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Solar Radiation Management and the Voluntary Carbon Market

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Geoengineering techniques seek to respond to climate change on a planetary scale by counteracting the global warming effects of the emission of greenhouse gases, principally Carbon Dioxide (CO_2).[1] These techniques are normally grouped into: Carbon Dioxide Removal (CDR), such as Afforestation; and Solar Radiation Management (SRM). An example of an SRM technique is Stratospheric Aerosol Injection which replicates the global cooling effects of volcanic eruptions by artificially injecting the stratosphere with sulphate aerosols. The aerosols increase the earth's albedo (whiteness), reflecting sunlight. SRM is a contentious emerging technology with many detractors. Nevertheless, deliberate and direct management of rising global temperatures may be an attractive means to control the potentially devastating consequences of uncontrolled anthropogenic climate change. Supporters of SRM may argue that allowing carbon emissions to continue is itself a type of deliberate climate manipulation, and SRM restores the world to a more natural state.

Uncertainties over the effects of SRM persist. Regional temperatures and precipitation responses to SRM vary,[2] thus there may be 'winners' and 'losers'. Further, there are concerns as to the response of the climate system if SRM deployment is stopped – known as 'termination shock'.[3] Mindful of the social, political and economic contexts in which SRM would take place, the Royal Society in 2009 called for SRM to be subject to governance structures.[4]

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[1] National Academy of Sciences, Climate Intervention: Reflecting Sunlight to Cool Earth, (National Academies Press: Washington, DC 20001, 2015); J. G. Shepherd et al, Geoengineering the Climate: Science, Governance and Uncertainty, (Royal Society: London 2009).
[2] K. L. Ricke, M. Granger Morgan & M. R. Allen, 'Regional Climate Response to Solar-Radiation Management' (2010) 3 Nature Geoscience 537-541, doi:10.1038/ngeo915.
[3] A. Jones et al. 'The impact of abrupt suspension of solar radiation management (termination effect) in experiment G2 of the Geoengineering Model Intercomparison Project (GeoMIP)' (2013) 118 Journal of Geophysical Research Atmospheres 9743–9752, doi:10.1002/jgrd.50762.
[4] See Shepherd et al, above n.1.

SRM techniques pose thorny issues for governance frameworks because they present new 'global risks' and can be implemented quickly, cheaply and unilaterally.[5] Most geoengineering literature on potential SRM deployments concentrates on threats involving a global alliance,[6] powerful bloc of countries,[7] rogue state, or wealthy individual.[8] A focus on these potential deployment scenarios has had three implications for governance issues. First there is the implicit expectation of a substantial 'barrier to entry' before a prominent actor commences SRM, not least because it may be assumed that the first mover would bear, or organise, the entire programme cost. This delay allows regulators a 'breathing space' before likely deployment. Secondly, the dominant justification for SRM governance scholarship has been to provide regulation which serves the public interest, rather than private interests. An explicit example is the first Oxford Principle that 'geoengineering is to be regulated as a public good'.[9] This principle underpins the primary assumption of public regulatory mechanisms and is evidenced in the domination of public international legal instruments, etc. Thirdly, and relatedly, the state(s) are typically viewed as the principal actor, as reflected in formal international legal structures such as the proposed amendments to the Convention on Biodiversity.[10] Even when private deployment is considered in the literature, typically it takes the form of a rich individual 'Greenfinger'[11] (a pun on the 'Goldfinger' character from Fleming's 'James Bond') rather than a loose transnational network of private actors intervening in the climate deliberately, but without any overarching public control.

States themselves appear reluctant to regulate. In 2009-2010 the UK House of Commons Science and Technology Committee recommended the development of a regulatory framework for geoengineering.[12] The government's response was that, since

[5] See National Academy of Science, above n.1 at 4.
[6] B. Banerjee, G. Collins, S. Low & J. Blackstock, Scenario Planning for Solar Radiation Management, (Yale Climate and Energy Institute: Workshop Report and Scenarios, 2013).
[7] K. L. Ricke, J. B. Moreno-Cruz & K. Caldeira, 'Strategic Incentives for Climate Geoengineering Coalitions to Exclude Broad Participation' (2013) 8 Environmental Research Letters 014021.
[8] J. Stilgoe, Experiment Earth: Responsible Innovation in Geoengineering, (Routledge: Abingdon, Oxon, 2015).
[9] S. Rayner, C. Heyward, T. Kruger, N. Pidgeon, C. Redgwell & J. Savulescu, 'The Oxford Principles' (2013) 121(3) Climatic Change 499-512.
[10] Decision X/33 CBD which addresses climate engineering.
[11] See Stilgoe, above n. 8 at 89.
[12] UK House of Commons Science and Technology Committee, The Regulation of Geoengineering 2010, Fifth Report of Session 2009-2010, HC 221, at para 55.

the science was too young, it was too early for a regulatory framework to be established.[13] Partly as a result of such delays, decisions about the social benefit of SRM have not been settled. In 2015, governance structures are, at best, nascent and focused on SRM research rather than deployment.[14] Consequently, decisions about the extent to which society benefits from SRM are at risk of being taken by default through an unrelated mechanism associated with private interests and rooted in the economic response to climate change: the voluntary carbon market.

The introduction of private interests, in the form of carbon credits, to the practice of public governance stems from the potential linking of SRM and CDR or mitigation technologies in voluntary carbon credit accounting. We suggest that if equivalence is established in the public mind between SRM and CDR, then entrepreneurs may have an incentive to use SRM to generate carbon credits. Through radiative forcing there is indirect equivalence of effect. Equivalence of effect exists because a given amount of SRM, were it to continue long-term, could offset closely a given amount of warming from CO_2. Further, forthcoming scientific research is likely to demonstrate that a direct CDR benefit occurs as a result of SRM via carbon cycle changes.[15] In other words, SRM causes a genuine reduction in atmospheric CO_2 for at least as long as the intervention continues.

This theoretical deployment scenario depends entirely on the business case for implementation. SRM is relatively cheap and quick to deploy[16] hence its attraction as a means to address climate change. For near-term, small-scale deployment by independent entrepreneurs, a low setup cost is essential. At least three reported techniques offer potential for small-scale, short-term SRM deployments.[17] For Stratospheric Aerosol Injection, delivery can be made by commercially-available high-

[13] UK Government, Government Response to the House of Commons Science and Technology Committee 5th Report of Session 20009-10: The Regulation of Geoengineering, 2010, at point 9 of page 4.
[14] J. Sargoni, Characterising the Legitimate Regulation of Geoengineering Research, (University of Bristol PhD Thesis, 2014).
[15] The forthcoming research paper on solar radiation management and carbon concentrations is anticipated from C. L. Zabel & D. W. Keith based on a poster presented at the Climate Engineering Research Symposium 2015 organised by GEOMAR Helmholtz Centre for Ocean Research Kiel, 7th July – 10th July Berlin.
[16] J. McClellan, D. W. Keith & J. Apt, 'Cost Analysis of Stratospheric Albedo Modification Delivery Systems' (2012) 7 Environmental Research Letters 034019.
[17] Ibid.

altitude balloons or by making limited modifications to small business jets. Airplanes are likely to have higher fixed costs and lower variable costs. Marine Cloud Brightening is an alternative, more speculative technique.[18] It relies on spraying a fine mist of seawater from ships or from ocean islands. All these methods have a setup cost within the budgets of many independent entrepreneurs or individual investors.

Only the voluntary carbon market is available for validating and marketing any credits produced by SRM. The compliance carbon markets of emissions trading schemes (e.g. European Union Emissions Trading Scheme, New South Wales Greenhouse Gas Reduction Scheme) strictly regulate the provenance of carbon credits, effectively making them non-tradeable beyond the boundaries of the scheme. By contrast, the voluntary carbon market offers a more flexible system which may be open to SRM carbon credits. Some parts of the voluntary carbon market have had legally binding obligations[19] whereas others such as the offset market, do not. It is the absence of an overarching framework that makes the voluntary carbon-offset market potentially suitable for trading SRM carbon credits.

The principal direct effects of SRM are temporary, lasting around one to two years. SRM scenarios considered by scientists therefore typically anticipate deployment for decades or centuries[20] to reflect the long lifetime of atmospheric CO_2, the effects of which last for centuries or millennia.[21] This temporal mismatch between short-term interventions and long-acting CO_2 has not prevented other short-term methods, such as tree-planting, from being used to generate carbon credits.[22] Two different accounting solutions may be used to address the mismatch problem. Firstly, resource may be provided for SRM's continuation in the long-term (comparable to an endowment or annuity). Secondly, SRM could be delivered in a short pulse – akin to the bulk purchase of a product which is used at a steady rate. A typical 'pulse' approach might be to deliver enough cooling within a few months or years, to offset the first 100 years of warming from a given amount of CO_2. This process would make the SRM purchased

[18] See Shepherd et al, above n.1 at 27-28.
[19] Such as the Chicago Climate Exchange which closed in 2010.
[20] See A. Jones et al, above n.3.
[21] M. Inman, 'Carbon is Forever' (2008) News Feature: Nature Reports Climate Change, doi:10.1038/climate.2008.122.
[22] World Bank, 'Reforestation Pilot in China is Earning Carbon Credits' (2012) Press Release, News.

generate net cooling on a timescale comparable to the lifetime of a tree. While these accounting methods may appear questionable, carbon credit accounting is already imperfect and controversial,[23] and yet there is a market demand for it.

There is, therefore, a realistic possibility that SRM could generate 'carbon credits' – direct or equivalent – that could be verified to the satisfaction of the voluntary carbon credit market. In the absence of obvious regulatory barriers, it could happen soon. Consequently, decisions about SRM governance need to be expedited. However, if negative perceptions restrict the market for these 'factory farmed' credits, market forces may regulate this SRM activity automatically, with buyers seeking traditional 'organic' alternatives. In the absence of state regulation, it is arguable that *any* constraint, albeit an economic concomitant one, is better than none.

Were a market to exist, the price of 'factory-farmed' SRM credits may not include the true cost of SRM to society, thereby turning it into a market externality. At this time, SRM research is unable to quantify accurately social risks, benefits and costs.[24] Whilst global temperatures will decrease following SRM, regional impacts on temperature and precipitation remain uncertain.[25] Moreover, any risk of harmful climatic disruption is likely to be exaggerated by a free-for-all in deployment loci and timing. Allowing the market to make unaided and unfettered decisions about the social benefit of SRM would be to rob all constituents, including scientists, of a say in that decision. Potentially a political economy of SRM that lacks democratic legitimacy or scientific consensus could be generated.

Here we enter, albeit with a twist, the familiar debate about the relative merits of political or economic responses to climate change. Were there to be a large-scale deployment of uncontrolled SRM, the voluntary market-based mechanism would not necessarily reduce carbon emissions but may produce very real physical, political and security risks. A political response is needed. We suggest that states expedite the

[23] R. Hodgson, 'Carbon-Credit Scheme Linked to Increased Greenhouse-Gas Production' (2015) Nature doi:10.1038/nature.2015.18238; L. Schneider & A. Kollmuss,'Perverse Effects of Carbon Markets on HFC-23 and FS_6 Abatement Projects in Russia' (2015) *Nature Climate Change* http://dx.doi.org/10.1038/NCLIMATE2772.
[24] National Academy of Sciences above n.1, at 8.
[25] Ibid.

development of governance structures: firstly, to maximise the possibility of securing legitimate decisions about the potential costs and benefits to society of SRM and its research; and secondly, to prepare to intervene, when necessary, in voluntary carbon markets by regulating legitimately the use of SRM in the production of carbon credits.