanisms to preserve space for rational deliberation on these technologies. The goal of the framework is not to promote or discourage solar geoengineering research or deployment but to protect the conditions necessary for informed democratic debate. The disinformation threat considered here does not arise from adversary opposition to (or support for) solar radiation modification per se, but rather from campaigns designed to prevent conditions necessary for evidence-informed debate and democratic choice. The capacity for evidence-based deliberation about climate cooling represents a crucial test of democratic resilience in contested information environments.

Introduction

This article examines a critical challenge for twenty-first-century democratic governance, namely, how societies can maintain evidence-based deliberation about planetary-scale technologies when adversaries can exploit information environments to prevent rational consideration of options. Solar geoengineering interventions are technologies designed to reflect sunlight to reduce global temperatures. They are attracting

DOI 10.30966/2018.RIGA.16.3

increased research and policy attention at the same time as being targets for disinformation campaigns and conspiracy theories.[1] These technologies have distinct characteristics that make them vulnerable to disinformation. They involve a planetary-scale intervention that would need to be maintained for many decades, with global consequences, uncertain risks, and implications for international relations. Consider a glimpse of how a geoengineering future might unfold.

A glimpse into a plausible future

The transformation starts in markets, not ministries. A late summer cluster of extreme weather events: a heat dome over western North America, an Atlantic hurricane, Mediterranean wildfires, and widespread European floods. The destruction pushes aggregate losses far beyond that which existing models treated as plausible. Primary insurers struggle and when reinsurers signal distress, panic is triggered across the insurance sector. Credit ratings are cut. To meet regulatory capital requirements and reassure investors, insurers and reinsurers sell huge volumes of government and corporate bonds. This pushes bond prices down and borrowing costs up across the economy. Contagion ripples across the economy, threatening to disrupt modern life. Overnight, the opinion polls flip: a public that yesterday prioritised maintaining their standard of living now demands urgent, dramatic climate action. As governments scramble to update policy, a coalition of like-minded countries signals its intent to accelerate the development of a solar geoengineering capability, to rapidly reduce global temperatures. Opposed adversarial states leverage the opportunity to ignite disharmony, seeking both to disrupt the geoengineering consensus and gain general geopolitical advantage. They inflame existing 'chemtrail' conspiracy theories, to seed doubt about the motives of the 'elites' poised to develop solar geoengineering capacity. Public protests erupt, with societies divided between those that want rapid climate relief and those that see geoengineering development as a ploy by elites to gain global control.

1 J.L. Reynolds, *The Governance of Solar Geoengineering: Managing Climate Change in the Anthropocene* (Cambridge University Press, 2019).

DOI 10.30966/2018.RIGA.16.3

The story above is fictional but is provided to challenge conventional assumptions about how policy debates evolve. As government interest in solar geoengineering grows, one might have assumed that knowledge about these technologies will develop gradually, allowing ample time for deliberative processes, stakeholder consultation, and careful consideration of options. However, we live in the times of the 'polycrisis', where there is a tendency for disparate crises, such as those associated with climate change and the proliferation of disinformation, to interact simultaneously and cause impacts far exceeding what might be expected from each disruption individually.[2] Concurrent crises can cause a rapid cascade of events that compress decision-making timelines, raising the risk of knee-jerk policies. Such periods of disruption increase the probability that disinformation could be more influential than empirical evidence in influencing rapid policy decisions.

The possibility that the world might experience the type of concurrent dramatic climate events outlined above is unfortunately plausible.[3] Climate change is intensifying and will cause devastating suffering worldwide in the coming decades. Despite global efforts toward clean energy transformation, atmospheric CO_2 emissions continue at record levels.[4] The year 2024 marked the first time that annual average global temperatures had exceeded 1.5 °C above pre-industrial baselines.[5] If current pledges to reduce emissions are adhered to, warming will approach 3 °C by 2100,[6] generating catastrophic human suffering and profound disruptions to global environmental and economic stability.

2 Adam Tooze, interview, 'This Is Why "Polycrisis" Is a Useful Way of Looking at the World Right Now', *World Economic Forum*, 7 March 2023. www.weforum.org/stories/2023/03/polycrisis-adam-tooze-historian-explains.

3 K.L. Ebi, 'Understanding the risks of compound climate events and cascading risks', *Dialogues on Climate Change 2,* Nº 1 (2024): 33–37. https://doi.org/10.1177/29768659241304857.

4 IEA, *World Energy Investment 2024* (Paris: IEA, 2024). www.iea.org/reports/world-energy-investment-2024.

5 World Meteorological Organization, 'WMO Confirms 2024 as Warmest Year on Record at about 1.55°C above Pre-Industrial Level', *WMO*, 10 January 2025. https://wmo.int/news/media-centre/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level.

6 United Nations Environment Programme, Emissions *Gap Report 2024: No More Hot Air … Please! With a Massive Gap between Rhetoric and Reality, Countries Draft New Climate Commitments* (Nairobi, 2024). https://doi.org/10.59117/20.500.11822/46404.

DOI 10.30966/2018.RIGA.16.3

These uncomfortable realities are creating pressure for policymakers to consider previously unthinkable interventions such as solar geoengineering. Decisions on solar geoengineering use or non-use should involve input from diverse stakeholders as part of an informed, evidence-driven democratic deliberation that can weigh complex trade-offs and tensions without succumbing to either panic or paralysis. Enabling an evidence-based debate will require the protection of these deliberations from disinformation campaigns designed to sow discord, obscure agreed facts, and undermine policy action.

This article presents a framework for preserving conditions necessary for informed democratic debate on climate cooling technologies. It draws on strategic communications theory and what is known about documented adversarial information operations to suggest actionable steps to protect deliberative space. The next section provides a brief background about solar geoengineering as an emerging technology. This is followed by an analysis of the strategic objectives and established practices that are used by adversaries to create disinformation campaigns about climate change and weather modification, and then by an examination of how disinformation techniques from adversary playbooks can be used to anticipate the communication vulnerabilities of solar geoengineering. Finally, a strategic communications framework to protect deliberative space on climate cooling technologies is presented.

Solar Geoengineering and the Challenge of Democratic Deliberation

Solar geoengineering interventions such as stratospheric aerosol injection (SAI: see 'Understanding stratospheric aerosol injection' below) are attracting increased political attention.[7] SAI remains deeply controversial across scientific, political, and civil society communities.[8] SAI involves a

7 T. Parson, 'The Politics of Geoengineering Are Getting Stranger', *Legal Planet*, 30 April 2025. https://legal-planet.org/2025/04/30/the-politics-of-geoengineering-are-getting-stranger.

8 Ibid.

DOI 10.30966/2018.RIGA.16.3

planetary-scale intervention with global consequences, uncertain risks, and implications for international relations. Its deployment would need to be maintained consistently for decades or even a century to prevent the risks of sudden cessation (termination shock).[9] All nations would be affected by SAI deployment, but not necessarily equally, or even with the same direction of effect.[10] Regional climate responses might vary, and attributing any effects to SAI directly (as opposed to natural climate variation) would be challenging.[11]

Understanding stratospheric aerosol injection

Solar geoengineering, sometimes called solar radiation modification (SRM), refers to purposeful, large-scale actions to reduce incoming solar radiation as a way of decreasing global temperatures.[12] SAI is one method of SRM that involves adding minute particles to the stratosphere to reflect some portion of sunlight back to space. It is not a solution to climate change. It does not address the underlying causes of global warming, nor fix the problem of rising atmospheric CO_2 concentrations. It would, however, work quickly (within months) to reduce global temperatures.[13] This makes SAI unique among other climate policy levers because alternatives to SAI require decades to have a meaningful impact. For this reason, SAI may be the only policy lever that might lend itself to a climate crisis response.[14]

9 A. Parker and P.J. Irvine, 'The Risk of Termination Shock from Solar Geoengineering', *Earth's Future* 6, Nº 3 (2018): 456–67. https://doi.org/10.1002/2017EF000735.

10 D.G. MacMartin, P.J. Irvine, B. Kravitz and J.B. Horton, 'Technical Characteristics of a Solar Geoengineering Deployment and Implications for Governance', *Climate Policy* 19, Nº 10 (2019): 1325–39. https://doi.org/10.1080/14693062.2019.1668347.

11 E.M. Bednarz, A.H. Butler, D. Visioni, Y. Zhang, B. Kravitz and D.G. MacMartin, 'Injection Strategy—A Driver of Atmospheric Circulation and Ozone Response to Stratospheric Aerosol Geoengineering', *Atmospheric Chemistry and Physics* 23, Nº 21 (2023): 13665–84. https://doi.org/10.5194/acp-23-13665-2023; MacMartin et al., 'Technical Characteristics of a Solar Geoengineering Deployment'.

12 Royal Society, *Solar Radiation Modification*, Policy Briefing (Royal Society, 2025). https://royalsociety.org/-/media/policy/projects/solar-radiation-modification/solar-radiation-modification-policy-briefing.pdf.

13 Wake Smith, 'The Cost of Stratospheric Aerosol Injection through 2100', *Environmental Research Letters* 15, Nº 11 (2020). https://doi.org/10.1088/1748-9326/aba7e7.

14 White House Office of Science and Technology Policy, *Congressionally Mandated Research Plan and an Initial Research Governance Framework Related to Solar Radiation Modification*, 30 June 2023. https://bidenwhitehouse.archives.gov/ostp/news-updates/2023/06/30/congressionally-mandated-report-on-solar-radiation-modification [accessed 12 October 2025].

DOI 10.30966/2018.RIGA.16.3

> SAI cannot be implemented in a way that its effects are felt only at a regional or local scale; it is a global process that would impact everyone on earth.[15] Research funding for solar geoengineering has increased in recent years. Annual funding exceeded US $30 million in 2023 and 2024, with a further $164.7 million already committed for 2025–2029 research. Commercial investment is increasing.[16] Alongside this funding growth is an increase in political and public attention. Since 2023, scientific assessments or governance or ethics reviews have been completed by UNEP,[17] the US White House,[18] the EU Commission,[19] UNESCO.[20] and the Royal Society.[21] There is growing recognition that SAI requires international governance. Despite this, deep divisions remain over whether to pursue scientific assessment, research, or non-use agreements, a disharmony that can easily be exploited by those looking to sow discord.

The combination of SAI's potential effectiveness, rapid deployment capability, and significant knowledge limitations[22] creates profound communication challenges that adversaries can readily exploit through disinformation campaigns. These efforts can target scientific uncertainty, governance gaps, and public anxieties about technological overreach. Policymaker and citizen debate on solar geoengineering will occur in an information environment already characterised by declining trust in

15 IPCC, *Climate Change 2021: The Physical Science Basis. Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, 2021), ch. 4. www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_FullReport.pdf.

16 SRM360, 'SRM Funding Overview', 14 May 2025. https://srm360.org/article/srm-funding-overview [accessed 12 October 2025].

17 United Nations Environment Programme, *One Atmosphere: An Independent Expert Review on Solar Radiation Modification Research and Deployment*, 28 February 2023. https://wedocs.unep.org/handle/20.500.11822/41903.

18 White House Office of Science and Technology Policy, *Congressionally Mandated Research Plan.*

19 Scientific Advice Mechanism to the European Commission, *Solar Radiation Modification: Evidence Review Report* (Brussels: European Commission, and 2024). https://doi.org/10.5281/zenodo.14283096.

20 World Commission on the Ethics of Scientific Knowledge and Technology, *Report of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) on the Ethics of Climate Engineering* (Paris: UNESCO, 28 November 2023). https://unesdoc.unesco.org/ark:/48223/pf0000386677.

21 Royal Society, *Solar Radiation Modification*.

22 J.M. Haywood, O. Boucher, C. Lennard, T. Storelvmo, S. Tilmes, and D. Visioni, 'World Climate Research Program Lighthouse Activity: An Assessment of Major Research Gaps in Solar Radiation Modification Research', *Frontiers in Climate* 7 (2025). http://doi.org/10.3389/fclim.2025.1507479.

DOI 10.30966/2018.RIGA.16.3

expertise,[23] political polarisation and a lack of confidence in democracy,[24] and sophisticated and widespread manipulation techniques.[25]

Most policymakers, stakeholders, and citizens have little knowledge of solar geoengineering.[26] However, recent research shows that 20 per cent of Americans believe that geoengineering is already happening[27] and conspiratorial content comprised approximately 60 per cent of geoengineering social media discourse by 2016,[28] suggesting those who are familiar with geoengineering may have developed that familiarity through conspiracy theorists, rather than via engagement with scientific discourse (Figure 1).[29]

23 G. Gauchat, 'Politicization of Science in the Public Sphere: A Study of Public Trust in the United States, 1974 to 2010', *American Sociological Review* 77, Nº 2 (2012): 167–87, https://doi.org/10.1177/0003122412438225; Martin Thunert, 'Waning Trust in (Scientific) Experts and Expertise?', in: *Authority and Trust in US Culture and Society: Interdisciplinary Approaches and Perspectives*, ed. Günter Leypoldt and Manfred Berg (Bielefeld: transcript, 2021). www.transcript-open.de/isbn/5189.

24 Gabriel R. Sanchez and Keesha Middlemass, 'Misinformation Is Eroding the Public's Confidence in Democracy', *Brookings Institution*, 26 July 2022, www.brookings.edu/articles/misinformation-is-eroding-the-publics-confidence-in-democracy; Alistair Cole, Ian Stafford, and Dominic Heinz, 'Democratic Decline? Civil Society and Trust in Government', in *Civil Society in an Age of Uncertainty, ed. Paul Chaney and Ian Rees Jones* (Policy Press, 2022), pp. 133–62, www.cambridge.org/core/books/abs/civil-society-in-an-age-of-uncertainty/democratic-decline-civil-society-and-trust-in-government/90E61CD3F299E0FBED29C00269949B7D.

25 B. Kennedy, A. Tyson, and C. Funk, *Americans' Trust in Scientists, Positive Views of Science Continue to Decline*, Pew Research Center, 14 November 2023, www.pewresearch.org/science/2023/11/14/americans-trust-in-scientists-positive-views-of-science-continue-to-decline; S. Lecheler and J.L. Egelhofer, 'Disinformation, Misinformation, and Fake News: Understanding the Supply Side', in *Knowledge Resistance in High-Choice Information Environments*, ed. Jesper Strömbäck, Åsa Wikforss, Kathrin Glüer, Torun Lindholm, and Henrik Oscarsson (Routledge, 2022), pp. 69–87.

26 K.T. Raimi, 'Public Perceptions of Geoengineering', *Current Opinion in Psychology* 42 (2021): 66–70. https://doi.org/10.1016/j.copsyc.2021.03.012.

27 H.J. Buck, P. Shah, J.Z. Yang, et al., 'Public Concerns about Solar Geoengineering Research in the United States'. Communications Earth & Environment 6 (2025): Nº 609. https://doi.org/10.1038/s43247-025-02595-5.

28 D. Tingley and G. Wagner, 'Solar Geoengineering and the Chemtrails Conspiracy on Social Media', *Palgrave Communications* 3 (2017): Nº 12. https://doi.org/10.1057/s41599-017-0014-3.

29 R. Debnath, R. Bardhan, S. Darby, K. Mohaddes, A. Coelho, O. Olufolajimi, D.A. Nguyen, F. Faturay, J. Malik, F. Mehmood, A. Mazzone, P. Manandhar, D.A. Quansah, P. Cox, I. Stone, Y. Xiao, C.M. Kayanan, S. Khalid, R. Khosla, and P. Ruyssenaars, 'Conspiracy Spillovers and Geoengineering', *iScience* 26, Nº 3 (2023): 106166. https://doi.org/10.1016/j.isci.2023.106166.

DOI 10.30966/2018.RIGA.16.3

Figure 1. Former representative Majorie Taylor Greene's social media post celebrating a ban on solar geoengineering research demonstrates the possibility that atmospheric intervention technologies may become subjects of political polarisation rather than evidence-based deliberation. *Source*: Majorie Taylor Greene (@mtgreenee), 'Florida passes geoengineering and weather modification ban!! Way to go!!', X, 1 May 2025, https://x.com/mtgreenee/status/1917890758046261405?s=46&t=yn4BhTih7iZhslkb05lYkg.

The information environment is further complicated by what Buck describes as 'para-environmentalism',[30] beliefs about ongoing atmospheric modification that are rooted in legitimate environmental concerns, but lack the empirical foundations and institutional legitimacy required to critically analyse information. These beliefs connect solar geoengineering to broader anxieties about corporate power, governmental transparency,

30 Buck et al., 'Public Concerns'.

DOI 10.30966/2018.RIGA.16.3

and environmental degradation, creating communication challenges that cannot be resolved through technical information alone, because they are an expression of an underlying world view.[31] The substantial uncertainty and legitimate fear around solar geoengineering, and the existence of both disinformation and conspiracy theories, create opportunities for malign actors to shape public understanding before factual knowledge has been developed (Figure 2).

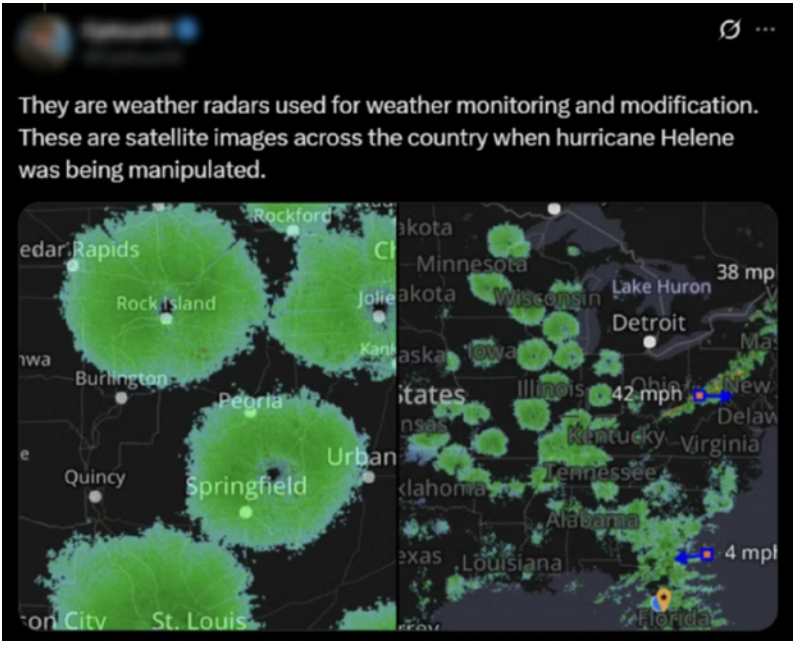

Figure 2. Following Hurricane Helene, altered satellite imagery was shared on social media alleging that geoengineering and HAARP (High-frequency Active Auroral Research Program, a research programme in Alaska) were used to modify the weather and manipulate the hurricane. *Source*: X posts, surfaced by Logically Intelligence, in N. Rampal, 'Weaponized Weather: When Disasters Become Information Battlegrounds', *Logically*, 20 August 2025, https://logically.ai/case-studies/case-study-weaponized-weather-when-disasters-become-information-battlegrounds.

31 Ibid.

DOI 10.30966/2018.RIGA.16.3

The methods by which adversaries might employ disinformation are well established, and these are readily adaptable to SAI. Russian state media has claimed that extreme weather events are linked to weapons deployed by Western powers to alter the climate[32] (this would be an ENMOD violation[33]); Chinese disinformation campaigns linked the 2023 Maui wildfires in Hawaii with US 'weather weapons';[34] and Iran has also claimed that the West is engaged in 'weather warfare'. If malign actors employ SAI misinformation as a hybrid threat (defined as forms of influence activity that 'have the malign intent of manipulating the political decision-making processes of a targeted nation by influencing the behaviours and attitudes of key audiences such as media organisations, the general public and political leaders'),[35] the capacity for publics to engage in evidence-based deliberation about this technology could be severely threatened.

The following section sets out a summary of the strategic objectives and operational patterns that are employed in related misinformation campaigns. However, the debate around geoengineering governance raises an additional challenge of requiring careful differentiation between adversary disinformation, domestic misinformation, and legitimate democratic discourse. Climate justice advocates, environmental organisations, and affected communities raise many of the same concerns that adversaries amplify; these include questions about technological imperialism, corporate power, democratic accountability, and distributional equity. These are not fringe positions. They are legitimate

32 M. Vrba, 'Climate Scepticism the Russian Way', *Green European Journal*, 13 June 2023. www.greeneuropeanjournal.eu/climate-scepticism-the-russian-way.

33 United Nations, 'Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques', 1977. https://treaties.un.org/doc/Treaties/1978/10/19781005%2000-39%20AM/Ch_XXVI_01p.pdf.

34 David E. Sanger and Steven Lee Myers, 'China Sows Disinformation about Hawaii Fires Using New Techniques', *New York Times*, 11 September 2023. www.nytimes.com/2023/09/11/us/politics/china-disinformation-ai.html.

35 Arsalan Bilal, 'Hybrid Warfare—New Threats, Complexity, and "Trust" as the Antidote', *NATO Review*, 30 November 2021; NATO Standardization Office (NSO), AAP-6, *NATO Glossary of Terms and Definitions* (2018), p. 62; S. Aday, M. Andžāns, U. Bērziņa-Čerenkova, F. Granelli, J. Gravelines, M. Hills, M. Holmstrom, A. Klus, I. Martinez-Sanchez, M. Mattiisen, H. Molder, Y. Morakabati, J. Pamment, A. Sari, V. Sazonov, G. Simons, and J. Terra, *Hybrid Threats: A Strategic Communications Perspective* (Riga: NATO Strategic Communications Centre of Excellence, 2019). https://stratcomcoe.org/pdfjs/?file=/publications/download/2nd_book_short_digi_pdf.pdf.

DOI 10.30966/2018.RIGA.16.3

political perspectives grounded in historical experience of unequal climate burdens and governance exclusion. The challenge for democratic societies is not to dismiss these legitimate concerns as disinformation, but rather to identify when legitimate political speech is being exploited through coordinated inauthentic behaviour, manipulated emotional triggers, or systematic undermining of shared epistemic standards.

Lessons from Related Disinformation Campaigns

The operational sophistication evident in weather modification and climate disinformation campaigns establishes clear precedents indicating solar geoengineering research could face similar threats. Understanding both the strategic objectives (why adversaries conduct these operations) and established tactics, techniques, and procedures (how they execute them) provides insight into probable approaches to solar geoengineering disinformation. The conspiracy frameworks, technical capabilities, and amplification networks developed through weather modification campaigns provide ready-made infrastructure for targeting solar geoengineering. This section examines documented disinformation operations targeting weather modification and climate change to identify the playbooks that may be adapted for solar geoengineering discourse.

Strategic Objectives of Related Disinformation Campaigns

Analysis of malign actor information operations targeting weather modification and climate events reveals five consistent strategic objectives that illuminate probable objectives for future solar geoengineering disinformation. These apparent goals, shared across multiple state actors, suggest coordinated strategic thinking about weaponising atmospheric technologies for multiple geopolitical objectives.[36] Five common objectives of climate and weather modification disinformation campaigns are as follows.

36 European Union External Action, *3rd EEAS Report on Foreign Information Manipulation and Interference Threats: Exposing the Architecture of FIMI Operations* (March 2025). www.eeas.europa.eu/sites/default/files/documents/2025/EEAS-3nd-ThreatReport-March-2025-05-Digital-HD.pdf.

DOI 10.30966/2018.RIGA.16.3

1. *To reduce social cohesion and sow disharmony.* Disinformation campaigns often aim not to push policy debates in a particular direction, but rather to amplify arguments on both sides of contentious issues to maximise societal division. Research on Russian Internet Research Agency operations demonstrates this bidirectional amplification strategy across multiple domains. For example, a 2018 investigation by the US House Committee on Science, Space, and Technology found that Russian-linked accounts simultaneously posted content opposing fossil fuel development (promoting pipeline protests and highlighting climate change) while also posting pro-fossil-fuel messages that dismissed climate science as a 'liberal hoax'.[37] This approach suggests the primary objective is not policy advocacy, rather the erosion of social cohesion and the creation of an environment where citizens cannot trust the authenticity of any position in public discourse.

2. *The fragmentation of multinational cooperation.* Faith in liberal democracies can be undermined by portraying Western climate policies as environmental imperialism or a 'neocolonial invention'.[38] Such operations undermine the multilateral cooperation essential for effective global climate governance. This uncertainty and consequent fragmentation of international consensus reduces Western soft power and creates opportunities for alternative, authoritarian governance frameworks.

3. *To undermine Western scientific institutional credibility.* By portraying weather modification research as evidence

37 US House of Representatives Committee on Science, Space, and Technology, *Russian Attempts to Influence U.S. Domestic Energy Markets by Exploiting Social Media: Majority Staff Report* (Washington, DC: House of Representatives, 1 March 2018). https://republicans-science.house.gov/sites/republicans.science.house.gov/files/documents/SST%20Staff%20Report%20-%20Russian%20Attempts%20to%20Influence%20U.S.%20Domestic%20Energy%20Markets%20by%20Exploiting%20Social%20Media%2003.01.18.pdf.

38 Central European University, Department of International Relations, 'The Grand Russian Disinformation Strategy in Environmental Politics', 2024, https://ir.ceu.edu/ohpa/research_blog/articles/rusdisinformation; J. Wainright and G. Mann, 'Climate Leviathan', *Antipode* 45, Nº 1 (2012): 1–22.

DOI 10.30966/2018.RIGA.16.3

of hidden programmes or technological authoritarianism, operations erode broader public confidence in the scientific enterprise.[39] This delegitimisation aims to reduce Western technological advantages, undermine evidence-based policymaking, and create space for alternative narratives that favour authoritarian governance.[40]

4. *To create confusion and policy paralysis.* Weather modification disinformation disseminated during environmental emergencies distracts the public,[41] effectively constraining democratic societies' ability to respond adequately to climate emergencies.[42] Similarly, conspiracy theories that portray solar geoengineering as evidence of elite manipulation may work to distract the public by connecting these technologies to broader anxieties about corporate power and governmental control.[43]

5. *To deflect attention from emissions responsibilities.* By focusing attention on purported Western atmospheric manipulation, campaigns can serve an immediate economic interest by distracting attention from adversary policy failures, such as the reliance on fossil fuel exports and resistance to emissions reduction commitments.[44] This strategy aids in prolonging environmentally destructive policies by allowing adversaries to portray themselves as victims of Western technological aggression.

39 Central European University, Department of International Relations, 'Grand Russian Disinformation Strategy'.

40 European Union External Action, *3rd EEAS Report*.

41 Tom Ellison and Brigitte Hugh, *Climate Security and Misinformation: A Baseline* (Council on Strategic Risks, 23 April 2024). https://councilonstrategicrisks.org/2024/04/23/climate-security-and-misinformation-a-baseline.

42 S. Hilberts, M. Govers, E. Petelos, and S. Evers, 'The Impact of Misinformation on Social Media in the Context of Natural Disasters: Narrative Review', *JMIR Infodemiology* 5 (2025), 5:e70413. https://doi.org/10.2196/70413.

43 Buck et al., 'Public Concerns'.

44 L. Yousef, 'Iran's "Cloudy" Accusations: A Cover-Up for Environmental Mismanagement', *Centre for Strategic and International Studies*, 23 May 2023. www.csis.org/analysis/irans-cloudy-accusations.

DOI 10.30966/2018.RIGA.16.3

Established Practices of Malign Actors

Disinformation spreads more easily than truth in today's information environment. Malign actors exploit this by creating emotionally compelling narratives that shape opinions quickly, before accurate but complex information can gain traction. Social media algorithms amplify sensational content over measured analysis,[45] artificial intelligence can generate convincing false information at scale, and established influence networks systematically undermine trust in institutions and exploit political divisions.

Foreign actors have already demonstrated their willingness to weaponise climate-related issues through information operations. China's Belt and Road Initiative increasingly uses climate technology as an influence tool.[46] Russia leverages energy relationships and climate disinformation for geopolitical advantage. Both nations amplify narratives about 'Western climate hypocrisy' and seed environmental conspiracy theories that erode trust in democratic institutions. Their exploitation of weather modification stories, which attributes extreme weather events to secret Western programmes, supports the thesis that solar geoengineering is an inevitable target for future malign influence campaigns. These and other documented campaigns show how conspiracy theories around atmospheric intervention serve as testing grounds for disinformation strategies, creating ready-made networks for amplifying false narratives about emerging climate technologies. Some of the common patterns that demonstrate established practices in climate and weather modification disinformation campaigns include the following.

45 W.J. Brady, J.C. Jackson, B. Lindström, and M.J. Crockett, 'Algorithm-Mediated Social Learning in Online Social Networks', *Trends in Cognitive Sciences* 27, Nº 10 (2023): 947–60. https://doi.org/10.1016/j.tics.2023.06.008.

46 Council on Foreign Relations, 'China's Massive Belt and Road Initiative', *CFR Backgrounder*, 3 February 2023, www.cfr.org/backgrounder/chinas-massive-belt-and-road-initiative; P.A.B. Duarte, A. Gasparyan, F.B. da Silva, et al., 'The Environmental Diplomacy of the Belt and Road Initiative: Going Green to Meet External Expectations', *Fudan Journal of the Humanities and Social Sciences*, 18 July 2025, https://link.springer.com/article/10.1007/s40647-025-00453-4.

DOI 10.30966/2018.RIGA.16.3

Rapid Exploitation of Crisis Events

Chinese political communications around weather manipulation demonstrate advanced capabilities for exploiting crisis events which may foreshadow the targeting of solar geoengineering research as a hybrid risk. Following the 2023 Maui wildfires, Chinese networks rapidly deployed narratives attributing the disaster to American weather weapons deployment.[47] The campaign showed operational speed and narrative sophistication, transforming a natural catastrophe into purported evidence of Western technological aggression within hours of the initial event, implying prior preparedness.[48]

During extreme weather events, when public attention intensifies and official information channels struggle with uncertainty, Chinese networks inject competing explanations that challenge authoritative assessments. This timing capitalises on periods when conspiracy stories can outpace careful scientific analysis, establishing emotional frameworks before factual explanations emerge.

Beijing's information operations are using increasingly sophisticated methods to enhance perceived narrative authenticity and audience reach; this includes the use of artificially generated testimonials from supposed experts. The use of legitimate scientific terminology and factual visual elements creates compelling pseudo-evidence. This disinformation evidence is used to provide an illusion of truth for conspiracy narratives.[49]

These sophisticated capabilities suggest both awareness of vulnerabilities in democratic communications, and the allocation of significant resources

47 Ellison and Hugh, *Climate Security*; Macrina Wang and Elisa Xu, 'Pro-China Disinformation Campaign Claims US Started Maui Fires in a "Weather Weapons" Experiment, Falsely Citing the UK's MI6', *NewsGuard*, 11 September 2023, www.newsguardtech.com/special-reports/pro-china-influence-operation-claims-us-military-started-maui-fires [accessed 12 October 2025]; Mack DeGeurin, 'Salacious Chinese Disinformation Campaign Blames Maui Fires on Deadly American "Weather Weapon"', *Gizmodo*, 11 September 2023.

48 Sanger and Myers, 'China Sows Disinformation'.

49 Ibid.

DOI 10.30966/2018.RIGA.16.3

to gain strategic advantage by undermining scientific discourse.[50] Existing disinformation playbooks might be quickly adapted to disrupt scientific debate in solar geoengineering—particularly given that public interest is partially concentrated in online conspiracy debates surrounding chemtrails narratives.

Pre-emptive Institutional Deflection

Weather manipulation has also been a feature of domestic disinformation campaigns in Iran, demonstrating how atmospheric intervention narratives can serve regime stability objectives.[51] Senior Iranian officials, including a former president and the head of Iran's Civil Defence Organisation, have claimed that drought and water shortages are attributable to foreign 'weather manipulation' or 'cloud theft', despite these claims being publicly rejected by Iran's own meteorological service.[52] Tehran is now facing critical water shortages.[53] Similarly, claims have been made about Western rain cloud destruction and accusations of four-decade-long American weather manipulation campaigns.[54]

Tehran's approach uses weather warfare claims as pre-emptive justification for governance inadequacies, enabling leadership to maintain legitimacy while pursuing anti-environmental policies. Claims of foreign atmospheric manipulation are seemingly intended to deflect national attention and protests away from local management of water resources, and justify policy failures by blaming external enemies.[55]

50 Erin Sikorsky and Tom Ellison, *Geoengineering and Climate Change in an Age of Disinformation and Strategic Competition* (Council on Strategic Risks, 23 April 2024). https://councilonstrategicrisks.org/2024/04/23/geoengineering-and-climate-change-in-an-age-of-disinformation-and-strategic-competition.

51 Richard Angwin, 'You've Stolen Our Weather!', *Al Jazeera*, 10 October 2011. www.aljazeera.com/news/2011/10/10/youve-stolen-our-weather.

52 AFP and TOI, 'Iranian General Blames Water Woes on Israeli "Cloud Theft"', *Times of Israe*l, 2 July 2018. www.timesofisrael.com/iranian-general-blames-water-woes-on-israeli-cloud-theft.

53 David Michel, Will Todman, and Jennifer Jun, 'Satellite Imagery Shows Tehran's Accelerating Water Crisis', *Centre for Strategic and International Studies*, 25 November 2025. www.csis.org/analysis/satellite-imagery-shows-tehrans-accelerating-water-crisis.

54 i24news, 'Iranian Expert Accuses US, Israel of "Weather Manipulation to Deepen Drought', 6 August 2024, www.i24news.tv/en/news/middle-east/artc-iranian-expert-accuses-us-israel-of-weather-manipulation-to-deepen-drought.

55 Yousef, 'Iran's "Cloudy" Accusations'.

DOI 10.30966/2018.RIGA.16.3

The institutional persistence of Iranian weather warfare narratives across multiple administrations indicates deliberate political communications doctrine rather than opportunistic messaging. This approach has had the effect of undermining regional cooperation on climate adaptation. Similar tactics could successfully target solar geoengineering, either by undermining and interrupting potential governance mechanisms, or by inflaming conspiracy theories around weather manipulation.

Strategic Amplification of Existing Stories

Russian information operations demonstrate opportunistic manipulation that could, in future, be employed to exploit solar geoengineering narratives while maintaining strategic deniability. Rather than creating novel conspiracy theories, Russian networks typically amplify existing stories to serve broader geopolitical objectives.[56] This approach maximises disruptive impact by leveraging established conspiracy communities. At the same time it avoids directly attributing disinformation content.

Pro-Kremlin information outlets routinely integrate 'weather-weapon' storylines into the conversations of broader conspiracy communities, providing those groups with apparent validations.[57] Russia's multi-pillar media ecosystem is further used to validate fringe accounts and direct activism towards politically useful targets.[58] This leverages the existing emotional energy and organisational infrastructure of grassroots movements towards objectives serving Russia's strategic interests.[59]

56 Christopher Paul and Miriam Matthews, *The Russian 'Firehose of Falsehood' Propaganda Model: Why It Might Work and Options to Counter It*, RAND Corporation Perspective (2016). www.rand.org/pubs/perspectives/PE198.html.

57 Global Engagement Centre, *GEC Special Report: Pillars of Russia's Disinformation and Propaganda Ecosystem* (2025), https://2021-2025.state.gov/russias-pillars-of-disinformation-and-propaganda-report/?safe=1; EUvsDisinfo, 'The Kremlin on Global Warming: Connecting the Dots; Disconnecting the Facts', 23 September 2019, https://euvsdisinfo.eu/the-kremlin-on-global-warming-connecting-the-dots-disconnecting-the-facts; *Digital Forensic Research Lab, Russian War Report: Pro-Kremlin Surrogates Accuse the US of Using 'Climate Weapons' in Crimea*, 30 November 2023, https://dfrlab.org/2023/11/30/russian-war-report-russia-accuses-climate-weapons.

58 Global Engagement Centre, *GEC Special Report*.

59 Natasha Lander Finch and Ryan Arick, 'How the US and Europe Can Counter Russian Information Manipulation about Nonproliferation', *Atlantic Council Issue Brief*, 4 October 2024. www.atlanticcouncil.org/in-depth-research-reports/issue-brief/how-the-us-and-europe-can-counter-russian-information-manipulation-about-nonproliferation.

DOI 10.30966/2018.RIGA.16.3

Multilateral Coordination and Complementary Framing

The consistency of Russia's coordination with Chinese messaging on atmospheric topics suggests increasing sophistication in multilateral information operations.[60] Complementary campaigns reinforce shared stories while avoiding obvious coordination.[61] For example, Chinese networks might emphasise technological aspects of purported weather weapons, while Russian disinformation networks focus on governance implications.[62] This enables comprehensive coverage and complicates attribution and response efforts.

Non-state Actor Force Multiplication

State-sponsored disinformation campaigns seek amplification by non-state actors who provide credibility unavailable to official state channels. Domestic conspiracy theory communities function as force multipliers. They transform content that originates outside the country into apparently organic grassroots movement output (termed information laundering), which is often more persuasive than obvious propaganda.[63] These networks operate through social media, alternative media platforms, and institutions lacking rigorous peer review, thus enabling unfounded claims to circulate under the guise of legitimate research.

60 Dan De Luce, 'Russia, China and Cuba Amplified Falsehoods about Recent Hurricanes, U.S. Official Says', *NBC News*, 28 October 2024, www.nbcnews.com/news/investigations/russia-china-cuba-amplified-falsehoods-recent-hurricanes-us-official-s-rcna177672; Tamas Matura, 'Sino-Russian Convergence in Foreign Information Manipulation and Interference: A Global Threat to the US and Its Allies', *CEPA*, 30 June 2025, https://cepa.org/comprehensive-reports/sino-russian-convergence-in-foreign-information-manipulation-and-interference.

61 Joe Stradinger, 'Narrative Intelligence: Detecting Chinese and Russian Information Operations to Disrupt NATO Unity', *Foreign Policy Research Institute*, 5 November 2024. www.fpri.org/article/2024/11/intelligence-china-russia-information-operations-against-nato.

62 De Luce, 'Russia, China and Cuba'; Matura, 'Sino-Russian Convergence'.

63 B.V. Rodríguez, *Information Laundering in the Nordic-Baltic Region* (NATO Strategic Communications Centre of Excellence, November 2020). https://stratcomcoe.org/pdfjs/?file=/publications/download/nato_information_laundering_small_file_10-12-2020-1.pdf.

DOI 10.30966/2018.RIGA.16.3

Cross-platform narrative spillover can amplify conspiracy theories beyond their original scope.[64] Weather modification conspiracies migrate from specialised forums to mainstream platforms, encountering broader audiences and merging with other conspiracy discourses. This organic amplification makes initial foreign influence operations more effective than direct propaganda, creating more sustainable disinformation ecosystems that continue to generate content beyond the initial seeding efforts.[65]

Strategic Vulnerabilities: Applying Adversary Playbooks to Solar Geoengineering

The operational sophistication evident in weather modification disinformation campaigns establishes clear precedents that could be applied to solar geoengineering research or policy decisions. The conspiracy frameworks, technical capabilities, and amplification networks developed through weather modification and climate campaigns provide ready-made infrastructure and processes that could easily be applied to solar geoengineering. As SAI research programmes expand and field trials commence, these established patterns suggest adversaries may accelerate efforts to exploit scientific uncertainty, governance gaps, and the public's unfamiliarity with SAI to achieve similar strategic objectives through solar geoengineering disinformation. This section examines immediate and future strategic risks arising from potential solar geoengineering disinformation campaigns.

Table 1 sets out a threat assessment summarising characteristics of SAI which make it susceptible to information manipulation: the objectives that disinformation campaigns might seek to achieve, how messages

64 R. Debnath et al., 'Social Media Posts around Solar Geoengineering "Spill Over" into Conspiracy Theories', *University of Cambridge Research News*, February 2023. www.cam.ac.uk/research/news/social-media-posts-around-solar-geoengineering-spill-over-into-conspiracy-theories [accessed 21 October 2025].

65 Christina Nemr and William Gangware, *Weapons of Mass Distraction: Foreign State-Sponsored Disinformation in the Digital Age*, US Department of State Report, March 2019. www.state.gov/wp-content/uploads/2019/05/Weapons-of-Mass-Distraction-Foreign-State-Sponsored-Disinformation-in-the-Digital-Age.pdf.

DOI 10.30966/2018.RIGA.16.3

might be exploited (for both anti- and pro-SAI messaging), and related examples for documented adversary information operations.

Disinformation objective	Anti-SAI exploitation	Pro-SAI exploitation	Related examples
SAI vulnerability characteristic: **(1) Technical complexity and scientific uncertainty**			
Prevent evidence-based evaluation of trade-offs; create policy paralysis or premature decisions.	Amplify uncertainty and worst-case scenarios; present fringe opposition as equally valid; undermine experts. 'Scientists are divided, it is too dangerous to proceed.'	Claim false certainty; dismiss legitimate concerns as anti-science; suppress discussion of risks. 'Scientific consensus is clear, resistance is denialism.'	Chinese networks using scientific terminology in Maui wildfire narratives;[a] Iranian officials citing meteorological concepts to support manipulation claims.[b]
SAI vulnerability characteristic: **(2) Global scale with uneven regional impacts**			
Reduce international cooperation; undermine multilateral governance; position adversary as defender of vulnerable nations (either through protection or action).	Frame as Western/Northern technological imperialism; amplify Global South grievances. 'Rich nations are controlling the thermostat at poor nations' expense.'	Frame hesitation as abandoning vulnerable nations; exploit climate justice to demand immediate action. 'Inaction is condemning the vulnerable to climate catastrophe.'	Russian narratives linking Western climate policy to neocolonial control.[c]
SAI vulnerability characteristic: **(3) Long implementation timeframes (decades+)**			
Undermine either long-term policy capacity or democratic accountability in governance; create conditions where evidence-based multi-decadal planning becomes impossible.	Portray as elite imposition on future generations; amplify democratic accountability concerns. 'Unelected technocrats are binding our children.'	Portray as necessary insulation from short-term politics; amplify technocratic governance narratives. 'Democratic cycles are too slow for a climate emergency.'	Iranian regime using weather warfare claims across multiple administrations to deflect from governance failures.[d]

DOI 10.30966/2018.RIGA.16.3

SAI vulnerability characteristic: **(4) Rapid onset of cooling capability (months to effect)**			
Establish emotional frameworks during crisis moments when rational analysis is difficult; prevent measured evaluation of deployment decisions.	Exploit extreme weather to seed conspiracy theories; attribute disasters to covert deployment. 'Secret programmes are already operating.'	Exploit extreme weather to demand immediate deployment. 'The climate emergency requires immediate action'; 'Waiting is a luxury we cannot afford.'	Chinese rapid exploitation of Maui fires within hours;[e] Russian amplification of disinformation narratives during European climate events.[f]
SAI vulnerability characteristic: **(5) Governance gaps and deployment accessibility**			
Undermine alliance cohesion; prevent coordinated governance development; create policy paralysis or premature decisions.	Amplify fears of rogue actors; exploit policy differences between allies to fragment coordination. 'Billionaires will control the climate.'	Create urgency through fear of being left behind; exploit policy differences to pressure rapid action. 'China will deploy first and set terms.'	Russian hybrid warfare and disinformation designed to challenge NATO cohesion.[g]
SAI vulnerability characteristic: **(6) Public unfamiliarity with SAI technology**			
Build self-sustaining ecosystems that prevent informed public engagement; establish either fear-based or deference-based responses rather than critical evaluation.	Seed established conspiracy networks (chemtrails); merge with anti-elite narratives. 'The elites are poisoning us.'	Frame opposition as ignorance; merge with techno-optimist narratives. 'The public are too unsophisticated to understand necessity'; 'Trust the experts.'	60% of social media SRM discourse already conspiratorial by 2016;[h] existing chemtrail narratives widespread, providing ready-made amplification infrastructure.
SAI vulnerability characteristic: **(7) Intersection with deeply held beliefs**			
Make technical debate emotionally charged; prevent cost–benefit analysis; exploit cultural and religious sensitivities to drive either rejection or acceptance without deliberation.	Connect to anxieties about corporate power and transparency; frame as violation of natural order; exploit religious objections. 'Playing God with the climate.'	Exploit climate anxiety and intergenerational justice concerns; frame opposition as privileged inaction; dismiss concerns as superstition. 'Moral imperative to act.'	Iranian framing of Western weather manipulation.[i]

Table 1. Threat assessment outlining examples of solar geoengineering information vulnerabilities, how they could be exploited in a bidirectional pattern (both anti- and pro-SAI messaging), and documented examples from related disinformation campaigns

DOI 10.30966/2018.RIGA.16.3

Current documented operations predominantly exploit anti-SAI narratives,[66] reflecting present geopolitical alignments where Western research leadership creates strategic incentives for disruption. However, the same vulnerabilities that enable anti-SAI manipulation could be exploited to pressure premature deployment should geopolitical dynamics shift. For example, an adversary state may emerge as a primary SAI advocate and use disinformation to reduce deployment timelines as a source of geopolitical leverage. Alternatively, disinformation campaigns could amplify both pro- and anti-geoengineering content to sow discord and reduce societal cohesion.

a Tom Ellison and Brigitte Hugh, *Climate Security and Misinformation: A Baseline* (Council on Strategic Risks, 23 April 2024), https://councilonstrategicrisks.org/2024/04/23/climate-security-and-misinformation-a-baseline; Macrina Wang and Elisa Xu, 'Pro-China Disinformation Campaign Claims US Started Maui Fires in a "Weather Weapons" Experiment, Falsely Citing the UK's MI6', *NewsGuard*, 11 September 2023.

b i24news, 'Iranian Expert Accuses US, Israel of Weather Manipulation to Deepen Drought', 6 August 2024, www.i24news.tv/en/news/middle-east/artc-iranian-expert-accuses-us-israel-of-weather-manipulation-to-deepen-drought.

c Central European University, Department of International Relations, 'The Grand Russian Disinformation Strategy in Environmental Politics', 2024, https://ir.ceu.edu/ohpa/research_blog/articles/rusdisinformation [accessed 21 October 2025].

d AFP and TOI, 'Iranian General Blames Water Woes on Israeli "Cloud Theft"', *Times of Israel*, 2 July 2018, www.timesofisrael.com/iranian-general-blames-water-woes-on-israeli-cloud-theft.

e Ellison and Hugh, *Climate Security*; Wang and Xu, 'Pro-China Disinformation Campaign'; Mack DeGeurin, 'Salacious Chinese Disinformation Campaign Blames Maui Fires on Deadly American "Weather Weapon"', *Gizmodo*, 11 September 2023.

f Global Engagement Centre, *GEC Special Report: Pillars of Russia's Disinformation and Propaganda Ecosystem* (2025), https://2021-2025.state.gov/russias-pillars-of-disinformation-and-propaganda-report/?safe=1; EUvsDisinfo, 'The Kremlin on Global Warming: Connecting the Dots; Disconnecting the Facts', 23 September 2019, https://euvsdisinfo.eu/the-kremlin-on-global-warming-connecting-the-dots-disconnecting-the-facts; Digital Forensic Research Lab, *Russian War Report: Pro-Kremlin Surrogates Accuse the US of Using 'Climate Weapons' in Crimea*, 30 November 2023.

g H. Hardt, 'NATO after the Invasion of Ukraine: How the Shock Changed Alliance Cohesion', *International Politics* (16 October 2024). https://doi.org/10.1057/s41311-024-00629-x.

h D. Tingley and G. Wagner, 'Solar Geoengineering and the Chemtrails Conspiracy on Social Media', *Palgrave Communications* 3 (2017): Nº 12. https://doi.org/10.1057/s41599-017-0014-3.

i Richard Angwin, 'You've Stolen Our Weather!', *Al Jazeera*, 10 October 2011, www.aljazeera.com/news/2011/10/10/youve-stolen-our-weather.

66 N. Rampal, 'Weaponized Weather: When Disasters Become Information Battlegrounds', *Logically*, 20 August 2025. https://logically.ai/case-studies/case-study-weaponized-weather-when-disasters-become-information-battlegrounds.

DOI 10.30966/2018.RIGA.16.3

Table 1 clearly demonstrates the bidirectional possibility of SAI disinformation. Any framework to preserve democratic dialogue should be designed to protect from manipulation in either direction. The threat is not adversary opposition to (or support for) SRM per se; rather it is adversary exploitation of misinformation opportunities to prevent the conditions necessary for evidence-based democratic choice. Defence against influence operations requires an awareness that a malign actor could have multiple strategic objectives for spreading disinformation, including the following.

Disruption of Social Cohesion

The deliberate amplification of divisive narratives constitutes a fundamental threat to societal capacity for collective deliberation about solar geoengineering. Disinformation campaigns often aim not to push policy debates in any particular direction, rather to amplify arguments on both sides of contentious issues to maximise societal division. This bidirectional approach, which has been documented across climate policy, public health, and other contested domains, creates environments where citizens cannot trust the authenticity of any position in public discourse. When applied to solar geoengineering, adversaries can exploit existing social divisions around environmental justice, technological governance, or international cooperation to fracture communities along manufactured fault lines. The result is not merely disagreement about specific policies, but breakdown of the social cohesion necessary for democratic societies to deliberate collectively about complex technological choices that affect shared futures.

DOI 10.30966/2018.RIGA.16.3

Erosion of Democratic Governance

The erosion of evidence-based policymaking constitutes a substantial immediate threat from solar geoengineering disinformation.[67] By undermining public trust in atmospheric science and climate research institutions, adversary campaigns could establish conditions where evidence-based deliberation becomes progressively challenging.[68]

Existing political polarisation of climate policy responses could be inflamed to achieve strategic effects. Political candidates and parties may be forced into position taking on complex technical matters while lacking understanding, and may simultaneously be confronted with organised disinformation campaigns. Even if they are suspicious of disinformation narratives, political expediency may force conformity.

Reduction of Alliance Cohesion

Militaries may be called upon to conduct, defend, or block geoengineering operations. In NATO and other geopolitical alliances, differing national stances on solar geoengineering research could create opportunities for exploitation by malign information operations.[69] While some member states have invested substantial research into solar geoengineering (US, UK, and Australia), others maintain restrictive or cautious approaches (Germany), generating policy disparities that hostile actors can leverage in targeted disinformation efforts.

The absence of agreed fact-based messaging regarding solar geoengineering research or development permits malign actors to exploit information

67 United Nations Development Programme, 'What Are Climate Misinformation and Disinformation and How Can We Tackle Them?', *UNDP Climate Promise*, 1 May 2025. https://climatepromise.undp.org/news-and-stories/what-are-climate-misinformation-and-disinformation-and-how-can-we-tackle-them.

68 Sikorsky and Ellison, *Geoengineering and Climate Change*.

69 Rym Momtaz, 'Taking the Pulse: Are Information Operations Russia's Most Potent Weapon Against Europe?', *Strategic Europe*, 5 December 2024. https://carnegieendowment.org/europe/strategic-europe/2024/12/taking-the-pulse-are-information-operations-russias-most-potent-weapon-against-europe.

DOI 10.30966/2018.RIGA.16.3

voids through audience-specific targeting. One could imagine foreign information networks customising disinformation for particular national environments, emphasising anxieties around sovereignty in certain countries (raising questions around who controls the global climate) and the moral hazard (the potential for developing solar geoengineering to distract from climate mitigation) in others. This methodology exploits existing political fractures in alliances. It could convert technical or governance disagreements about solar geoengineering into fundamental questions regarding faith in democratic processes and institutional credibility.[70]

Existing reservations about 'big tech' dominance, combined with pre-existing tensions in divergent approaches to climate policy, create strategic opportunities for adversaries to characterise solar geoengineering as technological imperialism. These sensitivities could be exploited to fragment allied cooperation precisely when coordination between allies is essential for effective governance of emerging climate technology.

Scientific Institution Damage

Inflaming legitimate public concerns around geoengineering, or inflaming existing conspiracy theories, could allow malign actors to significantly damage the reputation of scientific institutions and disrupt research programmes that aim to better understand solar geoengineering.[71] Public opposition to solar geoengineering research has already coincided with the cancellation of major scientific programmes, a trend that could be leveraged by those wishing to disrupt scientific institutions and research.

70 Carme Colomina, Héctor Sánchez Margalef, and Richard Youngs, *The Impact of Disinformation on Democratic Processes and Human Rights in the World*, European Parliament Study, April 2021. www.europarl.europa.eu/RegData/etudes/STUD/2021/653635/EXPO_STU(2021)653635_EN.pdf.

71 Genna Reed, Yogi Hendlin, Anita Desikan, Taryn MacKinney, Emily Berman, and Gretchen T. Goldman 'The Disinformation Playbook: How Industry Manipulates the Science-Policy Process—and How to Restore Scientific Integrity', *Journal of Public Health Policy* 43, Nº 1 (2022): 37–49, https://doi.org/10.1057/s41271-021-00318-6; Kathleen Hall Jamieson and Dolores Albarracín, 'Misinformation in and about Science', *Proceedings of the National Academy of Sciences* 117, Nº 26 (9 April 2021): 13743–51. https://doi.org/10.1073/pnas.1912444117.

DOI 10.30966/2018.RIGA.16.3

Harvard University's Stratospheric Controlled Perturbation Experiment (SCoPEx) represents the most significant attempt at field-based solar geoengineering research, but it was officially abandoned in March 2024 after sustained resistance from environmental and Indigenous advocacy groups.[72] Plans for a small-scale outdoor experiment in Sweden were terminated in 2021, when the Saami Council condemned the experiment as contradicting Indigenous principles of natural harmony.[73] Continued public pressure ultimately led to the end of the research effort, which researchers acknowledged had become symbolic of broader controversies surrounding legitimacy in geoengineering research. This was not the first time that geoengineering experiments were cancelled amid controversy.[74]

The implications are wider than individual research programmes and raise broader questions of research governance and institutional credibility. When sustained political pressure can terminate scientific research, regardless of methodological rigour or ethical oversight, democratic societies risk losing essential capabilities for investigating technologies crucial to global challenge responses. This dynamic enables hostile actors to constrain Western technological advancement through indirect influence operations that exploit domestic opposition groups.

Global South Relations and Climate Justice Narratives

Solar geoengineering disinformation campaigns could exploit North–South climate justice narratives. They connect conspiracy theories around Western weather manipulation to legitimate grievances regarding historical climate responsibility and contemporary adaptation to perceived inequities. These powerful emotional frameworks could be used to

72 J. Temple, 'Harvard Has Halted Its Long-Planned Atmospheric Geoengineering Experiment', *MIT Technology Review*, 18 March 2024. www.technologyreview.com/2024/03/18/1089879/harvard-halts-its-long-planned-atmospheric-geoengineering-experiment.

73 James Temple, 'Geoengineering Researchers Have Halted Plans for a Balloon Launch in Sweden', *MIT Technology Review*, 31 March 2021. www.technologyreview.com/2021/03/31/1021479/harvard-geoengineering-balloon-experiment-sweden-suspended-climate-change.

74 D. Cressey, 'Geoengineering Experiment Cancelled amid Patent Row', *Nature, 15 May* 2012. https://doi.org/10.1038/nature.2012.10645.

DOI 10.30966/2018.RIGA.16.3

undermine multilateral climate cooperation by fragmenting developing country support for Western-led initiatives.

Development cooperation could face potential disruption if solar geoengineering becomes portrayed as Western technological imperialism through successful disinformation campaigns. International organisations and development agencies could fear their climate programmes may be questioned or rejected due to being connected in the public mind with theories of atmospheric manipulation. Accounts of weather manipulation designed to deflect attention from domestic policies could have regional security or geopolitical implications. This could undermine decades of cooperation building precisely when coordinated global action becomes most crucial.

A Strategic Communications Framework for Solar Geoengineering

Presented here is a strategic communications framework to preserve democratic deliberation in a contested information environment (see summary of key principles in Figure 3). The challenge of supporting democratic capacity to address solar geoengineering extends beyond this single technology. If democratic societies cannot engage in reasoned debate about atmospheric intervention, their capacity to govern other emerging technologies and contested policy challenges effectively comes into question. Information operations undertaken by malign actors detailed in previous sections demonstrate that solar geoengineering discourse will perhaps face sophisticated manipulation designed to prevent rational deliberation, fragment international cooperation, and undermine scientific institutions.

DOI 10.30966/2018.RIGA.16.3

Figure 3. Summary of key principles supporting a strategic communications framework for SAI, including the probable objectives of disinformation, characteristics of SAI that make it vulnerable to disinformation, and the techniques and objectives recommended for preparing for and addressing disinformation threats (figure created by the author)

A strategic communications framework that protects deliberative space must work equally hard to preserve legitimate dissent while countering manipulation designed to prevent rational consideration of options. Climate justice advocates, environmental organisations, and affected communities raise many of the same concerns that adversaries amplify; however, these are not fringe positions but legitimate political perspectives grounded in historical experience. Development of an effective strategic communications campaign thus requires moving beyond simplistic distinctions between 'pro-SRM' and 'anti-SRM' positions to focus instead on protecting conditions including transparency, good-faith engagement, epistemic humility, and respect for evidence. Such norms of debate enable democratic publics to evaluate complex technological choices, without being manipulated by either domestic opportunists or foreign adversaries.

Successfully defending access to informed policy debate requires recognising that strategic communications about solar geoengineering is fundamentally about preserving the very notion of democratic

DOI 10.30966/2018.RIGA.16.3

deliberation. The goal is not to promote particular policy outcomes. Rather it is to create conditions where citizens and policymakers engage with evidence, consider trade-offs, and make informed decisions—without being manipulated by malign actors. This section outlines a strategic communications framework to support democratic resilience in contested information environments.

Foundational Principles of Strategic Communications

Strategic communications is defined as 'a holistic approach to communication based on values and interests that encompasses everything an actor does to achieve objectives in a contested environment'.[75] It provides an essential foundation for building the democratic resilience necessary to preserve deliberation rooted in empirical evidence about emerging technologies, including solar geoengineering. This approach focuses on moving beyond reactive responses to conspiracy theories. Instead, it takes a proactive approach to understand the information environment, work with an understanding of human psychology, and cultivate a two-way conversation with citizens to build societal resilience against information manipulation and maintain space for legitimate scientific debate.

Strategic communications operates fundamentally as a long-term communications discipline grounded in liberal democratic values that prioritise individual freedoms and evidence-based decision-making. Unlike crisis communications or reactive counter-disinformation efforts, strategic communications operates on timescales extending ten to twenty years into the future. It fundamentally recognises that meaningful societal change requires sustained engagement rather than reactive responses to emerging threats.

75 Neville Bolt and Leonie Haiden, *Improving NATO Strategic Communications Terminology* (Riga: NATO Strategic Communications Centre of Excellence, 2019).

DOI 10.30966/2018.RIGA.16.3

The field is designed with a thorough appreciation of human psychology as it relates to knowledge building. It recognises that 'everything communicates'. Humans attach meaning to objects, actions, and non-actions within their environment, so the images that communicators use, their choice of words, the symbols employed, and even silence all carry communicative power. This recognition builds appreciation that solar geoengineering discourse will be influenced as much by existing cultural frameworks around environmental protection, governmental authority, and technological advances as by purely technical explanations.

Crucially, strategic communications recognises that democratic societies operate in crowded media environments where most communications fail to reach their intended audiences. Citizens are overwhelmed by information, and effective communication necessitates moving from one-way communications approaches that talk at populations towards genuine two-way or many-sided conversations that engage citizens as active participants in democratic deliberation.

Understanding the Information Environment through Structured Analytic Techniques

Understanding solar geoengineering information threats requires a systematic understanding of the information environment using structured analytic techniques (SATs). These are 'a mechanism by which internal thought processes are externalised in a systematic and transparent manner so that they can be shared, built on, and easily critiqued by others'.[76] These techniques provide organised frameworks for anticipating adversary tactics, understanding audience needs, and developing effective disinformation countermeasures.

SATs evolved from intelligence requirements for systematic threat assessment but have been adapted to address the changing nature of

76 Richards J. Heuer and Randolph H. Pherson, *Structured Analytic Techniques for Intelligence Analysis*, 3rd edn (Washington, DC: CQ Press, 2020).

DOI 10.30966/2018.RIGA.16.3

information warfare and strategic communications challenges.[77] Figure 4 introduces the acronym ADAPT to outline SATs that could be applied to solar geoengineering discourse to understand audience needs, detect deception, anticipate likely developments, plan contingencies for various scenarios, and stress-test response plans.

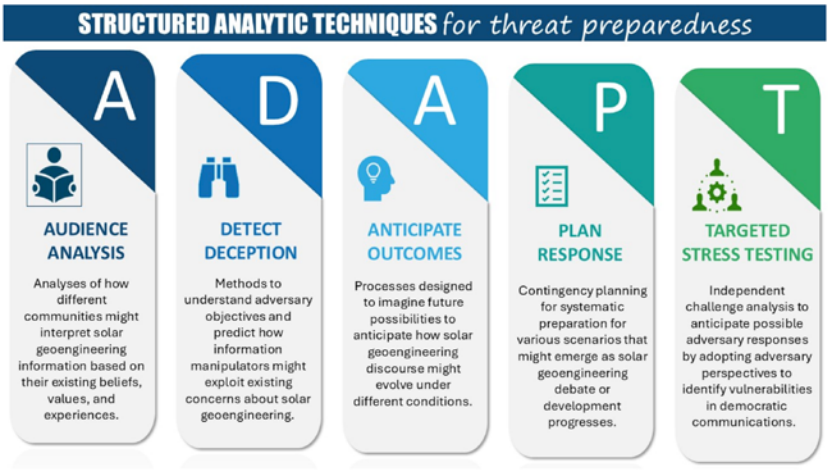

Figure 4. Structured analytic techniques for conducting a threat assessment on geoengineering information operations (figure created by the author)

1. *Anticipating audience needs* requires a systematic analysis of how different communities might interpret solar geoengineering information based on their existing beliefs, values, and experiences. Techniques such as 'four ways of seeing' help practitioners understand how different audience perspectives might interpret the same atmospheric intervention research as a promising climate solution, a dangerous technological overreach, an elite manipulation tool, or a necessary emergency response.[78]

77 Central Intelligence Agency, *A Tradecraft Primer: Structured Analytic Techniques for Improving Intelligence Analysis*, 2nd edn (Washington, DC: CIA Center for the Study of Intelligence, 2009).

78 US Army, *Red Team Handbook* (Fort Leavenworth, KS: University of Foreign Military and Cultural Studies).

DOI 10.30966/2018.RIGA.16.3

2. *Detecting the presence of deception* and understanding adversary objectives requires techniques such as 'deception detection' that analyses how information manipulators exploit legitimate concerns about solar geoengineering to achieve broader strategic goals of undermining democratic institutions and fragmenting international cooperation.[79] These approaches help distinguish between genuine criticism of atmospheric intervention technologies and coordinated campaigns designed to prevent rational deliberation.

3. *Anticipating likely developments* can be achieved through techniques such as 'premortem analysis' and analysis of competing hypotheses about future possibilities to anticipate how solar geoengineering discourse might evolve under different conditions. Premortem techniques explore how well-intentioned initiatives might fail due to unforeseen complications.[80] Analysis of competing hypotheses is designed to reduce cognitive biases in intelligence analysis by systematically evaluating multiple explanations for a phenomenon against the available evidence.[81]

4. *Planning for responses* can include methods of contingency planning through approaches such as 'pros-cons-faults-fixes' which enable systematic preparation for various scenarios that might emerge as solar geoengineering research progresses.[82] These techniques help practitioners develop flexible response capabilities that can adapt to different threat environments rather than relying solely on predetermined messaging strategies.

5. *Targeted stress testing of response options* can be carried out to ensure responses are robust to possible adversary responses. Techniques such as 'red team analysis' are effective for this

79 Heuer and Pherson, *Structured Analytic Techniques*.

80 Gary Klein, 'Performing a Project Premortem', *Harvard Business Review* 85, Nº 9 (September 2007): 18–19.

81 Heuer and Pherson, *Structured Analytic Techniques*.

82 Ibid.

DOI 10.30966/2018.RIGA.16.3

purpose. This technique involves systematically adopting adversary perspectives to identify vulnerabilities in democratic communications.[83]

Understanding Citizen Perspectives through Behavioural Insights

Effective communication requires understanding how citizens process information about complex technologies like solar geoengineering. Behavioural science provides a systematic and evidence-based approach for tailoring communications to work with, rather than against, natural psychological tendencies. This enables practitioners to anticipate responses and design communications that are more resistant to manipulation techniques.

Research consistently demonstrates that people underestimate how much their behaviour is driven by social norms and habits compared to personal preferences. At the same time, they systematically underestimate their capacity to change their emotional response in ways that conflict with their initial preferences.[84] These insights prove particularly relevant for solar geoengineering communications. Citizens who evaluate unfamiliar technologies while navigating competing expert claims and conspiracy theories tend to be disproportionately influenced by the 'status quo' and the views of their peer group, compared to the technical information available.

The OECD's ABCD framework[85] provides a systematic approach for understanding how citizens might engage with solar geoengineering information. It explains the influence of four factors: attention, belief formation insights, choice architecture, and determination factors:

83 Ibid.

84 Robert B. Cialdini, 'Basic Social Influence Is Underestimated', *Psychological Inquiry* 16, Nº 4 (2005): 158–61.

85 OECD, *Tools and Ethics for Applied Behavioural Insights: The BASIC Toolkit* (Paris: OECD Publishing, 2019).

DOI 10.30966/2018.RIGA.16.3

1. The first factor, **attention**, recognises that citizens cannot focus simultaneously on technical complexity, governance challenges, ethical implications, and risk assessments. Communications must therefore sequence information delivery but acknowledge competing priorities for public attention. This is especially relevant during times when conspiracy theories are spreading rapidly.

2. Insights into how we form our **beliefs** reveal the ways citizens use mental shortcuts when evaluating information, often overestimating or underestimating probabilities based on emotional associations rather than technical analysis. Understanding these heuristics enables practitioners to design communications that work with cognitive tendencies, rather than expecting citizens to process complex information like technical experts.

3. **Choice architecture** refers to the different ways that choices can be presented to decision-makers and publics, and the impact of those design choices on decision-making outcomes.[86] It becomes crucial when presenting solar geoengineering options, as framing effects and social influences substantially affect how citizens evaluate technological alternatives. Citizens' preferences may be shaped more by how options are presented relative to each other than by absolute assessments of risks and benefits. This understanding helps explain why conspiracy theories that position solar geoengineering within broader framing about elite manipulation may prove more persuasive than isolated technical corrections.

4. **Determination** acknowledges that maintaining support for complex, long-term research programmes requires understanding how citizens sustain their commitment in the face of evolving information and social pressures. Citizens who may initially

86 R.H. Thaler and C.R. Sunstein, *Nudge: Improving Decisions about Health, Wealth, and Happiness* (New Haven, CT: Yale University Press, 2008).

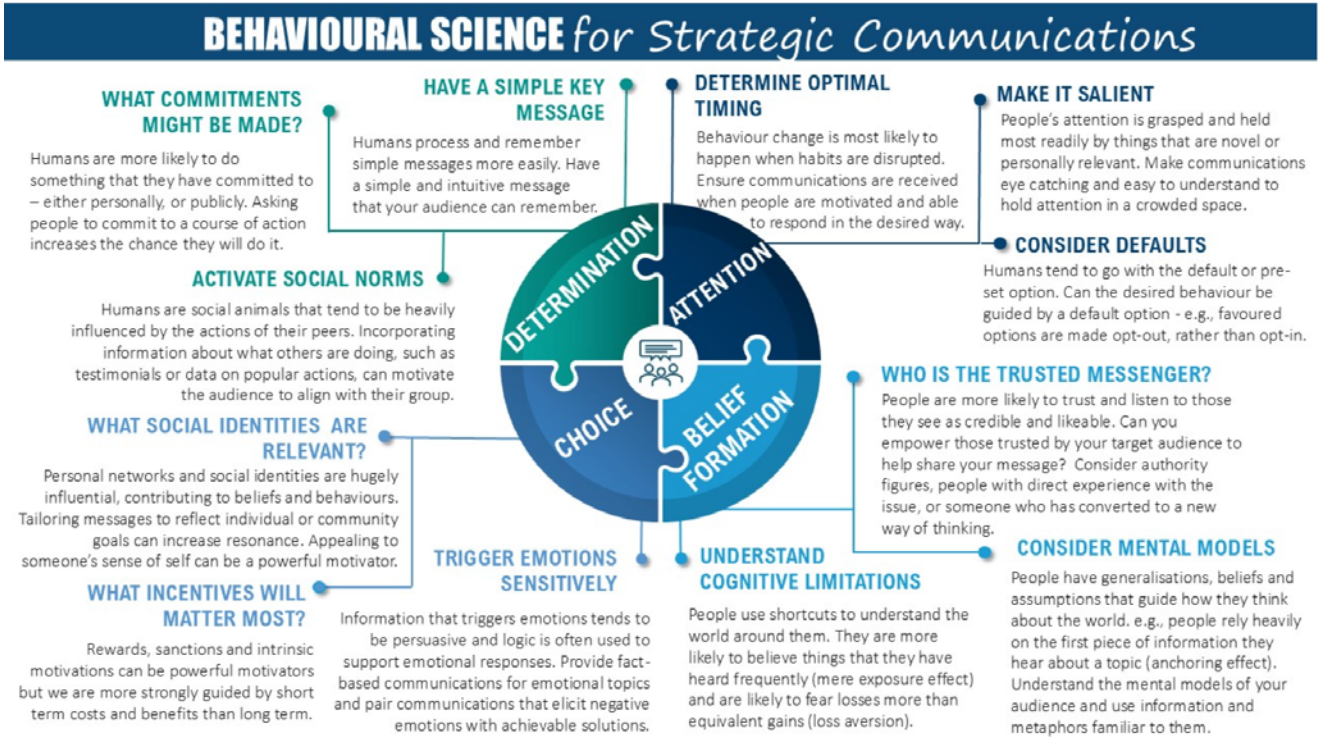

Figure 5. Visual prompt demonstrating how the OECD ABCD framework principles can be applied to strategic communications (figure created by the author)

DOI 10.30966/2018.RIGA.16.3

support the need for solar geoengineering research may change positions if governance frameworks fail to address underlying concerns about democratic accountability and international cooperation.

A visual prompt demonstrating how these behavioural science principles can be applied to strategic communications is provided in Figure 5.

Citizen Engagement and Two-Way Communication

Understanding both the information environment and how citizens process information encourages fresh approaches to effective engagement. Solar geoengineering presents particular challenges for democratic governance because it involves planetary-scale interventions with global consequences that extend beyond traditional electoral cycles and national boundaries. Citizens cannot be expected to accept expert assessments about such profound technological choices without meaningful opportunities to express concerns, explore implications, and participate in shaping governance frameworks.

Traditional approaches that lecture audiences about technical details while dismissing their concerns as misinformation may prove counterproductive when addressing sophisticated disinformation campaigns that exploit legitimate anxieties about technological governance. Citizens experiencing genuine concerns about elite manipulation, environmental justice, or democratic accountability will not be persuaded by communications that fail to acknowledge these underlying issues.

Effective engagement requires creating structured opportunities for citizens to articulate their values, explore trade-offs, and participate in deliberative processes about solar geoengineering governance. This means moving beyond public information campaigns towards genuine consultation processes that influence policy or research development, rather than simply building support for predetermined decisions.

DOI 10.30966/2018.RIGA.16.3

Two-way communication proves particularly crucial because solar geoengineering intersects with deeply held beliefs about humanity's relationship with nature, appropriate responses to climate change, and legitimate governance of global technologies. Citizens bring different cultural, religious, and political frameworks to these discussions that cannot be addressed through technical information alone.

Strategic foresight offers one effective tool for facilitating these conversations by engaging citizens in structured exploration of multiple possible futures, as opposed to debating specific technologies in isolation. Rather than asking whether solar geoengineering should be pursued, foresight exercises invite citizens to imagine different future scenarios—for example, one with accelerated climate change, one with successful mitigation efforts, one with various atmospheric intervention options, and one with different governance arrangements.

These exercises reveal how different values and priorities lead to different assessments of technological risks and benefits while building capacity for evaluating complex information. Citizens exploring scenarios where solar geoengineering proves necessary for avoiding catastrophic warming, alternatives where emissions reduction makes intervention unnecessary, or futures where governance failures lead to unilateral deployment can better understand the trade-offs involved.

Strategic foresight exercises also help inoculate democratic discourse against conspiracy theories that present single, deterministic narratives about elite manipulation or technological inevitability. By engaging citizens in considering various possibilities, these approaches build resilience against information manipulation while maintaining openness to the uncertainty inherent in emerging technology development.

DOI 10.30966/2018.RIGA.16.3

Framework Implementation: Building Resilience and Response Capacity

Building Whole-of-Society Resilience

Vulnerability to disinformation about solar geoengineering extends far beyond the climate policy domain. The same manipulative tactics that adversaries employ to distort solar geoengineering discourse—including exploiting anxieties about elite control, amplifying both sides of debates to sow division, and 'weaponising' legitimate concerns through conspiracy frameworks—appear across discussions of vaccines, energy policy, emerging technologies, and democratic institutions themselves. This reality demands a whole-of-society approach to resilience building that strengthens democratic capacity to navigate contested information environments rather than developing domain-specific responses in isolation.

Effective resilience requires developing public familiarity with complex topics like solar geoengineering well in advance of outdoor experimentation or policy debates. Attempting to build understanding and trust during critical movements, such as when research programmes announce plans for outdoor experimentation, will prove far more difficult than establishing foundations for informed deliberation before such pressure exists. This extended timeline enables citizens to develop sophisticated understanding of trade-offs, articulate their values, and engage meaningfully with governance frameworks while building their subject matter familiarity.

Central to this approach is recognition that citizens must be engaged as active participants in shaping technology governance rather than passive recipients of expert guidance. Lecture-style communication that attempts to educate publics about solar geoengineering without creating genuine opportunities for dialogue not only fails to build resilience but risks reinforcing the concerns about elite manipulation that adversaries exploit. Citizens need structured opportunities to express their feelings and concerns, explore trade-offs, and have their perspectives genuinely

DOI 10.30966/2018.RIGA.16.3

influence governance frameworks, not simply receive information about decisions already made elsewhere.

For instance, citizens could be empowered to engage with universities through structured mechanisms like citizen panels that provide ongoing input into research oversight processes. Such panels create transparency while building institutional understanding of public values. This early engagement, which should occur before any outdoor experimentation debates intensify, would create foundations for informed deliberation when more consequential decisions must be made.

Understanding where different citizen groups currently stand in their relationship to solar geoengineering information proves essential for tailoring communication approaches that work with rather than against existing perspectives. Educational initiatives building critical thinking skills will enable recognition of manipulation techniques, while maintaining openness to scientific uncertainty and democratic debate. These initiatives should equip citizens to participate effectively in two-way communications rather than simply consuming expert assessments.

Trusted messenger cultivation proves particularly crucial. Research indicates that people are more likely to listen to, and be persuaded by, those whom they trust. University-based scientists may enjoy higher public credibility than government sources for solar geoengineering information, but the most trusted messengers may not be people in positions of authority at all. Strategic communications frameworks must support and empower those who are trusted within communities to communicate on this issue, while protecting them from systematic harassment campaigns that exploit solar geoengineering discourse to target scientific institutions and individuals more broadly.

Long-term strategic communications about solar geoengineering requires developing authentic narratives that address emotional frameworks underlying conspiracy theories while maintaining scientific accuracy. Rather than dismiss concerns about elite manipulation or technological

DOI 10.30966/2018.RIGA.16.3

governance, proactive communications must engage directly with anxieties about democratic accountability, while distinguishing between legitimate governance concerns and conspiracy theories designed to prevent rational deliberation.

The need to protect long-term institutional credibility extends beyond solar geoengineering to encompass democratic governance of emerging technologies generally. Sustained and genuine engagement between institutions and citizens builds trust over time. Empowering citizens to interact with, and have a voice in guiding, relevant institutions reduces the risk that organised campaigns can successfully sow suspicion and prevent evidence-based investigation of technologies crucial to addressing global challenges.

Disinformation Response Capabilities

Alongside long-term resilience building, democratic societies require response capabilities that can address acute disinformation threats when they emerge. If solar geoengineering disinformation campaigns achieve significant penetration, coordinated response mechanisms must address both immediate discursive threats and longer-term institutional damage, while maintaining democratic principles.

Pre-bunking techniques have demonstrated cross-cultural effectiveness in helping citizens identify manipulation techniques used by malign actors before they encounter misinformation. This approach proves more effective than reactive debunking that attempts to correct beliefs after disinformation exposure. Implementation mechanisms range from educational games to mass-deployment social media interventions. Games placing players in the roles of misinformation producers show cross-cultural effectiveness at increasing disinformation identification. Short pre-bunking videos significantly improve recognition of manipulation techniques and sharing decisions. These interventions establish

DOI 10.30966/2018.RIGA.16.3

'psychological inoculation at scale', where brief exposures trigger cognitive processes that generalise across topics.

Developing civil society partnerships proves essential for addressing disinformation that exploits concerns around environmental justice, and for building coalitions capable of supporting evidence-grounded deliberation about atmospheric intervention technologies. These partnerships acknowledge legitimate grievances about climate responsibility while countering conspiracy theories, and require sustained engagement rather than dismissive responses to concerns about solar geoengineering.

The benefits of this comprehensive resilience approach extend well beyond solar geoengineering. Critical thinking capacities, trust-building engagement practices, and response capabilities developed for addressing solar geoengineering disinformation strengthen democratic deliberation about all emerging technologies characterised by complexity, uncertainty, and potential for adversary exploitation. Building resilience around solar geoengineering thus serves both as specific preparation for potential atmospheric intervention decisions and as broader investment in democratic capacity to govern technological change in contested information environments. If organised campaigns can use coordinated disinformation, regardless of scientific merit, to successfully prevent evidence-based investigation of technologies crucial to addressing global challenges, democratic societies risk losing essential capabilities for navigating twenty-first-century governance questions.

Conclusion: Solar Geoengineering as a Test Case for Twenty-First-Century Democratic Governance

Solar geoengineering represents more than a technical challenge for climate policy. It has emerged as a critical test of whether democratic systems can maintain evidence-based deliberation about planetary-scale technologies

DOI 10.30966/2018.RIGA.16.3

in an era of sophisticated information warfare. The framework outlined here provides practical tools for building resilience, but its successful implementation will require a recognition of several uncomfortable realities about contemporary democratic governance.

First, the threat timeline is compressing. Information operations by malign actors that target atmospheric intervention technologies are already sophisticated and operational. In contrast, democratic communications capacity remains fragmented and reactive. Conspiracy frameworks, amplification networks, and coordination mechanisms documented in weather modification campaigns provide a ready-made infrastructure for disrupting solar geoengineering discourse as geoengineering research programmes expand. Waiting for a consensus on governance frameworks before addressing vulnerabilities in communications cedes the strategic advantage to adversaries who face no such constraints.

Second, technical expertise alone cannot resolve this challenge. The cancellation of major research programmes like SCoPEx demonstrates that existing methodological and ethical oversight may not be enough to assure citizens that their concerns have been addressed. Democratic societies must develop the capacity to distinguish between authentic public engagement and manipulation campaigns designed to prevent rational deliberation. However, they must ensure this capability does not itself become a tool for dismissing legitimate criticism.

Third, success requires unprecedented coordination across traditionally separate domains. Effective strategic communications about solar geoengineering demands climate science be integrated with behavioural research, intelligence analysis, international diplomacy, and public engagement expertise. Current institutional structures that separate these functions create exploitable gaps in the ability of democracies to respond.

The consequences extend beyond solar geoengineering. They encompass broader questions about democratic resilience in environments where information is contested. Similar dynamics are already emerging around

DOI 10.30966/2018.RIGA.16.3

the governance of artificial intelligence, the regulation of biotechnology, and other strategic technologies. In such cases democratic deliberation faces systematic disadvantages against disinformation, whereby disinformation spreads virally before evidence-based explanations can be established.

Proactively addressing these challenges may yield additional unexpected benefits for building democratic resilience. Building citizen capacity for evaluating complex technological information, developing robust frameworks for two-way communications about contested policies, and strengthening institutional resilience against information manipulation will serve broader democratic interests beyond solar geoengineering. The tools developed here provide blueprints for democratic adaptation to information environments that systematically favour simplistic narratives over nuanced analysis.

The framework outlined in this paper provides a starting point rather than a final solution. Implementation will require iterative adaptation as malign actor tactics evolve and new vulnerabilities emerge. Efforts to preserve democratic deliberation about solar geoengineering require sustained investment in citizen engagement, institutional credibility, and communications capacity to address both technical and political dimensions of the challenge.

Democratic societies face a choice. Continue with reactive approaches that cede strategic initiative to malign actors and hope that citizens will proactively engage with the evidence base needed for rational debate. Or recognise that to evolve proactive communications strategies in response to twenty-first-century threats represents a security imperative requiring the same commitment of attention and resources as traditional defence challenges. Solar geoengineering discourses may be the first major test of this choice, but they will not be the last.

DOI 10.30966/2018.RIGA.16.3

Bibliography

Aday, S., M. Andzans, U. Berzina-Cerenkova, F. Granelli, J. Gravelines, M. Hills, M. Holmstrom, A. Klus, I. Martinez-Sanchez, M. Mattiisen, H. Molder, Y. Morakabati, J. Pamment, A. Sari, V. Sazonov, G. Simons, and J. Terra, *Hybrid Threats: A Strategic Communications Perspective* (Riga: NATO Strategic Communications Centre of Excellence, 2019). https://stratcomcoe.org/pdfjs/?file=/publications/download/2nd_book_short_digi_pdf.pdf.

Australian Government, *Policy Fit for Future: The Australian Government's Futures Primer* (Canberra: National Security College, Australian National University), 23 July 2024. https://nsc.anu.edu.au/content-centre/research/policy-fit-future-australian-government-futures-primer.

Bednarz, E.M., A.H. Butler, D. Visioni, Y. Zhang, B. Kravitz and D.G. MacMartin, 'Injection Strategy—A Driver of Atmospheric Circulation and Ozone Response to Stratospheric Aerosol Geoengineering', *Atmospheric Chemistry and Physics* 23, Nº 21 (2023): 13665–84. https://doi.org/10.5194/acp-23-13665-2023.

Bilal, Arsalan, 'Hybrid Warfare—New Threats, Complexity, and Trust as the Antidote', *NATO Review*, 30 November 2021.

Buck, H.J., P. Shah, J.Z. Yang, et al., 'Public Concerns about Solar Geoengineering Research in the United States', *Communications Earth & Environment* 6 (2025): Nº 609. https://doi.org/10.1038/s43247-025-02595-5.

Central European University, Department of International Relations, 'The Grand Russian Disinformation Strategy in Environmental Politics', 2024. https://ir.ceu.edu/ohpa/research_blog/articles/rusdisinformation.

Debnath, R. et al., 'Social Media Posts around Solar Geoengineering Spill Over into Conspiracy Theories', *University of Cambridge Research News*, February 2023. www.cam.ac.uk/research/news/social-media-posts-around-solar-geoengineering-spill-over-into-conspiracy-theories [accessed 21 October 2025].

Ellison, Tom, and Brigitte Hugh, *Climate Security and Misinformation: A Baseline* (Council on Strategic Risks, 23 April 2024). https://councilonstrategicrisks.org/2024/04/23/climate-security-and-misinformation-a-baseline.

European Commission, *Tackling Online Disinformation: A European Approach* (Brussels: European Commission, 2018). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0236.

European Union External Action, *3rd EEAS Report on Foreign Information Manipulation and Interference Threats: Exposing the Architecture of FIMI Operations* (March 2025). www.eeas.europa.eu/sites/default/files/documents/2025/EEAS-3nd-ThreatReport-March-2025-05-Digital-HD.pdf.

Haywood, J.M., O. Boucher, C. Lennard, T. Storelvmo, S. Tilmes, and D. Visioni, 'World Climate Research Program Lighthouse Activity: An Assessment of Major Research Gaps in Solar Radiation Modification Research', *Frontiers in Climate* 7 (2025). http://doi.org/10.3389/fclim.2025.1507479.

Hilberts, S., M. Govers, E. Petelos, and S. Evers, 'The Impact of Misinformation on Social Media in the Context of Natural Disasters: Narrative Review', *JMIR Infodemiology* 5 (2025), 5:e70413. https://doi.org/10.2196/70413.

IPCC, *Climate Change 2021: The Physical Science Basis. Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, 2021), ch. 4. www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_FullReport.pdf.

Lavery, Trish J., Dexter Docherty, Cale Hubble, and Chiara Varazzani, 'Navigating Uncertainty: Combining Behavioural Science and Strategic Foresight for a Systemic Approach to Decision-Making', *Behavioural Economics Guide 2023* (2023).

DOI 10.30966/2018.RIGA.16.3

MacMartin, D.G., P.J. Irvine, B. Kravitz and J.B. Horton, 'Technical Characteristics of a Solar Geoengineering Deployment and Implications for Governance', *Climate Policy* 19, Nº 10 (2019): 1325–39. https://doi.org/10.1080/14693062.2019.1668347.

Monteiro, Bruno, and Rodrigo Dal Borgo, *Supporting Decision Making with Strategic Foresight: An Emerging Framework for Proactive and Prospective Governments* (Paris: OECD, 2023). www.espas.eu/files/OECD-September-2023.pdf.

NATO Standardization Office (NSO), *AAP-6, NATO Glossary of Terms and Definitions* (2018), p. 62.

Nemr, Christina, and William Gangware, *Weapons of Mass Distraction: Foreign State-Sponsored Disinformation in the Digital Age*, US Department of State Report, March 2019. www.state.gov/wp-content/uploads/2019/05/Weapons-of-Mass-Distraction-Foreign-State-Sponsored-Disinformation-in-the-Digital-Age.pdf.

OECD, *Misinformation and Disinformation: An International Effort Using Behavioural Science to Tackle the Spread of Misinformation*, *OECD Public Governance Policy Papers*, Nº 21 (Paris: OECD Publishing, 2022). https://doi.org/10.1787/b7709d4f-en.

Parker, A., and P.J. Irvine, 'The Risk of Termination Shock from Solar Geoengineering', *Earth's Future* 6, Nº 3 (2018): 456–67. https://doi.org/10.1002/2017EF000735.

Reynolds, J.L., *The Governance of Solar Geoengineering: Managing Climate Change in the Anthropocene* (Cambridge University Press, 2019).

Royal Society, *Solar Radiation Modification*, Policy Briefing (Royal Society, 2025). https://royalsociety.org/-/media/policy/projects/solar-radiation-modification/solar-radiation-modification-policy-briefing.pdf.

Scharf, Cynthia, Giulia Neri, Matthias Honegger, Roxane Cordier, '*Climate Interventions: Policymakers' FAQ—CFG*', *Centre for Future Generations*, 12 June 2025, https://cfg.eu/policymakers-faq-climate-interventions.

Scientific Advice Mechanism to the European Commission, *Solar Radiation Modification: Evidence Review Report* (Brussels: European Commission, 2024). https://doi.org/10.5281/zenodo.14283096.

Sikorsky, Erin, and Tom Ellison, *Geoengineering and Climate Change in an Age of Disinformation and Strategic Competition* (Council on Strategic Risks, 23 April 2024). https://councilonstrategicrisks.org/2024/04/23/geoengineering-and-climate-change-in-an-age-of-disinformation-and-strategic-competition.

Smith, Wake, 'The Cost of Stratospheric Aerosol Injection through 2100', *Environmental Research Letters* 15, Nº 11 (2020). https://doi.org/10.1088/1748-9326/aba7e7.

SRM360, 'SRM Funding Overview', 14 May 2025. https://srm360.org/article/srm-funding-overview [accessed 12 October 2025].

Tingley, D., and G. Wagner, 'Solar Geoengineering and the Chemtrails Conspiracy on Social Media', *Palgrave Communications* 3 (2017): Nº 12. https://doi.org/10.1057/s41599-017-0014-3.

UK Government Communication Service, *PITCH Toolkit* (London: Cabinet Office, 2023). https://gcs.civilservice.gov.uk/wp-content/uploads/2023/12/6.8586_CO_PITCH-Toolkit_v6a_WEB.pdf.

UK Government Communication Service, *RESIST-2 Counter-Disinformation Toolkit* (London: Cabinet Office, 2021). https://gcs.civilservice.gov.uk/publications/resist-2-counter-disinformation-toolkit.

UK Government Communication Service, *Strategic Communication: A Behavioural Approach* (London: Cabinet Office, 2020). https://gcs.civilservice.gov.uk/wp-content/uploads/2020/03/Strategic-Communications-a-behavioural-approach.pdf.

United Nations Environment Programme, *One Atmosphere: An Independent Expert Review on Solar Radiation Modification Research and Deployment*, 28 February 2023. https://wedocs.unep.org/handle/20.500.11822/41903.

US House of Representatives Committee on Science, Space, and Technology, *Russian Attempts to Influence U.S. Domestic Energy Markets by Exploiting Social Media: Majority Staff Report* (Washington, DC: House of Representatives, 1 March 2018). https://republicans-science.house.gov/sites/republicans.science.house.gov/files/documents/SST%20Staff%20Report%20-%20Russian%20Attempts%20to%20Influence%20U.S.%20Domestic%20Energy%20Markets%20by%20Exploiting%20Social%20Media%2003.01.18.pdf.

Wainright, J., and G. Mann, 'Climate Leviathan', *Antipode* 45, Nº 1 (2012): 1–22.

White House Office of Science and Technology Policy, *Congressionally Mandated Research Plan and an Initial Research Governance Framework Related to Solar Radiation Modification*, 30 June 2023. https://bidenwhitehouse.archives.gov/ostp/news-updates/2023/06/30/congressionally-mandated-report-on-solar-radiation-modification [accessed 12 October 2025].

World Commission on the Ethics of Scientific Knowledge and Technology, *Report of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) on the Ethics of Climate Engineering* (Paris: UNESCO, 28 November 2023). https://unesdoc.unesco.org/ark:/48223/pf0000386677.