

## Solar geoengineering

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# Solar Geoengineering: The View from Just War/Securitization Theories

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## Abstract

As the world continues to fail to reduce and control global surface temperatures, the use of solar radiation management (SRM) technology by one actor or by a small coalition of actors is becoming increasingly likely. Yet, most of the social scientific literature on solar geoengineering does not tend to systematically engage with this possibility; scholars focus either on global governance or on banning SRM usage and research altogether. On the margins of this debate, a handful of researchers have sought to bring insights from the just war tradition to the issue of unilateral and minilateral SRM usage. This article is concerned with the contribution just war/securitization theories can make to our understanding of the debate surrounding climate engineering. It scrutinizes and deepens existing attempts by just war scholars to examine the moral permissibility of unilateral and minilateral SRM usage, including from the perspective of Just Securitization Theory.

## Resumen

A medida que el mundo sigue siendo incapaz de reducir y controlar las temperaturas globales de la superficie, el uso de la tecnología de gestión de la radiación solar (SRM, por sus siglas en inglés) por parte de un agente o de una pequeña coalición de agentes es cada vez más probable. Sin embargo, la mayor parte de la bibliografía científica social sobre geoingeniería solar tiende a no abordar de manera sistemática esta posibilidad: los académicos se centran en la gobernanza global o en prohibir por completo el uso y la investigación en materia de SRM. Al margen de este debate, existe un grupo de investigadores que han tratado de aportar ideas procedentes de la tradición de la guerra justa a la cuestión del uso de la SRM tanto unilateral como minilateral (por parte de un número reducido de países). Este artículo trata acerca de la contribución que las teorías de guerra justa y de securitización pueden aportar a nuestra comprensión del debate en torno a la ingeniería climática. El artículo estudia y profundiza en los intentos existentes por parte de los académicos en el campo de la guerra justa para examinar la permisibilidad moral del uso unilateral y minilateral de la SRM, incluso desde la perspectiva de la Teoría de la securitización justa.

## Résumé

Alors que le monde ne parvient toujours pas à réduire et contrôler les températures de la surface terrestre, l'utilisation de la technologie de gestion du rayonnement solaire (GRS) par un acteur ou une

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petite coalition d'acteurs devient de plus en plus probable. Pourtant, la majorité de la littérature scientifique sociale relative à la géo-ingénierie solaire a tendance à ne pas systématiquement s'intéresser à cette possibilité. Les chercheurs se concentrent soit sur la gouvernance mondiale, soit sur l'interdiction pure et simple de l'utilisation de la GRS et la recherche sur le sujet. En marge de ce débat, une poignée de chercheurs ont cherché à tirer des enseignements de la tradition de guerre juste pour la problématique de l'utilisation unilatérale ou multilatérale de la GRS. Cet article s'intéresse à la potentielle contribution des théories de guerre/sécuritisation juste quand il s'agit de comprendre le débat relatif à l'ingénierie climatique. Il analyse et approfondit des tentatives passées de chercheurs travaillant sur la guerre juste pour examiner l'admissibilité morale de l'utilisation unilatérale ou multilatérale de la GRS, notamment du point de vue de la théorie de la sécuritisation juste.

**Keywords:** just war, just securitization, climate change, geoengineering, global justice, solar radiation management

**Palabras clave:** guerra justa, securitización justa, cambio climático, geoingeniería, justicia global, gestión de la radiación solar

**Mots clés:** guerre juste, sécuritisation juste, changement climatique, géo-ingénierie, justice mondiale, gestion du rayonnement solaire

## Introduction

In 2006, the world-renowned atmospheric scientist and Nobel laureate Paul Crutzen caused a proverbial storm when he—in an editorial essay in *Climatic Change*—argued in favor of sustained research into stratospheric solar radiation management (SRM; Crutzen 2006). These are technologies aimed at increasing Earth's reflective capacities (albedo effect) to reduce global surface temperatures. The two most prominent SRM technologies are stratospheric aerosol injection and marine cloud brightening (SRMGI 2021). Importantly, both would be deployed from the global commons: the first in the stratosphere and the second on the high seas.

Crutzen's intervention was *not* determined by a belief in a quick technological fix for climate change, but by the observation that the world seems unable to bring down global carbon emissions, and therefore temperatures, in good time (i.e., before a crucial threshold of *X* number of degrees of warming is reached). Crutzen died in January 2021, by which time SRM had not only become seriously considered by teams of researchers the world over but increasingly regarded as at least a “stop-gap” to global temperature rise (see also Chalmin 2019; Tollefson 2021; Patrick 2022, 7). Given this, it seems reasonable to hold that SRM will form some part of the fight against global climate change in the future. After all, while such action includes many risks and downsides, “there is very little scientific doubt that using SRM approaches would cool particular regions or the planet” (Nicholson 2020, cf. Ming et al. 2014; Reynolds 2019). Moreover, while these technologies remain in the experimental phase, *if* global surface temperatures continue to rise, then desper-

ation could drive actors to deploy such technologies either unilaterally or most likely in small groups (i.e., minilaterally) (cf. Keith 2020).

This article is concerned with the justice of unilateral and minilateral deployment of solar geoengineering. Before I can start, a disclaimer is in order. I do not hold or suggest that the unilateral deployment of SRM is preferable to a global governance solution. I am interested in examining the moral permissibility of unilateral deployment, not because it is morally preferable to a global governance solution, but because it has been neglected (as we shall see, most scholars open to SRM research are focused on a global governance solution). And, because unilateral or minilateral deployment is currently a more likely scenario than a global governance solution (cf. Young 2023). To be sure, the likelihood of unilateral deployment does not render it more justifiable; it merely renders it worth our attention.

In much of the contemporary debate in the social scientific literature on SRM research and usage, this issue is eschewed: SRM is considered dangerous, unjust, and counter-productive (cf. Prelude). The exception is formed by a handful of scholars who invoke the just war tradition precisely to examine the issue of unilateral action, namely Elizabeth L. Chalecki and Lisa L. Ferraris' (2018) “just geo-engineering theory” and Kyle Fruh and Marcus Hedahl's (2019) “climate change is unjust war”. This article looks at this marginal literature, its logic, and its conclusions. It does this by comparing and contrasting arguments advanced by the two different pairs of authors with one another, as well as with Just Securitization Theory (JST; Floyd 2019a, b, 2022a, b), which leans heavily

on the just war tradition, but arguably can account for climate change as a threat better than aggressor-focused just war theories. Relatedly, this research doubles up as a critical test case of JST, not so much regarding whether it works, but instead whether it offers anything new vis-à-vis just war theory (JWT). Overall, this article is informed by the following research question: “How do just war/securitization theories contribute to our understanding of debates over climate engineering?”

The argument proceeds in three parts. Part one lays the groundwork for the analysis that follows. It briefly summarizes scholars’ concerns regarding SRM research and deployment, explaining why many scholars ignore the issue of the permissibility of unilateral deployment. It goes on to clarify why a minority of scholars have turned to JWT to discuss this issue. The section ends by suggesting that geoengineering is perhaps best understood as a case of exceptional security practice aka securitization. Following this, the section ends by briefly introducing JST (Floyd 2019a).

Part two examines the strengths and weaknesses of the two existing proposals that have applied JWT to SRM deployment. I will show that both fall short in significant ways: Just geoengineering theory chiefly because it morphs back into a global governance argument, while Fruh and Hedahl’s (2019) approach permits SRM usage only when states are—quite literally—disappearing (by sinking into the sea) or when they become uninhabitable. Moreover, given that the two pairs of authors disagree on several key points (including on the all-important issues of *who* may deploy such technology and under *what* circumstances) that analysis remains inconclusive.

The third section of this article considers the case of unilateral and/or minilateral SRM geoengineering from the point of view of JST. The evidence suggests that JST has added value vis-à-vis JWT. In this specific case, it cannot only deal with the shortcomings of the existing just war approaches to SRM, but also, it can answer several additional questions raised by the prior analysis. Including on whether non-state actors may deploy SRM technology; if such deployment can ever be morally required and—given the risks—whether we should not simply ban research into climate engineering. Because JST—provided certain conditions are satisfied—permits the unilateral deployment of SRM technologies, this article will not sit easily with some prominent academics working on climate engineering, including in international relations, many of whom are party to a call for an international non-use agreement (Biermann et al. 2022). These scholars may very well consider this research argument dangerous, perhaps even immoral (cf. Reynolds 2021), imperialistic

(cf. Taylor Smith 2021), and paternalistic (Hourdequin 2020). Not at last because it recommends that the US government, including the Pentagon, should invest in SRM research (see also National Academies of Sciences, Engineering, and Medicine 2021). In response, however, I suggest that rather than reading the analysis as a refutation of their view, the findings are also a stark reminder of what will happen, indeed what will need to happen, unless the problem of climate change is finally properly addressed.

## Part 1: Prelude

At the present time, a commitment to SRM research is not equal across the world. Readers might be surprised to learn, for example, that the US government’s attention to SRM research is negligible (cf. Felgenhauer et al. 2022). A recent (April 2022) special report published by the Council on Foreign Relations shows that only three agencies—the National Oceanic and Atmospheric Administration (NOAA), the Department of Energy (DOE), and the National Science Foundation (NSF)—have funding for small, related studies, including, for example, the effect of conventional aerosol use on the atmosphere. In addition, NASA and the Pentagon also take note of the effects of aerosols. The Pentagon, for instance, monitors the effect of aerosols on military readiness (ibid, 17). Importantly, however, none of these agencies has a “mandate to monitor the feasibility and effects” of SRM (Patrick 2022, 16). By contrast, some of the US’s geopolitical rivals seem to be investing in research. Notably, China is not only putting money into relevant research, but it is expanding and increasingly using its localized weather modification program (Watts 2020). Likewise, for more than a decade, the Indian government has funded research into several different solar geoengineering projects, seemingly seeking to become a leader in this field (Bala and Gupta 2018). Moreover, several non-state actors, including rich philanthropists (notably Bill Gates), are funding research into SRM, especially in the United States (Stephens et al. 2021).

Among others, US and Chinese experts are all too aware that SRM technology poses a series of challenges, risks, and downsides (Dai et al. 2021). Some of these are ethical, including concerns about who will benefit from SRM, who will suffer adverse effects, and who will decide when and where to employ these technologies (for an excellent overview, see Heyward 2019). In addition, there are environmental issues to consider, including potentially irreversible alterations and changes to global hydrological cycles, including the monsoon rains, as well as effects (both positive and negative) on crop cycles and

crop yields (Saheed et al. 2018, 1). Above all else, there is the termination effect, namely the calculation that if SRM technologies are turned off abruptly, there will be a steep increase in warming. There is also the possibility that some SRM technologies will damage the ozone layer (SRMGI 2021). Finally, there are security challenges, including great power rivalry, which could lead to limited strikes and/or cyberattacks to eliminate SRM facilities of rivals (Lockyer and Symons 2019) and potentially also the weaponization of SRM technologies (Schellhuber 2011). In short, there are very good reasons to be concerned about SRM development and use.

Anticipating these and other problems, scholars, from a wide range of disciplines, have sought to pre-empt the damaging effects of SRM. For the most part, they seek to address the problems of SRM by advocating good or legitimate global climate engineering governance (e.g., Nicholson et al. 2018; Callies 2019; Gardiner and Fragnière 2020; Wolff 2020). Leading this area are the Oxford Principles, which demand that “Any decisions with respect to deployment should only be taken with robust governance structures already in place, using existing rules and institutions wherever possible” (Rayner et al. 2013). The idea behind such principles is sound. A just climate engineering regime based on consent, regulated transparently, by accountable decision-makers would reduce global political tensions and ameliorate impending security dilemmas. Moreover, those foreseeably harmed by SRM technologies could be compensated. Recent research based on empirical evidence gathered on the receipt of a draft resolution on geoengineering governance proposed by the UN Environment Assembly in 2019, however, shows that the creation of effective global governance on this issue is difficult to achieve (McLaren and Corry 2021). The authors found that “overall the evidence suggests that common assumptions in geoengineering research, presupposing comprehensive future governance of geoengineering, are unwarranted in a world where actors clash over goals as well as underlying interests but also differ on knowledge–politics and visions of world futures” (Ibid 2019, 21). This realization is also one of the reasons why several prominent scholars endorse an international non-use agreement on solar geoengineering. “The current world order seems unfit to reach such far-reaching agreements on fair and effective political control over solar geoengineering deployment” (Biermann et al. 2022).

This literature is insightful and important, however, because of its critical stance on SRM, it does not examine the important question: What kind of actors *may* unilaterally or in small groups (minilaterally) deploy SRM technologies, and under what circumstances? On the margins

of the social scientific geoengineering literature, a handful of scholars have, in separate publications, sought to answer these questions (see Chalecki and Ferrari 2018; Fruh and Hedahl 2019). Both pairs of authors do so with recourse to the just war tradition, which theorizes the moral permissibility of war. The reasons for this methodological choice are two-fold: First, JWT is a non-ideal theory; there would be no just cause for SRM use if all states brought down emissions through mitigation (Morrow and Svoboda 2016, 84; see also Pattison 2018a). Second, SRM bears in its exceptionality some comparison with war. Indeed, in the news media and other outlets there is increasing talk of a “war on climate change” (Burke 2019). If SRM is a form of war, then it makes sense to examine the issue from the point of view of the long-established just war tradition. Just war scholars theorize the morality of war by setting out universal moral principles on justice before, during, and after war. Importantly, just war scholars are not pro-war, but rather they aim “to restrain both the incidence and the destructiveness of warfare” (Orend 2006, 31). This means that any approach to SRM inspired by the just war tradition is likely to set a high threshold for when the use of SRM technologies is morally permissible.

While the JWT is a useful way into this problem, standard principles generated by the tradition are difficult to square with climate change, notably there is no aggressor intent on doing harm (certainly, in the JWT, self-defense and other-defense from aggression are the only just causes for war) (cf. Taylor Smith 2021, 139, 142ff). Moreover, while SRM might be an emergency measure that compares to war, it is not war per se; no matter how damaging it might be it does not involve combat and intentional killing. Still, it feels intuitively right to apply the JWT to SRM usage. A possible way out of this conundrum is to classify SRM as an exceptional security measure, or else securitization, not as war. Doing this then opens the possibility of applying JST (Floyd 2019a,b) to SRM usage. JST resembles the JWT closely, however, unlike all other attempts to theorize the ethics of force short of war (Gross and Meisels 2017; Pattison 2018b; Brunstetter 2021), JST is not limited to agent-intended threats<sup>1</sup> and can therefore account for climate change.

1 An agent-intended threat is “a threat that is intentionally levelled at another actor, order or entity. Agent-lacking threat = refers to a threat that does not originate from human agents (e.g., a truly natural disaster) [...] agent-caused threat = refers to a threat that is a consequence of an agent’s behaviour, but is not intended by that agent. I differentiate between two sub-types of agent-caused threats: 1) by obliviousness, i.e., when people do not

Moreover, given that in *The Morality of Security: A Theory of Just Securitization* (Floyd 2019a) and subsequent works on the issue (Floyd 2019b), JST is not applied to a singular empirical case; this article offers a valid test case for JST. That is, beyond the findings on SRM deployment, this article sheds light on the question of whether JST offers anything beyond JWT repackaged.

JST combines insights from securitization studies with JWT. The term securitization was coined by Ole Wæver (1995). He observed that in international relations issues transform into security threats not because of some objective reality, but when they are framed as such by powerful elites. In securitization studies, there is considerable debate over what securitization entails. For some scholars' securitization is merely rhetorical and pertains to the (mostly) verbal identification of a threat together with a specific grammar of security (point of no return, etc.) coupled with the acceptance by an "audience" (e.g., Vuori 2011; Côté 2016). For others, including the Copenhagen School, securitization succeeds when rhetoric and audience acceptance are followed by emergency action and the breaking of rules that otherwise bind (Buzan et al. 1998, 26). In short, successful securitization, as opposed to "merely" rhetorical securitization, is tantamount to exceptional security practice. Still, securitization can be hard to grasp. Unlike war, securitization is threat-dependent. This means that exceptional measures to address, for example, terrorism are likely to look quite different from those tailored at COVID-19. Overall, the descriptive words *exceptional* or *extraordinary* designate that what is done to address a given threat is at odds with "whatever passed as normal until an exception was installed" (Wæver and Buzan 2020, 6).

SRM could be—and is in this paper examined as—the full expression of a securitization against climate change, while it could also be just one of several security measures in a multi-pronged securitization of climate change.

JST is about the moral permissibility of securitization. The theory is divided into three parts: (1) the just initiation of securitization; (2) the just conduct in securitization; and (3) the just termination of securitization. Given that this paper focuses on deployment, it is concerned with the just initiation of securitization only. The just initiation of securitization consists of the following criteria:

1. **Just reason:** There must be an objective existential threat to a referent object, that is to say, a) realize that their (combined) actions are potentially threatening to other entities; or b) by harmful neglect i.e., when relevant agents fail to protect against foreseeable harmful events/consequences" (Floyd 2019a, xv).

danger that—with a sufficiently high probability—threatens the survival or the essential character/properties of either a political or social order, an ecosystem, a non-human species, or individuals.

2. **Just referent object<sup>2</sup>:** Referent objects are entitled to defend themselves or are eligible for defensive assistance if they are morally justifiable. Referent objects are morally justifiable if they meet basic human needs, defined here as necessary components of human well-being. Political and social orders need to satisfy a minimum level of basic human needs of people part of or contained within that order, and they must respect the human needs of outsiders. Ecosystems and non-human species, in turn, need to make a contribution to the human needs of a sufficiently large group of people. Human beings are justifiable referent objects by virtue of being intrinsically valuable; all other referent objects therefore have instrumental value derived from the needs of human beings.
3. **Right intention:** The right intention for securitization is the just cause. Securitizing actors must be sincere in their intention to protect the referent object they themselves identified and declared.
4. **Proportionality:** The expected good gained from securitization must be greater than the expected harm from securitization, where the only relevant good is the good specified in the just cause.
5. **Chance of success:** Securitization must have a reasonable chance of success, whereby the chances of achieving the just cause must be judged greater than those of [less harmful] alternatives to securitizing (Floyd 2019a, 19–20).

While JST is concerned only with the moral permissibility of securitization, it stands to reason that securitization may *sometimes* be morally required (obligatory) of relevant actors. Securitization is morally mandatory, only once other less harmful options have failed to satisfy just cause and securitization is the "last" option (Floyd in Sardoč 2021; Floyd forthcoming). This is different from the moral permissibility of securitization; here, in accordance with the success condition, securitization is morally permissible when it is judged *ex ante* to have better chances of succeeding in addressing just cause than less harmful feasible alternatives (Floyd, 2019, chapter 5). At the point when such alternatives have been tried as opposed to their effects merely anticipated; however, relevant actors do not merely have

- 2 Just reason + just referent object = just cause (Floyd 2019a, 20).



a just cause, but instead a “*must cause*” to securitize (Floyd cited in Sardoč 2021, 146; Floyd forthcoming). We can find a similar logic among scholars of armed humanitarian intervention, albeit then under the term “last resort”. By contrast, among just war scholars, the decision on whether to go to war is considered the prerogative of states, and moral obligation is usually not further discussed (cf. Oberman 2015).

## Part 2: Just Geoengineering Theory and “Climate Change Is Unjust War”

Elisabeth Chalecki and Lisa Ferrari’s just geoengineering theory starts from the twin observation that there is a lacuna of “any specific laws, treaties, or norms governing planetary technologies” and that “geoengineering on any but the smallest scale means that one state may be able to substantially change the material conditions in another state or even globally on a unilateral basis” (2018, 83). Here, as elsewhere in the just war tradition, the concern is with restraining the use of force while acknowledging that it might still sometimes be morally permissible. “Just geoengineering theory” starts from the legal requirement that only defensive force, including defensive “environmental force” (ibid, 84), is morally permissible. The theory’s *jus ad climate engineering* component tracks all major criteria of *jus ad bellum* (namely just cause, proportionality, last resort, right intention, legitimate authority, and it has a success condition) if not necessarily under those headings, or rather, at times distinct principles are combined. In more detail, just cause for geoengineering is conceptually wide. Chalecki and Ferrari recognize that climate-induced existential threats are unequal, to wit, they depend on the relative ability of a state to cope with, for example, droughts, flash floods, and crop failure. Instead of capturing a wide existential threat theoretically, Chalecki and Ferrari propose that we rely on the “competent national authority” to define *ex ante* what thresholds (in lives lost and financially) constitute an existential threat (ibid, 95). As such, just cause encompasses proportionality, as only harms that do big enough damage and not environmental damage *simpliciter* qualify. The competent national authority is the state (which is to say government) + climate experts (Ibid, 93).

Chalecki and Ferrari also specify the right intention; they hold that the “security threat must be publicly attributable to climate change” (Ibid, 95). Moreover, their theory contains a success criterion. They hold that “the real or assumed cost of equivalent climate change mitigation or adaptation efforts must be “too high” to afford or take “too long” to be effective” (ibid, 95). In

other words, geoengineering must have a better chance at satisfying just cause than other politically viable less harmful alternatives. Chalecki and Ferrari’s next criterion comes closest to JWT’s legitimate authority. In JWT, legitimate authority “restricts the right to wage war to certain entities”—usually states (Reitberger 2013, 65). Chalecki and Ferrari propose that national decisions to use geoengineering need to be signed off by the UN Security Council. In more detail, they argue that

National decisions concerning evaluation of just war criteria, and determination of national security in general, are not usually subject to international discussion before they are implemented. But geoengineering technologies are not like other weapons due to their unique combination of global reach, potential for nonlinear effect, and fundamental implications for the liveability of our planet. Any type of weapon used in modern conflict can be subject to the just war constraints of proportionality and discrimination; geoengineering technologies should be as well. Barring formation of a new body, the only standing body that could provide such consent, and hence legitimacy under our just geoengineering theory criteria, is the UN Security Council. This means that any discussion of deployment would be subject to the veto of the five permanent members, which may act as a restraining force on states seeking approval for deployment (Chalecki and Ferrari 2018, 96–97).

Let me now turn to evaluating this proposal. I want to begin by stating that there is much I agree with here. Many concerns regarding, for example, the success condition and the right intention are relevant and valid. In other words, my aim here is not to criticize the effort wholesale, but to examine how useful just geoengineering theory is in informing the just use of SRM technologies of individual states. Recall here that we started from the assumption that unilateral or minilateral SRM usage is on the cards in the foreseeable future.<sup>3</sup> With this in mind, we can see that the major shortcoming with just geoengineering theory is that it effectively collapses into a global governance solution because here the UNSC is the arbiter of SRM deployment.<sup>4</sup> To be clear, I do not wish to dismiss global governance solutions to SRM. I do not doubt that a global governance approach to

3 Notably, IPCC 2022 assessment report for the first time—albeit briefly—makes mention of solar radiation management techniques.

4 For more on the pivotal role of the UN in global governance, see <https://globalchallenges.org/global-governance/>.

SRM is preferable to unilateral action. My point here is simply that just geoengineering theory does not deliver in theorizing bona fide unilateral deployment of SRM technologies.

A second weakness of the proposal is that the threshold for the just reason is subjective, not objective. Though the authors try and objectify just reason by arguing that “the estimated damage must meet some threshold in lives or dollars” (Chalecki and Ferrari 2018, 95), they hold that the competent authority decides what the threshold is. Hence, the competent authority could set a very low threshold for just cause.

Kyle Fruh and Marcus Hedahl’s (2019) work on “Climate change is unjust war” examines “whether and how the use of SRM technology could be justified *in the absence* of an international consensus” (386: emphasis in the original). Fruh and Hedahl do not develop a just SRM deployment theory. Their ultimate concern is with achieving climate justice. Instead of following the well-trodden path of examining what obligations affluent states have on this issue toward the poor (see various in Gardiner et al. 2010), the authors argue that climate change itself is tantamount to unjust war, ergo self-defense by those most severely affected is morally permissible. Unilateral deployment of SRM technologies is one form of self-defense. Given that the authors ultimately wish to avoid the latter, they use the possibility of justified “war” not to sanction or endorse such action, but to encourage wealthy and relatively climate-secure states to stop the situation from getting so bad that SRM technologies will be used. In short, like other just war scholars, they aim to reduce the occurrence of “war” not to vindicate it.

So much on the general aim of Fruh et al.’s paper, let us now turn to the details. The authors begin by making several salient points regarding the suitability of intent-lacking threats for just war theorizing. They argue:

As the Westphalian order of nation states solidified, punishment was removed as a just cause for war’ [...] ‘the move away from punishment as a just cause is a move toward threats *themselves* rather than the intentions behind those threats. Modern justification for war has less to do with locating the analogue of *mens rea* in an aggressor than it does with recognizing the existence of incursion on sovereignty, regardless of how or why it has come about (Fruh and Hedahl 2019: 387-88, emphases in original).

In short, a defensive war does not have to be aimed *against* someone. Moreover, they show that the magnitude of threats, not their origin (i.e., agent-intended or intent-lacking), ought to be decisive for just war. Given that the authors go through this effort it is surprising

that—within their proposal—just cause for unilateral SRM technology use is conceptually narrow. Whereas Chalecki and Ferrari hold that what counts as an existential threat for individual states is subjective (2018, 95), Fruh et al. mean threats of a magnitude spelling the actual survival of the state. Notably, climate threats that would make the state uninhabitable or sea-level rise leading to the disappearance of states (ibid, 382, 390 FN 13, p.394).

Fruh and Hedahl go on to consider each of the standard *ad bellum* requirements and affirm each one in turn. In many ways, their proposal matches that of Chalecki and Ferrari discussed above. Right intention as resting with satisfaction of just cause features, so does macro-proportionality and a comparative—vis-à-vis less harmful alternatives—success condition. The last resort is interesting insofar as the authors consider state relocation (a proposal sought by some leaders of low-lying small island states), not an alternative to be tried before the last resort is satisfied. They, and in my view correctly, argue that “Establishing a limited but operational government in another state’s sovereign territory still capitulates in important respects to the threatened state’s demise” (Ibid, 394).

Given that the authors write about bona fide unilateral SRM use, it is not surprising that they have a different view on legitimate authority than the previous pair of authors. Fruh et al. do not insist on UNSC approval, rather—like many within the just war tradition—they hold that states satisfy the criterion of legitimate authority when they are “democratic states that respect human rights and whose government are alighted with the interests of their citizens” (Ibid, 390; cf. Orend 2006).

So far so good. Let us now critically examine their proposal. For our purposes here, the major shortcoming of Fruh and Hedahl’s proposal is that the threshold for just cause is too high. Only a very small number of states are at risk of becoming uninhabitable because of climate change, while populations of all states will feel the human and other security implications of climate change (IPCC 2014). While those affected may still be able to inhabit their state, ways of living and traditions can become so severely challenged that sufferers are no longer able to live life in the way they used to. There are countless examples. Consider, for instance, the fate of the Saami people in the Arctic. “Snow plays a central role in the Saami way of life and their reindeer herding culture, [...] as the amount and structure of snow in the area changes, and the snow-free season grows longer, it is triggering changes to Saami culture, language, and livelihoods” (WWF 2021).

A further limitation of the proposal is that it mentions only national self-defense as a just cause, but



not other-defense. Given that (low-lying and thus most vulnerable to rising sea levels) Tuvalu, Bangladesh, Kiribati, and the Maldives are poor developing states they are unlikely to be able to pay for SRM technologies, many of which would have to be run continuously to be effective. However, if the criteria for “jus ad SRM” are satisfied it raises the question whether another more powerful state, or actor would be permitted, indeed morally required, to come to the rescue of a threatened state by deploying SRM technology? On the first point, Fruh et al.’s proposal merely states that other states are justified to launch SRM technologies if it comes “at the behest of the threatened states themselves” (Ibid, 395). However, this begs two further questions: (1) Can states have a moral obligation to deploy such technologies to save strangers without their consent (note, in this context, that the Sami people are opposed to geoengineering [McGwin 2021])? (2) Can non-state actors have such duties?

To summarize, while there is much of value in both articles, for the purposes of this paper, a few weaknesses persist. Some of these result from under-theorization, others from the fact that the two pairs of authors hold opposing views on key issues. In more detail:

- (1) It remains unclear whether, and if so why, unilateral deployment of SRM technologies is morally permissible? Fruh and Hedahl think it is morally permissible provided that deploying states are just and existentially threatened, whereas Chalecki and Ferrari insist on UNSC approval and hence effectively deny the possibility of just unilateral action.
- (2) If (1) can be answered in the affirmative, then it remains unclear *who* is morally permitted to launch such measures? Fruh et al. think legitimate authority is central; however, it remains unclear how this would translate to capable non-state actors? Moreover, what if illegitimate states have both the means and the right intention, could they not be trusted to do a just deed?
- (3) It remains unclear what the just reason (part of just cause) for the deployment of SRM technologies is? The two pairs of authors are at opposite ends of a possible spectrum. Hence, for Chalecki and Ferrari, “threatiness” (Wæver 2009, 20) is essentially subjective, while Fruh and Hedahl operate with what others have called a “beyond the pale” (Morrow and Svoboda 2016) definition of just cause.
- (4) Finally, if climate engineering is morally permissible, can it also be morally required of capable actors? If so, who can be required to act in this way?

And when precisely do we move from permissibility to obligation?

In what follows, I will endeavor to examine whether JST can provide answers to these questions, in the process establishing the added value of JST vis-à-vis JWT.

### Part 3: Just and Mandatory Securitization: Answers to Four Outstanding Questions/Issues

Unlike the other papers examined and the vast majority of just war theories, JST does not contain legitimate authority as part of its just initiation criteria (cf. above). In *standard*, which is to say traditional, not revisionist, JWT, the requirement of legitimate authority determines whose “belligerent activities are eligible for justification” [because] “for a war to be morally justified, it must be fought by an entity that possesses a certain set of properties. Wars fought by entities lacking such properties are unjustified” (Parry 2017, 170). In a word, legitimate authority ensures that only some states’ warring action is morally justifiable. As such, legitimate authority plays an important part in restricting the occurrence of war. Beyond that, according to Brian Orend, this criterion also serves to ensure that unjust regimes subject to armed humanitarian intervention for grave human rights abuses have no moral right to defend themselves against “aggression” by the intervening state (Orend 2006, 71, 91). For Orend, states have legitimate authority when they are minimally just, meaning that they (1) are recognized as legitimate by their own people and by the international community; (2) “avoid violating the rights of other countries”; and (3) “make every reasonable effort to satisfy the human rights of their own citizens” (Orend 2006, 35–6). Securitization, unlike war, however, is not *always* targeted against an aggressor, meaning that in just securitization the legitimacy of the securitizing actor is less important. Moreover, illegitimate actors can—at least in principle—be the architects of just securitization. Indeed, all states, legitimate or not, have a moral duty to protect their populations from threat and to provide—at least—negative peace (Lammer-Heindel 2012).

But what about other-securitization? It is one thing to allow unjust or illegitimate states to secure via securitization their populations from climate change in a just way, but quite another to permit unjust states to save strangers in this way. It is therefore feasible to argue that unjust regimes ought to be prevented from providing just other-securitization, which is to say securitiza-

tion of people in other states against objective existential threats. But this too is counterproductive. It would mean that undemocratic—hence within the parameters of JST unjust—China or Russia<sup>5</sup> would not be permitted to deploy SRM technologies to save small low-lying island states who cannot do so themselves (Keith 2020). A major downside of this is that legitimate authority in other-defense only reduces the already small pool of states prepared to go out on a limb to save strangers, which is why some writers on humanitarian intervention are prepared to sacrifice legitimate authority altogether (see Pattison 2010).

Legitimacy can also be understood in a different way. Indeed, among those just war scholars writing about non-state actors, victim consent makes up for legitimate authority (see, e.g., Finlay 2015; Parry 2017). The fear is that unless those on whose behalf political violence is sought have consented, the violence could simply serve the political goals of the non-state actor. Consent is also hugely important in many proposals for climate engineering governance (cf. Gardiner and Fraginière 2020). Likewise, Fruh and Hedahl raise the possibility of other-securitization, if the same comes at the behest of those existentially threatened (2019, 395). In short, for them, legitimacy of other-securitization rests on the victim's consent. In JST, however, consent is not a moral requirement of the just initiation of securitization. There are two reasons for this. First, the criterion of the just referent object coupled with the criterion of right intention ensures that misrepresentation is warded off from the outset because securitization is morally justifiable only if it benefits—first and foremost at least—the just referent object, not the securitizing actor. Second, consent does more to safeguard the securitizing actor than the victim. If things go wrong and victims end up worse off because of—here—SRM technology use, then they will have little grounds to complain because they consented to the securitizing measures (cf. Floyd 2019, 145).

Of course, this hangs on referent objects being morally justifiable, raising the question: How is the justice of referent objects derived? The definition rests on the view that human beings are intrinsically valuable and that the value of all other things is measured in terms of its contribution to objective human well-being. This includes ecosystems, which are valuable insofar as they contribute to the satisfaction of basic human needs

5 In JST, a state is just when it satisfies a minimum level of basic human needs. While this does not categorically exclude non-democratic states, in fact only democratic states are justified because only such states protect the basic human need of autonomy (cf. Floyd 2019a, 107).

(see above). Many scholars of environmental ethics will object to this anthropocentric take on valuing the environment. The debate between on the one hand ecocentrists and bio-centrists, who attribute intrinsic and not instrumental value to nature and the environment, and anthropocentrism on the other is unresolved. Scholars in the latter camp have argued that all approaches to environmental ethics are anthropocentric because judgments about value are inevitably made by humans (Attfield 2003, 14). More significantly, some have argued that environmental anthropocentrism is conducive to good stewardship of the environment (cf. Attfield 2003, 42–3); after all, human beings require a whole range of ecosystem services to achieve well-being.<sup>6</sup> I share this view. Anything else would permit the securitization of, for example, non-human species and ecosystems against human life and interests, even in cases where the so-secured entity would have a negative value for humans. Moreover, it is also worth noting that outside of environmental ethics, an anthropocentric view of value is standard. In philosophy, for example, value (goodness and badness) is often assessed in terms of what Joseph Raz calls the “humanistic principle”, which is to say, “from its contribution, actual or possible, to human life and its quality” (1986, 194).

If then the justice of SRM use is determined by the justice of the referent object, not by that of the securitizing actor, it follows that just and unjust/illegitimate states as well as non-state actors can—in principle—be morally permitted to use this technology.

The third outstanding issue is that of the just reason, which is to say: What magnitude of threat permits SRM technology deployment? Put differently, how bad does climate change need to get before deploying measures that will have harmful adverse effects for some are morally permissible? While neither pair of authors identifies a convincing threshold, both contribute something of value that ought to feed into a working threshold. Chalecki and Ferrari recognize that states etc. are differently adapted to climate change; hence, what threatens one entity might not threaten another (2018, 95). While Fruh and Hedahl hold that SRM usage is permissible only when a state is faced with actual survival issues. While—

6 On the question of whether geoengineering is bad for the environment. Peter Singer (2023) offers a more sobering point. He argues: “A more secular version of the objection might state that we should leave nature alone, but that battle was lost decades ago. We humans have already overwhelmed nature, to such an extent that many scientists suggest that we are now in a new geological epoch: the Anthropocene.”

as I go on to demonstrate—this threshold is too high, their insistence on existential threats is relevant.

Regarding the just reason, JST borrows from Ole Wæver and the Copenhagen School, for whom threats need to be existential in nature because only the logic of survival legitimizes recourse to normally impermissible behavior and actions (Wæver 2009, 22, see also Buzan et al. 1998, 30–31). However, unlike Fruh et al., Wæver and coauthors do not mean by this that the literal survival of, for instance, a state must be at stake, but rather an existential threat is a threat to the essential properties or character of a referent object (Wæver 2009, 23; Floyd 2019, 76). A less flexible view of existential threat would mean that Wæver et al. could not account for different sectors of security; where many threats do not have the ability to lead to the actual disappearance of the referent object, but “merely” possess the capability to alter the same as we know it. For example, Britain would be existentially threatened by a military coup that would lead to a military dictatorship, not because Britain would lose territory or disappear altogether, but rather because being a liberal democracy is a fundamental property of what it means to be Britain. Wæver puts this as follows: “An existential threat can only be understood in relation to the particular character of the referent object in question . . . The essential quality of existence will vary greatly across different sectors and levels of analysis, and therefore so will the nature of existential threats” (ibid, 23). Hence, like Chalecki and Ferrari, Wæver recognizes that distinct levels of resilience render the same (in magnitude and severity) threat existential to one thing/entity, but not to another. With a view to JST, all of this means that existential threats are not threats to survival per se, but rather threats able to alter the referent object as we know it. This also means that existential threats are not necessarily lethal threats to people. However, given that in—JST—only those referent objects that serve human wellbeing are of value and—if threatened—worth saving, the demise of a just referent object will always adversely affect human beings, without necessarily killing them.

While such a formulation can account for a wide range of threats to all manner of possible referent objects, not all qualify for just securitization. Following McMahan (2005), some “just causes may well be too trivial for securitization to be proportionate, and therefore that the agents at the source of the threat are not liable for the harm securitization is going to cause them” (Floyd 2019a, 129). In the *Morality of Security*, this is illustrated with the following hypothetical example:

[...] fragmentation of the EU due to member states leaving the union is an objective existential threat to

the essential properties of the EU, especially if fragmentation leads to disintegration, the abolition of the Schengen area as well as the Euro currency. Arguably, however, a securitization that would target the architects of BREXIT or other comparable national movements orchestrating the departure of member states – would be disproportionate.<sup>7</sup> Thus here, the just cause is insufficiently harmful to justify the harms securitization is going to cause agents at the source of the threat (including, detaining them, penalizing them, monitoring them, excluding them from positions of power/influence, not only in political life but in the media etc.) because – as in the Falklands case – “the conditions of ordinary life” will be “little different” outside of or without the EU (McMahan 2005, 5) (ibid, 129).

While Fruh and Hedhal also include proportionality into their theory of SRM deployment, their high threshold for just reason coupled with the great value they attribute to states as unique communities is such that proportionality does not do much work in their theory.<sup>8</sup> The authors hold that “the harms of SRM would have to be immense to be disproportionate” (ibid, 392). Concretely, this could mean that a possible SRM-induced overcooling of India or the overheating of China (ibid, 392) would be judged as insufficiently harmful to render SRM disproportionate. This does seem intuitively incorrect. In my view, the authors’ proportionality calculation is flawed because it focuses only on the magnitude of harm (is the harm caused as damaging as the harm prevented) not on the scale of the threat, which is to say on the number of people affected (cf. Floyd 2019a, 128ff). Properly understood proportionality requires us

- 7 McMahan (2009–10, 4) differentiates between narrow and wide proportionality. Proportionality<sub>n</sub> is concerned “with the harm inflicted on the person or persons who are liable to be harmed because of their moral responsibility for a threat of wrongful harm.” Proportionality<sub>w</sub> “risks or harms imposed on innocent bystanders, usually but not necessarily as a side effect of the defensive action taken against those who are liable to attack.”
- 8 Not so Chalecki and Ferrari for whom proportionality is key. They argue: “[. . .] the competent national authority must clearly demonstrate how the ecological and financial good outweighs the bad, based on the best scientific knowledge available at the time the decision is made. This could be measured in a number of ways: temperature lowered, lives saved, money saved, disasters avoided. If this cannot be determined, then the precautionary principle applies: put down the sulfur and step away” (Chalecki and Ferrari 2018, 97).

not “merely” to focus on the magnitude of harm (existential or minor), but also on the scale of the harm caused, that is, on how many people are affected. The question thus is this: Does the major harm caused to 1.6 million people (the combined population of Fiji, Kiribati, the Marshall Islands, and the Maldives) by the disappearance of their land and homes, outweigh the minor harm caused to 1.3 billion Indians resulting from SRM-induced overcooling (assuming here for the purposes of analysis that it would indeed be minor)? This is not easy to answer. However, it is generally accepted that minor harm (if sufficiently close in magnitude to major harm) to the many can outweigh major harm to the few. It therefore matters that Fiji, Kiribati, the Marshall Islands, and the Maldives’ combined population is just 0.12 percent of India’s and 0.06 percent of India and China’s populations combined.<sup>9</sup>

So far, we have said that the unilateral or the unilateral deployment of SRM technology is morally permissible when: (1) there is a just cause, (2) it is proportionate, (3) that the securitizing actors’ intention(s) correspond to just cause, and (4) that SRM deployment has *ex ante* a better chance at satisfying just cause than—less harmful—alternatives. If this is correct, then it raises the question of whether states and other actors can have a moral duty to deploy such technologies? Of course, such a duty applies only to actors who possess the relevant capability to act; after all, ought implies can. It seems to me that [Fruh and Hedahl \(2019\)](#) albeit tentatively touch on the issue, when they argue that states other than those directly existentially threatened may deploy SRM on the behest of victim states. Although they do not spell this out, it seems that states are not merely permitted to provide other-securitization via SRM, but they appear to have a Samaritan duty of rescue via relevant actions. The Samaritan duty whereby states, and other actors, have a duty to save others, including strangers, provided they can do so without harming themselves underwrites practically all modern ethics (cf. [Scheid 2014](#)), and I have no intention to quibble with this here. The more interesting question is: *When* do states that possess relevant capabilities have a moral duty to deploy SRM technology? Just war theorists concerned with this question usually hold something along the following lines:

Since wars of humanitarian intervention require weighty justification, we already have good prima facie reason to think that states are required to wage the humanitarian wars they are permitted to wage. Any

cause that is so important that it is worth intervening and killing for would seem to be a cause that states are required to support. A war that is permissible, moreover, will fulfill standard just war conditions: proportionality, last resort, reasonable chance of success, and so on. Why then would a state not be required to wage a permissible humanitarian war? There is a standard response to this question: the costs of a humanitarian war can be so high that the state is not required to wage it ([Oberman 2015](#), 258).

While we do not know where Fruh and Hedahl are positioned on this, [Chalecki and Ferrari 2018](#) seem to concur that doing the best is obligatory unless costs to the self (the capable actor) are prohibitive. Indeed, at one point they argue:

Under every accepted theory of modern international relations, a state is allowed, even *obligated*, to protect its national security. If the physical effects of anthropogenic climate change produce or contribute to threats to national security, then abating it or offsetting its negative consequences may be viewed as a *necessary* security requirement, maybe even on a pre-emptive or preventive basis ([Chalecki and Ferrari 2018](#), 90–1, emphasis added).

JST offers a different perspective. Pivotal to (morally) mandatory securitization is the concept of *must cause*, which is, in effect, a version of last resort (cf. [Aloyo 2015](#); [Floyd 2019b](#), forthcoming). “Must cause” is satisfied when (a) bar the success condition, the remaining four criteria of just initiation to securitization (just referent, just reason, proportionality, and right intention) are satisfied, and when (b) securitization is a last resort, which is the case when other feasible and less harmful options have been tried and have failed to address the just cause ([Floyd 2019b](#), [Floyd in Sardoč 2021](#)). To be sure, must cause can—in cases of other-securitization—be overridden by the costs and risks to the securitizing actor, but the main difference to the other proposals is that here a pro tanto moral obligation hangs on something other than simply the likely risks and costs incurred. Specifically, it would mean that states have a moral obligation to deploy SRM technology only when other—less harmful options—have been tried and failed to address the climate emergency. Certainly, if the other pairs of authors were to include a similarly stringent requirement of last resort as part of their criteria for just SRM usage and provided that they do indeed hold that the threshold for a corresponding duty to securitize is costs and risk to the would-be securitizing/ “warring” actor, there would—on this point—be no real difference between the

9 Figures on country population come from <https://www.worldometers.info/world-population/population-by-country/>.

different theories. The fact is, however, that neither of the two pairs of just war theorists does. In just geoengineering theory, SRM deployment must not be a first resort, while—confusingly—it could also be used pre-emptively (Chalecki and Ferrari 2018, 92 and 95). Fruh et al.’ set an equally low threshold. At least where low-lying island states are concerned, they opine that the last resort is already satisfied given the diplomatic failure to act on climate change, the lack of enforcement mechanisms, and the likely inability to stick to the 1.5°C temperature rise target (Fruh et al. 2019).

It is one thing to argue that states can be morally required to deploy SRM technology at the behest of just referent objects, but can they also be morally required to do this without the consent of would-be referent objects to rescue in this way? Our authors do not examine this question. However, given the role consent plays in their wider theories it seems highly likely that both pairs of authors writing in the just war tradition would consider consent an integral feature of moral duties, as it is indeed for many just war scholars writing about armed humanitarian intervention (see, e.g., McMahan 2010, 49).

Once again, JST differs. Consent is discounted as a matter of procedural justice. Moreover, consent is simply not needed because “whatever reasons putative non-pacifist referent objects may have for resisting securitization, all decisive reasons are already covered by the other substantive criteria of just initiation of securitization. That is to say, referents will object to securitization not because they have no say in it, but rather because there is no just cause, or because it lacks a reasonable chance of success, or because it is disproportionate” (Floyd 2019, 145). This means that in JST, actors could have the moral obligation to rescue via SRM even against the expressed preferences of the putative beneficiaries of other-securitization.

I am in no doubt that some readers will find this paternalistic even morally repugnant, raising the question of the moral foundation of JST. It is therefore important to clarify that while JST is a theory about just security practice, it is not a theory of justice. In ethics, theories of justice are about fairness, participation, and deliberation. JST, in turn, is a theory of justified action; the normative grounds it appeals to “are facts about objective human wellbeing, which is to say the condition whereby people are able to live minimally decent lives. [. . .] objective human well-being pertains to the satisfaction of basic human needs” (Floyd 2019, 18). We can see this most clearly in the definition of just referent objects, which are considered morally justifiable if they meet basic human needs. Of course, an extension of JST to include morally mandatory securitization must be complemented by a theory

of moral obligation. However, this does not necessitate a commitment to global distributive justice; instead, a basic duty to alleviate human suffering (e.g., the Samaritan duty) suffices.

Finally, what about non-state actors, could such an actor, if in possession of this capability, have a moral obligation to save a region from climate disaster by deploying this technology?<sup>10</sup> We do not know where Fruh and Heddal would stand on the issue because for them inclusion of non-state actors is completely beyond the scope of their argument (2019, 395 FN23). For Chalecki et al., in turn, only states are considered because “sovereign states, individually or in groups, are still the only actors that can legitimately use force in international relations, ostensibly in defense of their citizens” (2018, 93). As far as JST is concerned, we know that the theory applies to non-state actors as much as it does to state actors (cf. Wolfendale 2022). Moreover, if the duty to secure rests—at least partially—on capability (Floyd in Sardoč 2021, 146) and if non-state actors uniquely possess that capability,<sup>11</sup> then it follows that these actors too can have a conditional obligation to securitize in this way.

## Conclusion

This article was concerned with the contribution just war/securitization theories can make to our understanding of the debate surrounding climate engineering. I argued that the fundamental contribution of this literature is that it opens the otherwise closed issue of who may deploy SRM technology and under what circumstances. This is important because the deployment of SRM technology from the global commons by individual states or by small coalitions of states is increasingly a matter of *when* is this going to happen, not *if* it will. I have shown that while the two existing articles—both of which invoke JWT—result in impasses and disagreements, JST offers answers to four pertinent questions/puzzles generated by the existing literature on the topic. It can make this contribution because of several innovations that set it apart from JWT, including the focus on just referent objects, not legitimate authority, the ability to account for intent-lacking threats, and the overt inclusion of moral

10 This would be marine cloud brightening, which can be locally targeted (Keith 2020).

11 Note here that in the United States a range of private philanthropists fund solar engineering research at leading universities. See, for example, <https://geoengineering.environment.harvard.edu/funding>.



obligation, alongside permissibility. Together, these affirm JST's added value vis-à-vis JWT.

This article has shown that SRM may be deployed unilaterally that it can be deployed by unjust states as well as by non-state actors, for it is not the justice of the securitizing actor that matters but that of the referent object instead. I have shown that threats need to be existential in nature to qualify for SRM deployment, but also that threats to the existence of a thing or order are not restricted to outright fatal threats to “things” and people (e.g., the literal sinking of a state into the sea). Instead, they are threats of a magnitude able to alter the properties or characteristics of the threatened justified entity. Finally, I have argued that—in the future—SRM deployment is in certain circumstances not “merely” morally permissible, but—especially as a matter of other-securitization—quite possibly morally required of sufficiently capable actors. If this is correct, then it would mean that the US government ought to invest in SRM research. The reason is simple if they fail to invest and the occasion were to morally demand such use, then the United States would not be the most capable actor. Their claim to world leadership would be undermined by (a coalition of) China, India, and/or even by a capable non-state actor.

These findings will sit uneasily with many people, myself included. Indeed, many notable scholars are in favor of a qualified or even an outright ban on climate engineering research as well as a ban on deployment (see, e.g., McKinnon 2019; Biermann et al. 2022, but see Olúfémi et al. 2022; McDonald 2022; Singer 2023). While a ban on research would make the use of such technology less likely, the research findings of this paper suggests that, in the absence of concerted action to bring down carbon emissions, such a move might well be immoral. The possibility that geoengineering could be morally required must mean that we are also morally required to research such technologies; anything else would be a dereliction of duty. However, this puts us in a perverse situation because the evidence suggests that research into SRM technologies is likely to increase the possibility of its deployment (Quaas et al. 2017). Not because human beings are programmed to try out their creations, but because an impending technological fix is likely to foster lethargy on climate mitigation.

Before despair takes over, I would like to end by suggesting that the findings of this research do not straightforwardly endorse the use of SRM technologies; instead, following Fruh and Hedahl (2019), this research is also a warning of what will happen—indeed will *need* to happen—unless concrete climate action short of geoengineering is taken now.

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