THE CLIMATE EMERGENCY AND SOLAR GEOENGINEERING

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This Article examines the climate emergency and solar geoengineering: proposals to intentionally alter Earth's reflectivity to cool the planet. It first defends climate emergency as a concept and possible mode of doing government—while also warning against its hasty declaration. It then surveys the science and public language that gives shape to the climate emergency and examines how climate emergency-necessity frameworks are already interacting with the U.S. legal system and beyond. Next it reintroduces solar geoengineering as a potential climate emergency response and its research as an emergency measure. It closes by reviewing the legal theory on emergency measures within constitutional democracies and under international law, using those lessons to suggest governance principles for solar geoengineering research and, potentially, its development and deployment.

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Introduction

In December 2020, during a rising wave of the COVID-19 pandemic, the United Nations convened a virtual summit to ramp up climate efforts under the Paris Agreement.[1] Dozens of world leaders gave remarks, and U.N. Secretary-General António Guterres gave the welcoming speech.[2] He opened with a concise, dire, and well-worn summary of the climate crisis: carbon dioxide ("CO_2") levels had reached record highs, the planet was 1.2°C warmer than pre-industrial averages, and existing national commitments were nowhere near sufficient.[3] Then the Secretary-General did something unusual:

> If we don't change course, we may be headed for a catastrophic temperature rise of more than 3 degrees this century. Can anybody still deny that we are facing a dramatic emergency? That is why today, I call on all leaders worldwide to declare a State of Climate Emergency in their countries until carbon neutrality is reached.[4]

Public language on climate change has escalated over the last few years, following widespread media coverage of soaring CO_2 levels and record-breaking wildfires, heatwaves, storms, and floods.[5] In 2019, Oxford Languages chose "climate emergency" as its word of the year, capturing "a growing shift in people's language choice" and "a conscious intensification" of climate discourse.[6] COVID-19 has bolstered this rhetoric: if countries are willing to enact drastic policies in the name of public health, why not for the planet?[7] The Secretary-General leaned into this trend, calling on world leaders to declare states of emergency on climate change within their borders and to maintain those states of emergency, presumably for decades, until anthropogenic greenhouse gas ("GHG") emissions are zeroed out. With this, he seems to be trying to mobilize emergency rhetoric on climate into a literal mode of doing government.

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1. *See* Climate Ambition Summit 2020, https://perma.cc/L7FD-B7TJ.
2. *Id.*
3. *Secretary-General, Remarks at the Climate Ambition Summit*, U.N. Sec'y-Gen. (Dec. 12, 2020), https://perma.cc/R22G-WABJ.
4. *Id.*
5. *See* Marc Tracy, *As the World Heats Up, the Climate for News Is Changing, Too*, N.Y. Times (July 8, 2019), https://perma.cc/RJS5-7RQ7. For a definition of public language, see Jedediah Purdy, *The Politics of Nature: Climate Change, Environmental Law, and Democracy*, 119 Yale L.J. 1122, 1125 (2010) ("[It is] the repertoire of arguments and appeals that make up the ongoing conversation of a polity, . . . [including] the always-contested terms around which [people] orient individual identity and dispute the terms of common life.").
6. *Word of the Year 2019*, Oxford Languages, https://perma.cc/6Y7D-B53H; *see also* Dougald Hine & Duncan McLaren, *Climate Emergency: The Democracy Fork*, Open Democracy (Dec. 11, 2019), https://perma.cc/LP5E-CCX5.
7. *See* discussion *infra* Part I.B.3.

Secretary-General Guterres was not the first public official to do so. Several countries have already declared climate emergencies, often accompanying announcements of net-zero emission targets by mid-century.[8] Lawmakers and observers have described these legislative acts as symbolic messaging statements conveying a nation's seriousness on climate rather than a concrete exercise of emergency power.[9] It is possible, though, that symbolic acts of climate emergency could escalate into actual emergency declarations with actual powers to go with them.[10] To this point: less than two weeks after the Secretary-General's speech, U.S. Senator Jeff Merkley of Oregon called on now-President Joe Biden to declare a climate emergency.[11] Unlike the symbolic emergency resolution introduced in the Senate the year before,[12] Senator Merkley urged President Biden to "fully use[ ]" the Presidency's emergency authorities under statute to fight the climate crisis.[13] Front and center in Senator Merkley's appeal were the wildfires that devastated his state the summer prior.[14]

Some legal academic work on climate has also intensified of late. Recent scholarship explores how the U.S. President could unilaterally push climate policy forward using existing statutory authorizations and military powers.[15] The revived and burgeoning field of green criminology asks whether extreme environmental destruction could violate international criminal law and, if so, how to punish those crimes.[16] Others have investigated the basis for lawful mil-

8. *See, e.g.*, Linda Sieg & Aaron Sheldrick, *Japan Lawmakers Declare Climate Emergency After Government Sets Zero Emissions Goal*, Reuters (Nov. 19, 2020), https://perma.cc/G2Y5-9SNK; European Parliament Press Release IPR/67/110, The European Parliament Declares Climate Emergency (Nov. 29, 2019), https://perma.cc/24DL-FNAU; *UK Parliament Declares Climate Change Emergency*, BBC News (May 1, 2019), https://perma.cc/FT7J-H65C; Rachel Aiello, *Canada's House of Commons Has Declared a National Climate Emergency*, CTV News (June 17, 2019), https://perma.cc/XDJ4-PLSL.

9. *See, e.g.*, Sieg & Sheldrick, *supra* note 8.

10. *See* Geoff Mann & Joel Wainwright, Climate Leviathan: A Political Theory of Our Planetary Future 28–30 (2018) (using the arguments of Carl Schmitt, Giorgio Agamben, and Thomas Hobbes to argue the climate crisis could lead to a planetary state of emergency and a new type of planetary sovereign to govern it, the "Climate Leviathan").

11. Sen. Jeff Merkley, Opinion, *How Joe Biden Can Act Boldly to Address the Climate Crisis*, Wash. Post (Dec. 21, 2020), https://perma.cc/G6HY-2574.

12. *See* S. Con. Res. 22, 116th Cong. (2019).

13. Merkley, *supra* note 11.

14. *Id.*

15. *See, e.g.*, Mark P. Nevitt, *On Environmental Law, Climate Change & National Security Law*, 44 Harv. Envtl. L. Rev. 321, 351–56 (2020); Mark P. Nevitt, *The Commander in Chief's Authority to Combat Climate Change*, 37 Cardozo L. Rev. 437, 476–77 (2015); Daniel A. Farber, *Exceptional Circumstances: Immigration, Imports, the Coronavirus, and Climate Change as Emergencies*, 71 Hastings L.J. 1143, 1169–71 (2020) (citing Brennan Ctr. for Just., N.Y.U. Sch. of L., A Guide to Emergency Powers and Their Use (2020), https://perma.cc/DH3E-4RYY).

16. *See* Bruce Gilley & David Kinsella, *Coercing Climate Action*, 57 Glob. Pol. & Strategy 7, 14–15 (2015); Ludwik A. Teclaff, *Beyond Restoration: The Case of Ecocide*, 34 Nat. Res. J.

itary strikes that countries might invoke to coerce compliance with climate obligations.[17] Still more have analyzed the U.N. Security Council's power to create binding climate law.[18] They are part of a trend exploring—and often critiquing—the militarization, securitization, and unilateralization of climate policy.

This Article takes the Secretary-General's remarks as an invitation to think carefully about the law of emergencies and climate change. What is a climate emergency? What acts would be proportional to it? What procedures could guard against abuse of power? And, most importantly, what is the potential relationship between "planetary" emergency declarations and new forms of international governance? Existing scholarship has examined these questions somewhat narrowly, asking, for instance, the factual basis for a U.S. President's climate emergency declaration and the authorities that it would unlock.[19] Others have argued for dismissing climate emergency frameworks out of hand on semantic, epistemic, or normative grounds.[20] Missing, though, is a fuller examination of climate emergency's coherence and its implications for constitutional democracy and international climate policy.[21] If states commit themselves to climate policy by declaring climate emergency—if the climate crisis genuinely is an emergency, or could one day become so—what could "good" emergency governance look like? Is "good" even possible down this road?

This Article focuses on the governance of solar geoengineering, perhaps the ultimate emergency response to climate policy failure.[22] Solar geoengineer-

933, 933–34 (1994); Robyn Eckersley, *Ecological Intervention: Prospects and Limits*, 21 ETHICS & INT'L AFFS. 293, 301–10 (2007); Shirley V. Scott et al., *The Creation of a Climate Change Court or Tribunal*, *in* CLIMATE CHANGE AND THE UN SECURITY COUNCIL 66, 67–72 (Shirley V. Scott & Charlotte Ku eds., 2018).

17. Adam Betz, *Preventative Environmental Wars*, 18 J. MIL. ETHICS 223, 224–25 (2019); Eckersley, *supra* note 16, at 298–311; Craig Martin, *Atmospheric Intervention? The Climate Change Crisis and the* Jus ad Bellum *Regime*, 45 COLUM. J. ENV'T L. 331, 364–65, 396–99 (2020) (condemning the use of such doctrines on normative grounds).

18. *See generally* Shirley V. Scott & Charlotte Ku, *The UN Security Council and Global Action on Climate Change*, *in* CLIMATE CHANGE AND THE UN SECURITY COUNCIL, *supra* note 16, at 1.

19. *See supra* note 15.

20. *See, e.g.*, Hine & McLaren, *supra* note 6.

21. Initial work has examined the precautionary principle as a basis for a climate emergency. *See* Bruce Lindsay, *Climate of Exception: What Might a 'Climate Emergency' Mean in Law?*, 38 FED. L. REV. 255, 268–75 (2010) (working within the Australian constitutional tradition). Lindsay's analysis is limited by its use of climate tipping points as sufficient for declaring climate emergency, *see id.* at 256–59, a framing persuasively rebutted elsewhere, *see infra* Part II.B.2; *see also* JOCELYN STACEY, THE CONSTITUTION OF ENVIRONMENTAL EMERGENCY 1–2, 15–23 (2018) (arguing many environmental problems can be analyzed as emergencies subject to emergency governance).

22. *See* MICHAEL HULME, CAN SCIENCE FIX CLIMATE CHANGE?: A CASE AGAINST CLIMATE ENGINEERING 2 (2014) (calling climate engineering the "ultimate techno-fix"); *see also* MANN & WAINWRIGHT, *supra* note 10, at 139–42; Frédéric G. Sourgens, *Geo-Markets*, 38 VA. ENV'T L.J. 58, 113–14 (2020) (assuming emergency deployment of stratospheric

ing describes a suite of proposed technologies that could temporarily cool Earth on a regional or planetary basis.[23] It is different from emissions reduction and carbon removal, which work to reduce cumulative GHGs in the atmosphere, and from climate adaptation, which works to increase local resiliency against climate change impacts.[24] Solar geoengineering instead would alter the planet's reflectivity to directly and rapidly influence the flows of incoming energy from the sun and outgoing energy Earth radiates back into space.[25] The idea takes inspiration from cooling periods observed after some volcanic eruptions, when large amounts of aerosols released into the stratosphere reflected a small portion of incoming sunlight back into space, producing a temporary cooling effect worldwide.[26] Stratospheric aerosol injection ("SAI") could be a more tailored version of that natural process, using aircraft to introduce aerosols directly into the stratosphere.

Though so far relatively little has been invested into its scientific research, the prospect of solar geoengineering has provoked skepticism, controversy, and occasionally outrage.[27] Who would control deployment?[28] How could such a system of control possibly be legitimate?[29] Isn't it wrong, risky, and ultra-hubristic to even consider a project of this scale and nature?[30] And wouldn't it

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aerosol injection is inevitable). Solar geoengineering, of course, is not the only proposed climate emergency measure. *See* discussion *infra* Part I.B.3.

23. For an accessible overview, see Kurzgesagt – In a Nutshell, *Geoengineering: A Horrible Idea We Might Have to Do*, YouTube (Oct. 27, 2020), https://perma.cc/7M2D-WW3R. For a more technical survey, see Intergovernmental Panel on Climate Change, Global Warming of 1.5°C 347–52 (2018) [hereinafter IPCC, Global Warming of 1.5°C].

24. *See infra* Part II.

25. *See* IPCC, Global Warming of 1.5°C, *supra* note 23, at 347–49.

26. *See infra* Part II.A.1.

27. *See* Jane A. Flegal et al., *Solar Geoengineering: Social Science, Legal, Ethical, and Economic Frameworks*, 44 Ann. Rev. Env't & Res. 399, 400–01 (2019).

28. *See* Holly J. Buck et al., *Evaluating the Efficacy and Equity of Environmental Stopgap Measures*, 3 Nature Sustainability 499, 503 (2020) ("The lack of a procedural mechanism to address . . . [potential unequal physical impacts of solar geoengineering deployment] is seen as one of the key challenges to both governance and legitimate implementation."). *But see* Jeff Goodell, *What Will the World Look Like in 30 Years? Sci-Fi Author Kim Stanley Robinson Takes Us There*, Rolling Stone (Dec. 10, 2020), https://perma.cc/CT48-VR92 ("I feel like the intense prejudice against the idea of geoengineering . . . is a category error and is not paying attention to the realities of the danger we are in . . . . You put dust in the atmosphere and five years later it's gone. It's an experiment that won't go awry and kill the world." (quoting Kim Stanley Robinson, Author)).

29. *See* Joshua B. Horton et al., *Solar Geoengineering and Democracy*, 18 Glob. Env't Pol. 5, 5 (2018).

30. *See* Christopher J. Preston, *Ethics and Geoengineering: Reviewing the Moral Issues Raised by Solar Radiation Management and Carbon Dioxide Removal*, 4 WIREs Climate Change 23, 25–26 (2013).

delay emission reductions?[31] Because solar geoengineering is so troubling on so many fronts, its scientific and policy exploration has been couched in terms of necessity, that is, an appeal to the climate crisis itself.[32] Solar geoengineering research is justified, the argument goes, because the trajectory of warming and the possibility of conventional climate policy failure could lead us to something even worse.[33]

The appeal to crisis is what makes the framework of "climate emergency" so productive for imagining solar geoengineering's governance. Contrary to analyses that characterize solar geoengineering somewhat incongruously as a "risk management" exercise,[34] this Article argues that emergency frameworks provide a more realistic approach. This is in part because solar geoengineering proposals are so tightly linked with the climate crisis and the failures of government-as-usual to address it.[35] It is also because solar geoengineering poses so many challenges—conceptual, moral, jurisdictional, and scientific—to prevailing norms and established orders as to require extraordinary justification.[36] Solar geoengineering could indeed prove to be a new tool for managing climate risk and reducing harmful impacts, one realized through deliberate, sober-minded, and well-governed research. But it still would be an imperfect technology arising from profound crisis and contrary to "normality" as commonly understood. In other words, it would be an emergency measure, and its governance would reflect that.

This Article's claims are therefore primarily descriptive. There are, however, useful consequences for defining the problem this way. Emergency frameworks can center the imperfect and troubling character of solar geoengineering, enabling clearer-eyed analysis of the thing that is to be governed, while not ignoring the benefits it could bring about.[37] "Climate emergency" further removes solar geoengineering from the exclusive control of the expert and the technocrat, placing it squarely into the world of politics, moral-

31. *See generally* Albert C. Lin, *Does Geoengineering Present a Moral Hazard?*, 40 ECOLOGY L.Q. 673 (2013) (describing this problem as a "moral hazard").

32. *See infra* Part II.B.2.

33. *See, e.g.*, NAT'L ACADS. OF SCIS., ENG'G, & MED., REFLECTING SUNLIGHT: RECOMMENDATIONS FOR SOLAR GEOENGINEERING RESEARCH AND RESEARCH GOVERNANCE 5 (2021) [hereinafter NAS REPORT 2021].

34. Jane A. Flegal & Aarti Gupta, *Evoking Equity as a Rationale for Solar Geoengineering Research? Scrutinizing Emerging Expert Visions of Equity*, 18 INT'L ENV'T AGREEMENTS 45, 52 (2018) (reporting this trend); *see also, e.g.*, NAS REPORT 2021, *supra* note 33, at 200 (contrasting a "peak shaving" deployment scenario for solar geoengineering with a "climate emergency" scenario).

35. *See, e.g.*, NAS REPORT 2021, *supra* note 33, at xi.

36. *See infra* Part II.B.

37. *Cf.* David Morrow & Toby Svoboda, *Geoengineering and Non-Ideal Theory*, 30 PUB. AFFS. Q. 83, 87–96 (2016) (examining the tension between morally permissible uses of geoengineering and politically feasible scenarios).

ity, and subjectivity. What, after COVID-19, could be more contentious and contestable than "emergency"? Emergency frameworks therefore can put decision-makers and the public on guard against rash deployment and its potential for abuse. Emergency-mode analysis also yields a few concrete suggestions for governance structures for immediate and long-term implementation.

Part I of this Article defends climate emergency as a coherent concept and potential mode for doing government. It then describes how some contemporary climate emergency narratives came to be and their interactions with the U.S. legal system and beyond. Part II reviews the technical features of solar geoengineering and explains why it should be approached as a potential climate emergency measure. Part III reviews the international law of necessity and constitutional theory on states of emergency to distill principles for emergency governance. It then uses these lessons to sketch out oversight structures for solar geoengineering's research and potential development.

The ultimate trajectory of solar geoengineering technologies is unknown, and their development or abandonment will likely be a contentious, messy, and iterative process. In many ways, this Article asks what it means to "muddle through" climate emergency and, by extension, solar geoengineering.[38] "Muddling" will likely be the core method for realizing climate politics and the corresponding program of climate management.[39]

I. Climate Emergencies and the Law

A. Understanding Climate Emergencies

This section identifies elements common to many emergencies, then introduces *acute* and *chronic* climate emergencies. After clarifying the terms of analysis, it reviews the various bases used for declaring climate emergency as well as the scientific and policy structures that legitimize and complicate those claims. The analysis uncovers the value judgments that inform disagreement on whether there is or ever could be a "climate emergency."

38. Jesse L. Reynolds, The Governance of Solar Geoengineering 3 (2019).

39. *See* Bruno Latour, Facing Gaia: Eight Lectures on the New Climatic Regime 94–95 (Catherine Porter trans., 2017) ("When I talk of Gaia as a superorganism, I do not for a moment have in mind a goddess or some sentient being. I am expressing my intuition that the Earth behaves as a self-regulating system, and that the proper science for its study is physiology." (quoting James Lovelock)); *cf. id.* at 100 ("With Gaia [Theory], [James] Lovelock is asking us to believe not in a single Providence, but in as many Providences as there are organisms on Earth . . . . The simple result of such a distribution of final causes is not the emergence of a supreme Final Cause, but a fine muddle. This muddle is Gaia."). *But see* Leah Aronowsky, *Gas Guzzling Gaia, or: A Prehistory of Climate Change Denialism*, 47 Critical Inquiry 306, 326–27 (2021) (complicating Latour's use of Gaia theory by connecting the idea's origins to climate denialism propagated by fossil fuel companies).

1. Definitions, Analogies, and Neologisms

In its essay announcing "climate emergency" as its 2019 Word of the Year, Oxford Languages defines "climate emergency" as "a situation in which urgent action is required to reduce or halt climate change and avoid potentially irreversible environmental damage."[40] Another scholar says climate emergency is a situation of high risk, urgency, and necessity "requiring quick action."[41] A third work defines it as when "[s]evere consequences of climate change occur too rapidly to be significantly averted by even immediate mitigation efforts."[42] Others reinforce the ideas of impending catastrophe[43] and "rapid . . . drastic . . . and extremely pernicious" change,[44] themes found throughout much of climate discourse.[45]

These sources agree with more general definitions given for "emergency," which, per one dictionary, is "a state of things unexpectedly arising, and urgently demanding immediate action."[46] Says another, it is "[a] sudden and serious event or an unforeseen change in circumstances that calls for immediate action to avert, control, or remedy harm."[47] These meanings in turn accord with legal definitions for emergency, that is, circumstances justifying state of emergency declarations, emergency powers, and certain derogations of individual rights. They are "real and imminent danger[s] . . . threatening the life of the nation,"[48] "rationally indisputable major threats to the continued stable operation of . . . [the] political and social order,"[49] so "grave" as to "threaten[ ] its survival."[50]

Reading the literature together suggests elements common to wide-scale emergencies, climate or otherwise:

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40. *Word of the Year 2019*, *supra* note 6.
41. Joshua B. Horton, *The Emergency Framing of Solar Geoengineering: Time for a Different Approach*, 2 ANTHROPOCENE REV. 147, 147, 149 (2015).
42. JASON J. BLACKSTOCK ET AL., NOVIM, CLIMATE ENGINEERING RESPONSES TO CLIMATE EMERGENCIES 1 (2009), https://perma.cc/9RAR-D69R.
43. *See* Shinichiro Asayama, *Catastrophism Toward 'Opening Up' or 'Closing Down'? Going Beyond the Apocalyptic Future and Geoengineering*, 63 CURRENT SOCIO. 89, 89–90 (2014).
44. Sanna Joronen, Climate Change and the Ethics of Geoengineering—Implications of Climate Emergency Ethics 74 (Nov. 6, 2015) (Ph.D. dissertation, University of Turku), https://perma.cc/Y5EP-XBDP.
45. *See infra* Part I.B.
46. *Emergency*, OXFORD ENGLISH DICTIONARY (2d ed. 1989).
47. *Emergency*, BLACK'S LAW DICTIONARY (11th ed. 2019).
48. *See* EUR. COMM'N FOR DEMOCRACY THROUGH L., CDL-PI(2020)003, COMPILATION OF VENICE COMMISSION OPINIONS AND REPORTS ON STATES OF EMERGENCY 4 (Apr. 16, 2020) [hereinafter VENICE COMMISSION].
49. Mark Tushnet, *The Political Constitution of Emergency Powers: Some Lessons from* Hamdan, 91 MINN. L. REV. 1451, 1452 (2007).
50. *See* John Ferejohn & Pasquale Pasquino, *The Law of the Exception: A Typology of Emergency Powers*, 2 INT'L J. CONST. L. 210, 231 (2004).

(1) High risk. Risk represents the likelihood and severity of a potential harm,[51] and emergencies pose serious risk of harm to life, property, and potentially the state itself.[52] Examples include natural disasters, civil unrest, epidemics, and economic crises.[53]

(2) Response required. The gravity of the risk demands action to reduce it.[54] The "necessary" course of action may be possible using normal authorities or it may require emergency powers.[55]

(3) Urgency. Emergencies are time-constrained, often foreclosing better or less harmful policy responses. This may arise from imminence or surprise, as with a fast-evolving weather system; magnitude or complexity, like a global pandemic or war; or failure to prepare. Due to time constraints, the necessary response may be exceptionally difficult or may conflict with some requirements of law.[56]

(4) Agreement that the emergency exists. Emergencies are widely seen as such by the authorities.[57] This does not mean, though, that there is always broad agreement as to what response is appropriate for the emergency.[58]

(5) Temporary. Emergencies end, or at least they should end.[59] The harm is avoided, reduced, or neither. The emergency response, however,

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51. *See* Timothy M. Lenton et al., Comment, *Climate Tipping Points—Too Risky to Bet Against*, 575 NATURE 592, 595 (2020); *see also* François Ewald, *Insurance and Risk*, *in* THE FOUCAULT EFFECT: STUDIES IN GOVERNMENTALITY 197, 199, 205 (Graham Burchell et al. eds., 1991).

52. *See* Ferejohn & Pasquino, *supra* note 50, at 231.

53. VENICE COMMISSION, *supra* note 48, at 6.

54. *See Emergency*, *supra* note 46; *Emergency*, *supra* note 47.

55. *See* Ferejohn & Pasquino, *supra* note 50, at 210 (describing emergency powers as concentrating authority in one part of government or removing individual legal protections).

56. *See* Oren Gross, *Chaos and Rules: Should Responses to Violent Crises Always Be Constitutional?*, 112 YALE L.J. 1011, 1023 (2003).

57. *See* Adrian Vermeule, *Holmes on Emergencies*, 61 STAN. L. REV. 163, 168 (2008) (noting that in Justice Holmes's view, "an emergency is factual in a straightforward sense: it is a state of temporary economic or political dislocation in which the prevailing legal rules require the dominant forces of the community to bear a risk or harm that they are unwilling to bear"); *see also infra* Part I.B.3 (exploring who declares emergencies).

58. *See* VENICE COMMISSION, *supra* note 48, at 24 (instructing emergency measures should be proportionate to the crisis at hand); *see also* David Cole, *Their Liberties, Our Security: Democracy and Double Standards*, 31 INT'L J. LEGAL INFO. 290, 291–92 (2003) (critiquing U.S. emergency measures as unfair to non-citizens).

59. *See* BRENNAN CTR. FOR JUST., *supra* note 15, at *4.

may become normalized and persist, especially if the threat does not terminate.[60] Similarly, the harms of a crisis can linger long afterwards.

In short, an emergency is a time-sensitive crisis in which the necessary response conflicts with "normalcy," a concept that includes established laws and social practices, constitutional norms, and so on. With climate change, there seem to be two types of emergencies: *acute* and *chronic*. *Acute* climate emergencies describe severe weather events caused or worsened by climate change.[61] They include wildfires,[62] hurricanes,[63] droughts,[64] and heatwaves,[65] all events already conventionally accepted as emergencies. They also can include rapid, large-scale, and severe damage to ecosystems, like widespread bleaching events on coral reefs.[66] The case for characterizing these events as acute climate emergencies is straightforward. Natural disasters and large-scale deterioration of ecosystems are urgent problems posing grave and obvious harms. They often require extraordinary response from government and the public to mitigate and repair.[67] Some of these events, in turn, are made worse or more likely by climate change.[68] This is seen, for example, with recent wildfires in Australia and the United States that were essentially unprecedented in number and size.[69] Further, the relationship between climate change and its acute emergencies will likely become clearer as more GHGs accumulate in the atmosphere and the science of climate impact attribution improves.[70]

60. *See* Kim Lane Scheppele, *Small Emergencies*, 40 GA. L. REV. 835, 836, 840 (2006); Oren Gross, *The Normless and Exceptionless Exception: Carl Schmitt's Theory of Emergency Powers and the 'Norm-Exception' Dichotomy*, 21 CARDOZO L. REV. 1825, 1829 (2000); William E. Scheuerman, *The Economic State of Emergency*, 21 CARDOZO L. REV. 1869, 1869–70 (2000).

61. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 10.

62. *See The Climate Connection to California's Wildfires*, N.Y. TIMES (Dec. 3, 2020), https://perma.cc/G6GB-V5WU (citing A. Park Williams et al., *Observed Impacts of Anthropogenic Climate Change on Wildfire in California*, 7 EARTH'S FUTURE 892 (2019)).

63. *See* Thomas Knutson et al., *Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming*, 101 BULL. AM. METEOROLOGICAL SOC'Y E303, E317–18 (2020).

64. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 196–201.

65. *See id.* at 177, 191.

66. *See* U.S. GLOB. CHANGE RSCH. PROGRAM, 2 IMPACTS, RISKS AND ADAPTATION IN THE UNITED STATES: FOURTH NATIONAL CLIMATE ASSESSMENT 355 (David Reidmiller et al. eds., 2018) [hereinafter FOURTH NATIONAL CLIMATE ASSESSMENT].

67. *See, e.g.*, Daoping Wang et al., *Economic Footprint of California Wildfires in 2018*, 4 NATURE SUSTAINABILITY 252, 252 (2020) (estimating $148.5 billion in 2018 wildfire damages in California).

68. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 10.

69. *See, e.g.*, Sergey Khaykin et al., *The 2019/20 Australian Wildfires Generated a Persistent Smoke-Charged Vortex Rising up to 35 km in Altitude*, 1 COMMC'NS EARTH & ENV'T, art. no. 22, at 1 (2020) (reporting the event as "unprecedented").

70. *See, e.g.*, Knutson et al., *supra* note 63, at E317–18.

More controversial, and really what is at stake here, is the idea of a *chronic* climate emergency, describing climate change as a whole.[71] To introduce the idea briefly: climate change threatens the world with significant harm and requires an urgent, intensive response.[72] It is widely seen as such by scientists,[73] business leaders,[74] and virtually every national government.[75] The threat is time-sensitive because the harms worsen with each increment of additional warming and because there is significant, if uncertain, risk of non-linear, rapid, and largescale destabilization ("tipping points").[76] Finally, given the magnitude of the threat, the difficulty of reducing emissions completely, and the delay so far, time is "running out" to stabilize the climate.[77] The idea therefore includes, but is distinct from, climate change's acute wildfires and heatwaves. Though these devastating disasters punctuate climate discourse and sometimes motivate stronger policies, they are generally treated as ordinary emergencies. *Chronic climate emergency*, on the other hand, aggregates the problem and transforms it into something new.

Some reply that climate change as a whole lacks the imminence required of an emergency.[78] Unlike a hurricane, climate change is slow-moving, unfolding over the years with gradually worsening impact.[79] For example, a chronic medical condition can cause discomfort and even serious complications but does not in itself constitute an emergency; so too with climate change and its floods, heatwaves, and fires.[80] And even if a nation treated climate change as

71. *See, e.g.*, Hine & McLaren, *supra* note 6 (describing warnings against emergency rhetoric); *see also* ANDREAS MALM, CORONA, CLIMATE, CHRONIC EMERGENCY: WAR COMMUNISM IN THE TWENTY-FIRST CENTURY 75–107 (2020) (conceptualizing a form of "chronic" climate emergency).

72. U.N. Framework Convention on Climate Change [UNFCCC], Rep. of the Conf. of the Parties on Its Twenty-First Session, U.N. Doc. FCCC/CP/2015/10/Add.1, Annex (Jan. 29, 2016) [hereinafter Paris Agreement], https://perma.cc/Z8RC-J9NF ("*Recognizing* the need for an effective and progressive response to the urgent threat of climate change.").

73. William J. Ripple et al., Viewpoint, *World Scientists' Warning of a Climate Emergency*, 70 BIOSCIENCE 8, 8 (2020) (enumerating 11,263 scientist-signatories declaring a climate emergency).

74. *See, e.g.*, Press Release, UNFCCC, Commitments to Net Zero Double in Less than a Year (Sept. 21, 2020), https://perma.cc/52S4-E3U2 (reporting private sector net-zero commitments).

75. *See Paris Agreement*, U.N. TREATY COLLECTION [hereinafter *Signatories to the Paris Agreement*], https://perma.cc/GFC4-8ALW.

76. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 11. *See generally* Lenton, *supra* note 51.

77. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 13–14; *see also infra* Part I.A.2 (complicating the idea of climate deadlines).

78. *See, e.g.*, Ted Nordhaus & Alex Trembath, *Is Climate Change like Diabetes or an Asteroid?*, BREAKTHROUGH INST. (Mar. 4, 2019), https://perma.cc/2SXY-A3QU.

79. IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 10.

80. *See* Nordhaus & Trembath, *supra* note 78.

an emergency, it is a planetary problem and therefore beyond one country's power to manage adequately. The semantic argument thus seems to reason that climate change as a whole cannot be an emergency because it is very slow and very big.

This line of thought relies on a narrow understanding of what makes emergencies urgent. The timescale of an emergency depends on the type of crisis presented, and many emergencies are slow and long.[81] Pandemics and wars, paradigmatic examples of emergency, can last years or decades, and they are often managed throughout via extraordinary modes of governance.[82] Though wars and pandemics can have long periods of seeming uneventfulness, they can also threaten the state and its people with mass harm and disruption at short notice. So too with climate change.[83] The error may also arise from thinking too concretely about imminence or analogizing too closely to natural disasters. A better way to think about climate change's urgency is in terms of time constraint. With an emergency, there is limited time to meet a crisis threatening severe harm.[84] Imminence is therefore relative to the nature of the threat and the preparation required to meet it;[85] climate change is big and slow, from a human perspective, but so are the processes of mitigation and adaptation.

To make a clichéd analogy, an impending cataclysmic asteroid collision could present an emergency, even if it were identified a decade or more out from impact.[86] This is because there may be a very large gap between the asteroid-defense capacities at the time of discovery and the systems needed to avert or sufficiently mitigate the collision. Time and resource constraints could further force difficult decisions as to what is necessary to prepare for impact, depending on which risks decision-makers deem tolerable. Rapidly scaling up defense capacities—missiles, satellites, bunkers—even over a decade would be emergency preparation just as much as battening down the hatches before a storm.

If asteroids seem too outlandish, consider a more familiar example. A democracy's slide into authoritarianism is often gradual, the erosion of norms slow, until the sudden, catastrophic moment of autocratic breakthrough.[87] The

81. My thanks to Adrian Hindes for helping clarify this point.

82. *See, e.g.*, VENICE COMMISSION, *supra* note 48, at 8, 31.

83. *See, e.g.*, Kellie Hwang, *The Orange Sky Was Bay Area's Latest Extreme Climate Event. It Won't Be the Last*, S.F. CHRON. (Sept. 10, 2020), https://perma.cc/HS28-PWYG.

84. *Cf.* Lenton et al., *supra* note 51, at 595 (expressing this relationship between risk, urgency, and time as a formula).

85. *Cf. Imminent*, BLACK'S LAW DICTIONARY (11th ed. 2019) ("[T]hreatening to occur immediately; *dangerously impending*." (emphasis added)).

86. *See, e.g.*, Evan R. Seamone, *The Duty to "Expect the Unexpected": Mitigating Extreme Natural Threats to the Global Commons Such as Asteroid Impacts with the Earth*, 41 COLUM. J. TRANSNAT'L L. 735, 738–40 (2003).

87. *See* Masha Gessen, *By Declaring Victory, Donald Trump Is Attempting an Autocratic Breakthrough*, NEW YORKER (Nov. 5, 2020) (citing BÁLINT MAGYAR, THE ANATOMY OF POST-

threat does not cease to be urgent or call for less determined resistance because it is slow and incremental. Admittedly, this example takes place on a national scale and therefore does not capture climate change's planetary nature. So it goes: analogical reasoning has limits when confronting genuinely new issues like climate change. One analogy can capture its slowness, another its scale, and another its incremental nature or uncertainty, but climate change as a whole would present an *unprecedentedly* chronic emergency about which a national government could do little on its own.[88] The coinage of *climate emergency* recognizes this new kind of problem and gives it a name.

2. Complicating Chronic Climate Emergency

Climate change lacks an obvious "impact event" that an asteroid, nuclear war, or autocratic breakthrough might have.[89] Understanding why some call it an emergency therefore requires a nuanced understanding of climate science and international climate policy. Establishing this context will help explain why doing what is necessary on climate change may conflict with prevailing states of normalcy.

Atmospheric concentrations of GHGs are long-lived compared to other air pollutants, sometimes taking thousands of years to naturally fall out of circulation with the air, oceans, and biosphere.[90] As a result, global warming corresponds to the cumulative amount of GHGs emitted, not the annual rate of those emissions.[91] Until anthropogenic emissions are balanced against that absorbed by carbon sinks, the stock of GHG emissions will rise and climate change will worsen, even as annual emission rates fall.[92] One way to imagine this relationship is a bathtub slowly filling with water.[93] The drain is clogged, so only a small amount of water leaves the tub, far less than what the faucet adds. The bathtub's water level—average planetary warming—will keep rising even if the faucet were turned half-off—a decrease in emissions. Only when the faucet is turned off completely will the water stop rising. Unclogging the drain would also help, which can be done by restoring ecosystems like forests and wet-

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COMMUNIST REGIMES: A CONCEPTUAL FRAMEWORK (2020)), https://www.newyorker.com/news/our-columnists/by-declaring-victory-donald-trump-is-attempting-an-autocratic-breakthrough.

88. My thanks to Jesse Reynolds for raising this point.

89. *See infra* Part II.B.2 (discussing tipping points).

90. IPCC, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS 472 box 6.1 (2013) [hereinafter IPCC, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS].

91. *See id.* at 471 fig.6.1.

92. *See id.*

93. *See* Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153, 1165 (2009).

lands.[94] Keeping with the bathtub analogy, building carbon removal infrastructure would be like adding new drains.

The planet is already more than 1°C warmer than pre-industrial averages.[95] The Paris Agreement set a climate target of "well below" 2°C and aspires to prevent warming from exceeding 1.5°C.[96] These numbers are scientifically informed and politically constructed targets. 2°C emerged in the 1960s in climate literature as an early estimate of climate sensitivity, that is, the projected change in global average temperature associated with doubling CO_2 atmospheric concentrations.[97] Economist William Nordhaus is credited with introducing 2°C to the social sciences in 1977, using the value as a way to bound his cost-benefit analysis of climate change mitigation—though not as a concrete objective for climate policy.[98] Nordhaus selected 2°C as a "reasonable" target for his model because it represented the greatest change in global mean temperature observed over the last 100,000 years.[99]

There was no agreed-upon metric for "safe" warming through the 1970s and 1980s, with policymakers confused over whether to target emissions, atmospheric concentrations, temperature, or rate of change.[100] When National Aeronautics and Space Administration scientist James Hansen famously testified to Congress in 1988 on the dangers of anthropogenic climate change—the first testimony of its kind—he gave no limit for "reasonable" warming.[101] Nonetheless the 2°C target appeared in political negotiations a few years later, thanks partly to the Intergovernmental Panel on Climate Change ("IPCC") emission scenarios in the mid-1990s that characterized harms over 2°C as very severe.[102]

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94. *See* IPCC, Global Warming of 1.5°C, *supra* note 23, at 17.

95. World Meteorological Org., WMO-No. 1248, WMO Statement on the State of the Global Climate in 2019, at 6 (2020).

96. *See* Paris Agreement, *supra* note 72, at art. 2(1)(a).

97. Samuel Randalls, *History of the 2°C Climate Target*, 1 Wiley Interdisc. Rev. Climate Change 598, 599 (2010). Scientists used simplified temperature models, based on doubling CO_2, in part to accommodate the limited computing power of the day. *Id.*

98. *Id.*; *see also* William D. Nordhaus, *Economic Growth and Climate: The Carbon Dioxide Problem*, 67. Am. Econ. Rev. 341, 342 fig.1 (1977).

99. Nordhaus, *supra* note 98, at 342.

100. Randalls, *supra* note 97, at 599.

101. Simon Evans & Josh Gabbatiss, *COP25: Key Outcomes Agreed at the UN Climate Talks in Madrid*, CarbonBrief (Dec. 15, 2019), https://perma.cc/9BJA-AMD2 (citing Philip Shabecoff, *Global Warming Has Begun, Expert Tells Senate*, N.Y. Times (June 24, 1988), at A1, https://perma.cc/YZU3-8EMD); *see also Greenhouse Effect and Global Climate Change: Hearing Before the S. Comm. on Energy & Nat. Res.*, 100th Cong. 39–41 (1988) (statement of Dr. James Hansen, Director, NASA Goddard Inst. for Space Stud.) [hereinafter Statement of Dr. James Hansen].

102. Randalls, *supra* note 97, at 601 (citing IPCC, Second Assessment Climate Change (1995)).

In 2015, after percolating through decades of climate summits, 2°C was finally enshrined in Article 2 of the Paris Agreement.[103]

Climate advocates widely saw the Paris Agreement's 2°C target as a significant political achievement: it provided focus and urgency to collective mitigation commitments. The United States had long opposed the target for that very reason, and disagreement over whether to include a temperature target contributed to the collapse of climate talks in Copenhagen in 2009.[104] The Paris Agreement also received substantial press coverage,[105] with media outlets summarizing the parties' key goal as holding global warming "well below 2°C," publicizing the target and the cause worldwide.[106] With 2°C, climate's political culture had an objective it could use.

But 2°C is not immune to criticism. Some question the scientific rigor of equating 2°C with a "safe" level of warming or the ability of ordinary people to understand the significance of such an apparently small number.[107] Others ask whether the 2°C target oversimplifies the problem and crowds out other concerns on the road to a stable climate.[108] Still more doubt the 2°C target is achievable at all.[109]

One leading IPCC scientist admits 2°C is "oversimplified" because it fails to "cover all aspects and processes that are able to cause dangerous interference with the climate system."[110] But he argues it has "power" because "it is pragmatic, simple, and straightforward to understand and communicate, all important elements when science is brought to policymakers."[111] 2°C distills the complex contributions of climate science into what is essentially a slogan, giving political negotiations and scenario building a necessary shared point of reference. The benefits of this approach—urgency, concreteness, broad accept-

103. Evans & Gabbatiss, *supra* note 101 (noting the Cancun Agreements were the first international instruments to recognize the 2°C target).

104. *Id.* (citing John Vidal et al., *Low Targets, Goals Dropped: Copenhagen Ends in Failure*, GUARDIAN (Dec. 19, 2009), https://perma.cc/6F2F-8MSU).

105. *See* Sonya Gurwitt et al., *Global Issue, Developed Country Bias: The Paris Climate Conference as Covered by Daily Print News Organizations in 13 Nations*, 143 CLIMATIC CHANGE 281, 284–85 (2010).

106. *See, e.g.*, *The Road to a Paris Climate Deal*, N.Y. TIMES (Dec. 12, 2015), https://perma.cc/XRK7-USL7; Nina Chestney & Peter Hobson, *Greenhouse Gas Emissions Set to Bust Global Climate Pact in 2030*, REUTERS (Nov. 3, 2016), https://perma.cc/4D8H-B879.

107. *See, e.g.*, Reto Knutti et al., *A Scientific Critique of the Two-Degree Climate Change Target*, 9 NATURE GEOSCIENCE 13, 14–15 (2016).

108. *See, e.g.*, Holly J. Buck, *The Tragic Omissions of Governance by Curve*, STRELKA MAG (May 15, 2020), https://perma.cc/FLW5-ZXDW.

109. *Cf., e.g.*, NAS REPORT 2021, *supra* note 33, at 1 (recognizing the difficulty of meeting the 2°C target).

110. Roz Pidcock, *Scientists Weigh in on 2C Target for Curbing Global Warming*, CARBONBRIEF (Oct. 2, 2014) (quoting Thomas Stocker, Co-Chair, IPCC), https://perma.cc/Y6PL-YURA.

111. *Id.*

ance—seem to outweigh concerns that it is arbitrary or distortive.[112] Political action on the environment requires organization around some set of ideas,[113] and it follows that a key political task for scientists and their allies is to arrive at slogans, targets, and models that politicians and the public can understand and use. This is true whichever metrics are chosen to express environmental policy objectives: temperatures, atmospheric concentrations, human prosperity, or biodiversity loss avoided.

Temperature targets were set recognizing that climate impacts worsen with each additional tenth of a degree of warming: bad now, worse at 1.5°C, and severe beyond 2°C.[114] They therefore represent a collective, legitimate political judgment, established within an international agreement virtually all states have joined, about the climate risk that states are willing to tolerate. Because temperatures are already about 1°C warmer than pre-industrial averages, and because CO_2 pollution is slow to dissipate, there is a relatively small "budget" of CO_2 that humans can emit before crossing these temperature thresholds.[115] Achieving either temperature target therefore requires a dramatic transformation of the global economy to zero-out emissions.[116] It also likely requires the rapid build-out of a completely novel negative emissions infrastructure over the next few decades,[117] removing by century's end atmospheric carbon at a scale rivaled only by the rate of today's fossil fuel emissions.[118] Change of this size, speed, and comprehensiveness is unprecedented in human history.[119]

So there is a conflict between the Paris Agreement's climate targets—even 2°C, the current agreed-upon outer limit of tolerable warming—and what appears practically possible.[120] In turn, this conflict between the "necessary" and the "possible"—politically, socially, and technologically—gives rise to declarations of climate emergency. Not all agree. Some say 2°C is a patently unrealistic target and counsel in favor of more realistic warming thresholds.[121] Others argue that policy frameworks outside climate "deadline-ism" can deliver accept-

112. *Cf.* Ted Nordhaus, *The Two-Degree Delusion*, Foreign Affs. (Feb. 8, 2018), https://perma.cc/4CER-MCYE; Buck, *supra* note 108.

113. Purdy, *supra* note 5, at 1129–30.

114. *See* Randalls, *supra* note 97, at 601; IPCC, Global Warming of 1.5°C, *supra* note 23, at 10.

115. IPCC, Global Warming of 1.5°C, *supra* note 23, at 4, 11.

116. *See id.* at 13–16.

117. *See id.* at 17.

118. *Compare* Jan C. Minx et al., *Negative Emissions—Part 1: Research Landscape and Synthesis*, 13 Env't Rsch. Letters e063001, at 2 (2018) (reporting many billions of tons of atmospheric CO_2 would need to be removed by century's end to meet climate goals), *with* Oliver Morton, The Planet Remade 215–18, 220–22 (2016) (describing magnitude of human interference with Earth's carbon cycle from fossil fuels).

119. *See* IPCC, Global Warming of 1.5°C, *supra* note 23, at 15.

120. *See id.*

121. *See, e.g.*, Nordhaus, *supra* note 112.

able outcomes on climate.[122] It could also be too early to tell whether climate change has genuinely become an emergency.[123]

This touches on the heart of the debate about climate emergency. Declaring an emergency, climate or otherwise, boils down to judgment, and the bases for that judgment are indeterminate and contestable.[124] The decision process goes like this. *First*, is the risk significant, requiring some kind of urgent response?[125] *Second*, what course of action is necessary? *Third*, does the necessary response conflict with the prevailing social order?[126]

Each step in this process requires a value judgment. Recall the asteroid: Most would likely agree that a large asteroid striking Earth would pose a significant risk, assuming scientists predicted impact with sufficient certainty. The available and optimal responses, the second question, could also be rigorously defined by scientific and policy expertise. There could, however, still be political debate on which responses to pursue. There could also be disagreement on the third question, whether states and the international community, following standard rules and norms of organization, could mount a sufficient defense. That determination would depend on time until impact, the technology needed, and the resources required to realize the defense system. Emergency powers could be warranted if time were short and an asteroid defense system were a complex and expensive undertaking, or if necessary cooperation were unavailing, or if ordinary procedures would unacceptably slow construction.

These open-ended determinations regarding emergencies have serious consequences. Emergency declarations can conflagrate politics, dissolve deliberative processes, and concentrate extraordinary powers in a few hands while permanently damaging constitutional norms.[127] This is why the element of widespread agreement is important in guarding against abuse: it is one of the few structural assurances that an emergency is genuine.[128] With climate change, there is no room left for reasonable disagreement on the first question. All countries agree the risk is significant and merits serious response.[129] But reason-

122. *See, e.g.*, Jesse Reynolds, *The Danger of Climate Change Deadlines*, LEGAL PLANET (June 30, 2020), https://perma.cc/G392-5ATT.

123. *See* Shinichiro Asayama et al., Comment, *Why Setting a Climate Deadline Is Dangerous*, 9 NATURE CLIMATE CHANGE 570, 570 (2019).

124. *Cf.* Universal Camera Corp. v. NLRB, 340 U.S. 474, 489 (1951) (Frankfurter, J.) ("There are no talismanic words that can avoid the process of judgment. The difficulty is that we cannot escape, in relation to this problem, the use of undefined defining terms.").

125. *See* VENICE COMMISSION, *supra* note 48, at 4.

126. *See* Vermeule, *supra* note 57, at 168.

127. *See infra* Part III.B.

128. *See infra* Part III.B. One problem with the element of widespread agreement is that it is circular: "An emergency is an emergency when basically every reasonable authority agrees there is an emergency." Yet some indeterminateness is unavoidable when using words to capture value judgments.

129. *See Signatories to the Paris Agreement*, *supra* note 75.

able minds still disagree on the second question, in terms of how to zero out CO_2 emissions and how quickly. Accordingly, there is disagreement on the third question, whether the necessary conflicts with the normal political and economic order.[130]

It is hard to tell if there is a climate emergency when so many governments have moved so slowly to meet the problem. It seems odd to say that extraordinary power is needed when so much ordinary power goes unused. But as climate impacts mount, and if mitigation efforts continue to meander, consensus may build in favor of answering this third question affirmatively.[131] Because emergency consensus could cohere someday, a "chronic" climate emergency is a theoretically sound category and cannot be discarded outright. Having answered that question, we can now ask how climate emergencies are used.

B. Using Climate Emergencies

A sense of profound risk and potential crisis can be found in public language about climate change since at least the 1980s. James Hansen's watershed climate testimony warned of extreme weather events: *FORECAST FOR DISASTER* read the headline of an article submitted with his testimony.[132] *The New York Times*'s coverage of the hearing reported increased risk of drought, sea-level rise, and potential "widespread destruction of forests."[133] The U.N. Framework Convention on Climate Change ("UNFCCC"), the multilateral treaty coordinating the international community's climate policy, enacted in 1992, warned of "significant deleterious effects" to human and natural systems, particularly small island nations, coastal and arid regions, and the Global South.[134]

Yet this rhetoric did not amount to emergency declarations as seen today.[135] Many saw climate change as a serious problem, but one that was slow-moving, scientifically complex, and shrouded by uncertainty.[136] Deliberate mis-

130. Some also disagree whether there is still room for reasonable disagreement on this point. *See, e.g.*, Scott W. Stern, *Sabotage Can Be Done Softly: On Andreas Malm's "How to Blow Up a Pipeline"*, L.A. REV. BOOKS (Jan. 5, 2021), https://perma.cc/9X67-RPZS.

131. *See* MANN & WAINWRIGHT, *supra* note 10, at 17.

132. Statement of Dr. James Hansen, *supra* note 101, at 10, 39; *see also* Peter Sinclair, *Judgment on Hansen's '88 Climate Testimony: 'He Was Right'*, YALE CLIMATE CONNECTIONS (June 20, 2018), https://perma.cc/3ALX-NJ5B (explaining the significance of Hansen's testimony)

133. Philip Shabecoff, *Global Warming Has Begun, Expert Tells Senate*, N.Y. TIMES, June 24, 1988, at A14.

134. UNFCCC art. 1(1), art. 3(2), May 9, 1992, 1771 U.N.T.S. 107; S. TREATY DOC. NO. 102-38.

135. *See* Susanne C. Moser, *Communicating Climate Change: History, Challenges, Process and Future Directions*, 1 WIRES CLIMATE CHANGE 31, 32–33 (2010) (describing early public communication on climate change as restrained and technical).

136. *See id.* at 33–37.

information campaigns muddied things further, creating a false impression of expert debate on whether climate change was real, harmful, and caused by humans.[137] Though advocate messaging became more urgent and effective over the years,[138] the overall rhetorical temperature stayed relatively cool.[139] One exception was the climate justice movement in Europe and the United States, which began to gather force in the mid-to-late 2000s in response to international climate governance seen as too technocratic, moderate, and slow.[140] The climate justice movement linked climate change to structural problems of capitalism and imperialism, calling for radical reform of the world economic order.[141] Still, declarations of climate emergency during this period seem to have been rare.[142]

Only in the last few years has "climate emergency" broken through in English-language discourse.[143] As recently as 2018, emergencies were more typically used to describe family or medical crises and the like.[144] "Emergency" was also sometimes used in its legal sense, like public emergencies and emergency declarations.[145] "Climate emergency" is a new development, "an extension of emergency to the global level."[146] In 2019, this new use of the word was far

137. *See* John Cook, *Understanding and Countering Misinformation About Climate Change*, *in* Handbook of Research on Deception, Fake News, and Misinformation Online 281, 282–83 (2019). This misperception lingers today. *See, e.g.*, Rachel Frazin, *Barrett Says She Doesn't Have 'Firm Views' on Climate Change*, Hill (Oct. 14, 2020), https://perma.cc/TE6U-UFTH.

138. *See* Moser, *supra* note 135, at 32–33.

139. This can be seen in press coverage of the Kyoto Protocol in the late 1990s. *See, e.g.*, John H. Cushman, Jr., *U.S. Signs a Pact to Reduce Gases Tied to Warming*, N.Y. Times (Nov. 13, 1998), https://perma.cc/Q5JM-GLK7; John J. Fialka, *Foes of Kyoto Treaty in U.S. Could Kill Pact Around World*, Wall St. J. (Oct. 19, 1999), https://perma.cc/4C2G-LF42; Kevin Sullivan, *Four U.S. Senators Lobbying in Kyoto*, Wash. Post (Dec. 3, 1997), https://perma.cc/5WZH-WSHT; James Gerstenzang, *Delays Chill Effort to Combat Global Warming*, L.A. Times (June 13, 1998), https://perma.cc/BYU2-R6J6 ("If global warming is proceeding at an extremely slow pace, consider the tempo of the worldwide effort to reverse it.").

140. Karin Bäckstrand & Eva Lövbrand, *The Road to Paris: Contending Climate Governance Discourses in the Post-Copenhagen Era*, 21 J. Env't Pol'y & Plan. 519, 526–27 (2019).

141. *See id.* (collecting slogan examples, including, "if there is no justice there is no deal" and "[s]ystem change, not climate change"); *see also id.* at 528 tbl.2.

142. Invocations of "climate emergency" were somewhat more common in early discussions of solar geoengineering technology. *See, e.g.*, Blackstock et al., *supra* note 42, at III; Nat'l Rsch. Council, Climate Intervention: Reflecting Sunlight to Cool Earth 9–10 (2015) [hereinafter NRC Report 2015] (discussing climate emergency deployment scenarios). The critique and abandonment of this approach is discussed in Part II.B.2.

143. *See Word of the Year 2019*, *supra* note 6.

144. *Id.*

145. *Id.*

146. *Id.*

more common than older uses of medical, family, or public emergencies, "becom[ing] the most written about emergency by a huge margin."[147]

Though it has since been eclipsed by the use of emergencies regarding COVID-19, "climate emergency" persists.[148] To understand this trend better, this section describes the factual basis for climate emergency drawn from IPCC reports. It then tracks the shifting meaning of "emergency" in several places: news media coverage, climate activist movements, and acts of government.

1. IPCC: Providing the Factual Basis for Climate Emergency

The IPCC was established by the World Meteorological Organization and the U.N. Environment Programme to gather and report scientific information on climate change.[149] Under the UNFCCC, the IPCC acts as an authoritative body providing scientific and technical advice on climate policy.[150] To that end, the IPCC digests peer-reviewed scientific literature on climate, reporting comprehensive summaries on the state of climate change knowledge.[151] It is assisted in this task by countless scientists, academics, and policy experts who review and critique proposed drafts line by line. The IPCC is currently in its sixth assessment cycle, with a new synthesis report expected in 2022.[152]

It is difficult to overstate the importance of the IPCC's reports within the climate world. Disinformation campaigns by fossil fuel interests and their allies have long warped public understanding of climate science, creating the appearance of scientific uncertainty on issues where there is, in fact, overwhelming consensus.[153] This false perception continues today in the United States, with Republican Party leaders and rank-and-file members publicly doubting the reality, severity, and causes of climate change.[154] In response, climate advocates have developed "the mantra, 'believe the science,'" a shorthand meaning that scientific debate on these basic issues is over and the need to act is indisputa-

147. *Id.*

148. *See, e.g.*, Matthew Daly, *Sanders, Ocasio-Cortez Seek 'Climate Emergency' Declaration*, Seattle Times (Feb. 7, 2021), https://perma.cc/SB67-QCQ7.

149. *See About the IPCC*, IPCC, https://perma.cc/LQH5-KWCA.

150. UNFCCC art. 21(2), May 9, 1992, 1771 U.N.T.S. 107.

151. *About the IPCC*, *supra* note 149.

152. *AR6 Synthesis Report: Climate Change 2022*, IPCC, https://perma.cc/T9ZS-MDXJ.

153. *See* Naomi Oreskes & Erik M. Conway, Merchants of Doubt 1–9 (2010).

154. *See* Coral Davenport & Eric Lipton, *How G.O.P. Leaders Came to View Climate Change as Fake Science*, N.Y. Times (June 3, 2017), https://perma.cc/C8DM-JHQR; *cf.* Matthew T. Ballew et al., *Does Socioeconomic Status Moderate the Political Divide on Climate Change? The Roles of Education, Income, and Individualism*, 60 Glob. Env't Change 102024-1, 102024-7 (2020) (discussing conservatives' views on climate change).

ble.[155] *The science*, typically, is as described by IPCC literature reviews and then publicized by prominent science communicators.

The IPCC has not declared climate emergency. Its reports, however, serve as the factual basis for prominent climate deadlines and climate emergency declarations.[156] In 2018, the IPCC released *Global Warming of 1.5°C*, a special report highlighting the importance of not exceeding 1.5°C warming, the Paris Agreement's more aspirational target.[157] The IPCC makes its case by documenting the already-observable impacts of global warming at 1°C and comparing those harms against the ever-more dire consequences projected for warming at 1.5°C and 2°C. It developed the report at the request of a decision by the 2015 Conference of the Parties under the UNFCCC, the very same session that delivered the Paris Agreement.[158] That request, in turn, was the product of advocacy by countries especially vulnerable to climate change, such as low-lying and island nations, for whom 2°C warming represents an intolerable level of risk.[159] The in-depth analysis of risks above 1.5°C and associated emissions pathways for meeting 1.5°C led to the media's interpretation of 1.5°C as a "deadline" in coverage of the report.[160]

Another consequence of the IPCC's *Global Warming at 1.5°C* report has been the normalization of carbon removal within climate policy circles. The IPCC centered large-scale deployment of carbon removal strategies in its emissions scenarios for meeting 1.5°C and 2°C temperature targets.[161] It gave two reasons why. First, certain human activities would be very difficult, if not impossible, to decarbonize with current or imminent technologies, such as air travel, some industrial heat processes, and many agricultural practices.[162] Because climate stabilization requires approximately net-zero emissions, removals are needed to offset these residual emission sources.[163] Second, given emission

155. Rachel M. Cohen, *The Environmental Left Is Softening on Carbon-Capture Technology. Maybe That's OK*, INTERCEPT (Sept. 20, 2019), https://perma.cc/GJX9-2D9Z.

156. *See, e.g.*, Jonathan Watts, *We Have 12 Years to Limit Climate Change Catastrophe, Warns UN*, GUARDIAN (Oct. 8, 2018), https://perma.cc/7JEL-FXB2 (covering the IPCC's *Global Warming of 1.5°C* report).

157. IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 4; Paris Agreement, *supra* note 72, at art. 2.

158. Paris Agreement, *supra* note 72, at 4 (inviting "the [IPCC] to provide a special report of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways").

159. Graham Provost, *Rigorous and Relevant: Applying Lessons from the History of IPCC Special Reports to the Post-Paris Agreement World*, 43 HARV. ENVTL. L. REV. 507, 533 (2019).

160. *See infra* Part I.B.2.

161. IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 17.

162. *Id.* at 96.

163. Some emission sources can also be cleaned up using carbon capture and sequestration ("CCS") technologies. *See* S. JULIO FRIEDMANN ET AL., LOW-CARBON HEAT SOLUTIONS FOR HEAVY INDUSTRY: SOURCES, OPTIONS, AND COSTS TODAY 7–9 (2019). Carbon removal extracts CO_2 from ambient air, while CCS captures CO_2 at the emission source.

trends, it is likely that the global atmospheric "stock" of GHG pollution will exceed levels associated with even 2°C warming.[164] If there is an overshoot, the natural carbon cycle is far too slow to be the sole source of removals.[165] Negative emissions strategies will therefore be needed to supplement efforts and satisfy climate targets.[166] As a result, most IPCC emissions scenarios achieving 2°C by 2100, and "[v]irtually all" hitting 1.5°C, rely on substantial use of carbon dioxide removal ("CDR") infrastructure.[167]

In effect, CDR is the extraordinary measure required to meet the dire time constraints that temperature targets create.[168] Before the IPCC's 2018 models, CDR had been kept to the margins of climate policy.[169] It was grouped with the likes of SAI as a potentially dangerous and risky form of *geoengineering*.[170] It still is reviled by some prominent climate scientists and climate activists.[171] Yet the urgency of meeting temperature targets makes negative emissions seem necessary at an enormous scale, and what is considered "consensus" climate policy transformed as a result. That relationship is especially important when considering proposed climate emergency measures: from urgency, to necessity, to new consensus.

2. Media Coverage: Popularizing Climate Emergency

The IPCC—*the science*—appeared to have put the world on a tight deadline to avoid dangerous levels of global warming.[172] Some news organizations responded by ratcheting up the emotional intensity of climate coverage.[173] A few headlines show this amplification at work: *Major Climate Report Describes a*

164. *See* Brad Plumer & Nadja Popovich, *Yes, There Has Been Progress on Climate. No, It's Not Nearly Enough.*, N.Y. Times (Oct. 25, 2021), https://perma.cc/3NMV-C2S4; Harry Stevens & Brady Dennis, *National Climate Pledges Are Too Weak to Avoid Catastrophic Warming. Most Countries Are on Track to Miss Them Anyway.*, Wash. Post (Nov. 3, 2021), https://perma.cc/9ZUG-GFVF.

165. IPCC, Climate Change 2013: The Physical Science Basis, *supra* note 90, at 472 box 6.1.

166. IPCC, Global Warming of 1.5°C, *supra* note 23, at 96.

167. *Id.* at 268 box 7.

168. *Cf. supra* Part I.A.2 (defining emergency as conflict between necessity and normalcy).

169. *See* Minx et al., *supra* note 118, at 2–3.

170. *See, e.g.*, Naomi E. Vaughan & Timothy M. Lenton, *A Review of Climate Geoengineering Proposals*, 109 Climatic Change 745, 750–61 (2011).

171. *See, e.g.*, *Hands off Mother Earth!*, Indigenous Env't Network (Oct. 4, 2018), https://perma.cc/SA6A-6LM6; Michael Mann, The New Climate War 157–59, 164–68 (2021) (questioning the feasibility of large-scale carbon removal and the motivations behind it).

172. Mike Hulme, *Against Climate Emergency* (Oct. 17, 2018), https://perma.cc/97MM-NP6Q.

173. *See* Tracy, *supra* note 5.

Strong Risk of Crisis As Early as 2040;[174] *The World Has Just over a Decade to Get Climate Change Under Control, U.N. Scientists Say*;[175] *UN Report: 'Unprecedented Changes' Needed to Protect Earth from Global Warming*;[176] and *UN Says Climate Genocide Is Coming. It's Actually Worse than That*.[177] Many of these stories tended to emphasize worst-case scenarios, elide scientific uncertainties, and echo deadline-framings for climate policy.[178]

There are a few reasons for alarmist coverage, such as market bias toward exciting stories—floods, fires, shocking scientific findings—and an editorial goal to counteract climate-skeptic misinformation in right-wing media.[179] But, maybe more importantly, the climate story is genuinely and justifiably alarming. In addition to IPCC reports, journalists were covering unprecedented heatwaves, wildfires, ice melt, and other unusual weather events associated with climate change.[180] These acute impacts made the problem imminent.

Some editors have said as much. *The Guardian*, in a piece explaining its use of "climate emergency" and "climate crisis" instead of "climate change," argued the new terms were scientifically justified, conveying that "what scientists are talking about is a catastrophe for humanity."[181] The purpose of emergency narratives in media hence seems not solely tied to promoting a certain set of policies or desired state powers, but also to communicating the idea of urgency itself. "People need reminding the climate crisis is no longer a future problem—

174. Coral Davenport, *Major Climate Report Describes a Strong Risk of Crisis As Early as 2040*, N.Y. TIMES (Oct. 7, 2018), https://perma.cc/2NE5-FUUH (reporting a future "world of worsening food shortages and wildfires, and a mass-die off of coral reefs as soon as 2040").

175. Chris Mooney & Brady Dennis, *The World Has Just over a Decade to Get Climate Change Under Control, U.N. Scientists Say*, WASH. POST (Oct. 7, 2018), https://perma.cc/52HG-EDPP ("It's like a deafening, piercing smoke alarm going off in the kitchen. We have to put out the fire." (quoting Erik Solheim, Executive Director, U.N. Environment Program)).

176. Doyle Rice, *UN Report: 'Unprecedented Changes' Needed to Protect Earth from Global Warming*, USA TODAY (Oct. 7, 2018), https://perma.cc/ELK2-5J5Z.

177. David Wallace-Wells, *UN Says Climate Genocide Is Coming. It's Actually Worse than That.*, N.Y. MAG. (Oct. 10, 2018), https://perma.cc/L472-79YZ. Scientists and media critics have criticized some of Wallace-Wells' journalism from this period for being alarmist and misstating some aspects of climate science. *See, e.g.*, Chris Mooney, *Scientists Challenge Magazine Story About 'Uninhabitable Earth'*, WASH. POST (July 12, 2017), https://perma.cc/DN8C-HNDF.

178. *See* Matthew C. Nisbet, *Sciences, Publics, Politics: The Trouble with Climate Emergency Journalism*, ISSUES SCI. & TECH. (2019), https://perma.cc/5JQJ-UNB5.

179. *See* Tracy, *supra* note 5; *see also, e.g.*, *Bill Nye's Fiery Message on Climate Change*, FOX NEWS (Mar. 16, 2019), https://perma.cc/5C9J-GVCD (featuring climate denialist talking points).

180. *See* Tracy, *supra* note 5.

181. Damian Carrington, *Why the Guardian Is Changing the Language It Uses About the Environment*, GUARDIAN (May 17, 2019), https://perma.cc/C4Q7-CWT5 (also pointing to use of "climate crisis" by U.N. Secretary-General Guterres, activist Greta Thunberg, and members of the UK Parliament).

we need to tackle it now, and every day matters."[182] Other media critics have echoed this rationale, arguing tepid media coverage enables the climate crisis.[183]

News media narratives seem to have played a key role in popularizing and spreading climate emergency rhetoric, working in tandem with amplification on social media.[184] At the very least, it is correlated with the rapid increase in use of the term observed by Oxford Languages.[185] Something that could be called epistemic recursion may be at work as well. Emergency declarations of media outlets, high-profile activists, and political leaders cite each other to substantiate their own declarations—recalling the herding among authorities that occurs when other kinds of emergencies are recognized.[186] Amplification on social media could be just a new technological means of an old process for self-legitimization through repetition and spread.[187]

A few radical responses to climate change have reemerged in response to this emergency media narrative.[188] One is solar geoengineering, presented as a possible rapid method for reducing future risk from climate weather anomalies, examined in Parts II and III.[189] Another is the rise of more disruptive tactics by climate activists, explored immediately below.[190]

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182. *See id.*

183. *See, e.g.*, Mark Hertsgaard & Kyle Pope, *The Media Are Complacent While the World Burns*, Colum. Journalism Rev. (Apr. 22, 2019), https://perma.cc/KN5A-KHHQ ("A big part of the reason our civilization today faces the prospect of extinction is that we have waited so long to take action, not least because the media left the public and policy-makers misinformed about the threat and its solutions.").

184. *See* Nisbet, *supra* note 178; *cf.* Holly J. Buck et al., *Pandemic Politics—Lessons for Solar Geoengineering*, 1 Commc'ns Earth & Env't, art. no. 16, at 2 (2020), https://perma.cc/5KBJ-AJNL (describing how scientific publications, news narratives, and social media amplification interact to create dominant interpretations of the COVID-19 pandemic).

185. *Compare* Tracy, *supra* note 5 (observing media trend), *with Word of the Year 2019*, *supra* note 6 (suggesting rapid growth in "climate emergency" reflects "a conscious intensification . . . in people's language choice").

186. *See* Vermeule, *supra* note 57, at 168.

187. *Cf.* Charles R. Corbett, *Chemtrails and Solar Geoengineers: Governing Online Conspiracy Theory Misinformation*, 85 Mo. L. Rev. 633, 643–44, 649–50, 666 (2020) (describing the relationship between spread, repetition, and validation in misinformation streams on social media and in news media).

188. They have "reemerged" because both solar geoengineering discourse and radical climate protest tactics sprung up long before the latest round of climate emergency rhetoric. *See* Ken Caldeira & Govindasamy Bala, *Reflecting on 50 Years of Geoengineering Research*, 5 Earth's Future 10, 10–13 (2017); *see also, e.g.*, John Lemons & Donald A. Brown, *Global Climate Change and Non-Violent Civil Disobedience*, 11 Ethics Sci. & Env't Pol. 3, 8–9 (2011).

189. *See* Christopher Flavelle, *As Climate Disasters Pile Up, a Radical Proposal Gains Traction*, N.Y. Times (Nov. 10, 2020), https://perma.cc/GW3D-MSSP.

190. *See* J. Lester Feder, *Riot Police Teargassed Climate Protestors at Point-Blank Range*, BuzzFeed News (June 28, 2019), https://perma.cc/K5EV-TVYQ.

3. Climate Activism and the "Climate Necessity" Defense

During the summer of 2020, with businesses and schools shuttered to slow COVID-19's spread, Greta Thunberg and other climate activists sent an open letter to the European Union declaring a climate emergency.[191] They called on world leaders to divest immediately from fossil fuels, criminalize "ecocide" under international law, and set "annual, binding" emissions budgets compatible with 1.5°C warming targets.[192] The climate emergency required a revolutionary response, "a new system . . . a fully decarbonised economy that centres around the wellbeing of all people as well as the natural world."[193] If countries could shut down public life to limit the spread of COVID-19, the letter reasoned, they also could move swiftly to get off fossil fuels.[194]

As climate movements in Europe and the United States have grown and intensified, some have invoked climate emergency to make their case for change.[195] But are these demands for literal states of emergency suspending the normal constitutional and social order? It is unclear. Calls for rapid, centralized decarbonization mingle with demands for racial justice, labor rights, and democratic inclusion.[196] States of emergency, meanwhile, are often in tension with social justice goals because they often lead to derogations of political and civil rights.[197] It seems more likely that most activists who use emergency rhetoric do so to spur ordinary political processes to meet the climate crisis with force and focus. Annual, binding emissions codes, ending fossil subsidies, and expansions of international criminal law are all achievable within the legal system as it exists today. What is missing is the political will to enact these laws—which public appeals to climate emergency can help create.

But some activists make use of emergency rhetoric to justify more radical political demands, including, potentially, civil uprisings.[198] It all raises an important question: Who gets to declare emergencies? When arrested, some climate civil disobedients in the United States have invoked climate emergency via

191. Luisa Neubauer, Greta Thunberg, Anuna de Wever van der Heyden & Adélaïde Charlier, *Face the Climate Emergency: Open Letter and Demands to EU and Global Leaders* (July 16, 2020), https://perma.cc/L7Q4-R4K3.

192. *Id.*

193. *Id.*

194. *See id.*

195. *See* Justine Calma, *2019 Was the Year of 'Climate Emergency' Declarations*, VERGE (Dec. 27, 2019), https://perma.cc/8ZNH-JMQR; *see also* Arundhati Roy, *Literature Provides Shelter. That's Why We Need It*, GUARDIAN (May 13, 2019), https://perma.cc/5Y6J-YD8S (describing climate justice activism in India). *See generally, e.g.*, Dana R. Fisher, *The Broader Importance of #FridaysForFuture*, 9 NATURE CLIMATE CHANGE 430, 430–31 (2019).

196. *See* Neubauer, Thunberg, de Wever van der Heyden & Charlier, *supra* note 191.

197. *See* VENICE COMMISSION, *supra* note 48, at 4.

198. *See, e.g.*, Stern, *supra* note 130; *Citizens' Assembly*, EXTINCTION REBELLION, https://perma.cc/4DL8-XPRP.

the necessity doctrine, as a defense against criminal prosecution.[199] Examining these cases here is worthwhile for a few reasons. Ensuing legal proceedings have developed the climate emergency inquiry with unusual rigor, asking what is necessary to meet the climate crisis and whether it can legally justify property crimes.[200] The issue also foreshadows necessity under international law, examined later in this Article, which provides a possible channel for articulating climate emergency claims between states.[201]

Civil disobedience is the intentional, non-violent, and often conspicuous violation of the law done to spur social change.[202] As in other countries, the practice has a long history in the United States, from the Boston Tea Party to open defiance of the Fugitive Slave Act to student sit-ins protesting the Vietnam War.[203] Keeping with this tradition, climate activists have targeted fossil fuel companies and institutions with large carbon footprints, organizing sit-ins at universities[204] and blocking operation of oil and gas infrastructure.[205] These direct actions violate private property rights, and many participants have been charged with crimes ranging from misdemeanor trespassing to felony burglary,[206] generating substantial press coverage in the meantime.[207]

At trial, some climate disobedients have raised the "climate necessity defense," arguing climate change is so severe and U.S. political processes so unresponsive that no way to effect change remains but civil disobedience.[208] In essence, they declare climate emergency to justify their actions, tapping into the deep connections between emergencies and legal doctrines of necessity.[209] The

199. An earlier version of this argument appeared in Charles Corbett, *Asserting "Climate Necessity" in Defense of Civil Disobedience*, LEGAL PLANET (Apr. 28, 2020), https://perma.cc/2JN7-8RB6.

200. *See generally* CLIMATE DEF. PROJ., CLIMATE NECESSITY DEFENSE GUIDE: A GUIDE FOR ACTIVISTS AND ATTORNEYS (2019), https://perma.cc/4Z3T-AFKC (briefing prosecutions of civil disobedients citing "climate necessity").

201. *See infra* Part III.A.

202. *See* Kimberley Brownlee, *Civil Disobedience*, STAN. ENCYC. PHIL. (Dec. 20, 2013), https://perma.cc/WW8B-U9EE.

203. *See* Lemons & Brown, *supra* note 188, at 8.

204. *See, e.g.*, Nathan Clark, *Judge Won't Order UM to Provide More Evidence in Climate Strike Trespassing Case*, M LIVE (Oct. 10, 2019), https://perma.cc/36SH-AD8S.

205. *See* Carolyn Kormann, *Sometimes Fighting Climate Change Means Breaking the Law*, NEW YORKER (Apr. 3, 2018), https://perma.cc/3GTH-SWNY.

206. *See generally* CLIMATE DEFENSE PROJECT, *supra* note 200.

207. *See, e.g.*, Kormann, *supra* note 205.

208. *See* Lance N. Long & Ted Hamilton, *The Climate Necessity Defense: Proof and Judicial Error in Climate Protest Cases*, 38 STAN. ENV'T L.J. 57, 59–60 (2018).

209. *See* GIORGIO AGAMBEN, STATE OF EXCEPTION 24 (Kevin Attell trans., 2005) ("[A]ny discussion of the structure and meaning of the state of exception first requires an analysis of the legal concept of necessity."). *See generally* Vik Kanwar, Book Review, 4 INT'L J. CONST. L. 567, 570–74 (2006) (reviewing *id.*) (summarizing the relationship between states of emergency and necessity within constitutional theory); Pasquale Pasquino, *Locke on King's Prerog-*

necessity defense, long established at common law, recognizes that sometimes individuals must break the law to avoid a greater evil.[210] But because necessity risks lawlessness, the circumstances in which it may prevail are limited.[211] Under U.S. criminal law, it usually requires defendants to show they were responding to imminent danger; that the action taken was less harmful than the danger itself; that it was reasonable to believe the action would avoid or mitigate the danger; and that no reasonable, lawful alternative remained.[212] A sketch of the *climate necessity* defense using these elements follows below.

(1) Imminence. Scientists have shown, and courts have recognized, that climate change's dangers are immediate, severe, and accelerating.[213]

(2) Lesser harm. Climate change's damages far exceed the property interference or damage associated with direct actions.[214]

(3) Causal relationship. Civil disobedience is a core part of the U.S. political tradition and a proven mechanism for systemic change.[215]

(4) No reasonable alternative. State and federal governments have done little to reduce emissions and still subsidize fossil fuels despite years of warnings, climate impacts, and lawful protest.[216]

The defense rarely makes it to trial.[217] In most cases, it is excluded at pre-trial hearings finding the proposed defense insufficient as a matter of law: that is, the evidence offered in support is too weak to send to a jury.[218] Defendants encounter the most trouble on the third and fourth elements, with courts finding the causal relationship between the protest and climate mitigation too attenuated, or that other lawful options remain for activists to make their voices heard.[219]

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ative, 26 POL. THEORY 198, 199–200 (1998) (describing John Locke's theory of the executive's inherent emergency powers in the face of necessity).

210. *See* Edward B. Arnolds & Norman F. Garland, *The Defense of Necessity in Criminal Law: The Right to Choose the Lesser Evil*, 65 J. CRIM. L. & CRIMINOLOGY 289, 289–91 (1974).

211. *See id.* at 291 ("[N]ecessity creates the law; it supersedes rules; and whatever is reasonable and just in such circumstances is likewise legal."); *id.* at 294.

212. *See* CLIMATE DEF. PROJECT, *supra* note 200, at 1; *see also* Arnolds & Garland, *supra* note 210, at 294 (framing the inquiry in U.S. criminal law as whether the peril was genuine and whether the actions taken were appropriate).

213. *See* Long & Hamilton, *supra* note 208, at 89–96.

214. *See id.* at 81–84.

215. *See id.* at 84–89.

216. *See id.* at 96–104.

217. *See generally* CLIMATE DEF. PROJECT, *supra* note 200.

218. *See id.*

219. *See id.*

There is a more fundamental problem, though, one common to all necessity claims in defense of politically motivated violations of the law.[220] Civil disobedience is just a tactic, and anyone can use it. The validity of a political necessity claim therefore depends on a judge or jury's sympathy to the cause invoked. Acquitting climate disobedients who block an oil pipeline may seem righteous. Acquitting a clerk who refuses to issue marriage licenses to gay couples may not.[221] The answer will change depending on whom is asked. Any systematic attempt to distinguish these cases, to find the "correct" uses of political necessity, will end up sensitive to the underlying political cause.[222] It risks too much lawlessness, with activists, courts, and juries deciding for themselves which laws to follow and enforce based on political preference.[223]

This is not to say that all politically motivated violations of the law are the same, but the opposite. Distinguishing these acts requires an assessment of the worth of the political cause invoked.[224] Asking judges and juries to fairly sort between political necessity claims therefore raises enormous challenges for the rule of law. Many ideals of the courtroom—impartiality, neutrality, the absence of politics and partisanship—make it ill-suited to the task. This is why some argue for excluding political necessity defenses from criminal trials altogether.[225]

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220. *Cf.* Steven M. Bauer & Peter J. Eckerstrom, *The State Made Me Do It: The Applicability of the Necessity Defense to Civil Disobedience*, 39 STAN. L. REV. 1173, 1189–98 (1987) (explaining why the necessity defense may be philosophically inappropriate and why the courtroom may be an inefficient forum for such matters).

221. *See, e.g.*, Billy Kobin, *Court Rejects Kentucky's Attempt to Shirk Legal Fees in Kim Davis Gay Marriage Case*, COURIER J. (Aug. 24, 2019), https://perma.cc/F7WG-9SU4.

222. *Cf.* Long & Hamilton, *supra* note 208, at 83 n.142 (inadvertently demonstrating this point in attempting to distinguish climate political necessity claims from anti-abortion political necessity claims).

223. Bauer & Eckerstrom, *supra* note 220, at 1189–98. Consider the first use of the political necessity defense in U.S. courts: in 1917, a posse illegally rounded up more than a thousand striking miners in Arizona and deported them by freight train to New Mexico. *See* Long & Hamilton, *supra* note 208, at 74; *see also* Arnolds & Garland, *supra* note 210, at 292–94. Charged with kidnapping, a member of the posse argued necessity, given the strikes threatened capitalism and the U.S. war effort. *See id.* at 293–94. The judge allowed the argument at trial and the jury voted to acquit. *See id.*

224. *See* AGAMBEN, *supra* note 209, at 30 ("The concept of necessity is an entirely subjective one, relative to the aim one wants to achieve . . . . A revolutionary uprising may proclaim [its] necessity . . . but there must be agreement in [that] belief.").

225. *See* Bauer & Eckerstrom, *supra* note 220, at 1189–98. Consideration of political motivations could perhaps be considered at sentencing, which allows for holistic assessment of culpability. Regardless, defendants may also try to raise these arguments in a bid for jury nullification, when juries vote to acquit despite the facts and law of the case. *See* Alan Scheflin & Jon Van Dyke, *Jury Nullification: The Right to Say No*, 45 S. CAL. L. REV. 168, 181–85 (1972). Indeed, the origins of the necessity defense and jury nullification overlap, reflecting an intuition that the rule of law must sometimes give way to what justice requires. *See* Arnolds & Garland, *supra* note 210, at 296–98.

A couple of lessons emerge from this doctrinal analysis for understanding climate emergencies writ large. The first is that claims of emergency and necessity are intertwined, and the values underlying those claims are sensitive to personal viewpoint and ideology. The bases for such claims are also indeterminate, offering few clear stopping points for analysis or sure ways to bound the context that creates the perceived necessity. As a result, they cannot be dispassionately assessed via traditional modes of legal analysis and are politically contestable. Second, declaring legal emergencies is first and foremost a prerogative of governments, not peoples. When private citizens declare emergency as a basis for justifying illegal action, they seem to invoke something more akin to a right of revolution. Exploring that concept is beyond the scope of this Article, which focuses on state-declared emergencies. But it is important here to keep in mind that emergencies in their fullest sense can give license to fundamentally rework the state and society.

4. Government Declarations of Climate Emergency

Public language can become public law,[226] and emergency rhetoric can give rise to legal states of emergency.[227] The initial stages of this process appear to be underway with "climate emergency." Nearly a dozen national and international legislative bodies have declared climate emergencies,[228] including the European Parliament,[229] Japan,[230] Spain,[231] Ireland,[232] Portugal,[233] and New Zealand.[234]

226. *Cf.* JEDEDIAH PURDY, AFTER NATURE: A POLITICS FOR THE ANTHROPOCENE 229 (2015) ("Law is the warp and weft that binds . . . [the imagination and the natural world,] shaping the material landscape, guiding human action on it, by translating ideal images of people and nature into concrete regimes of power.").

227. *See* Lindsay, *supra* note 21, at 262–63 ("Implicit in most of the scientific and academic opinion noted is the need for exceptional action on climate change, which is to say governmental and public action outside of prevailing norms, especially economic and socio-ecological norms . . . . The presumed facts and the language of 'emergency' implies the use of emergency government."). *But see* Hulme, *supra* note 172 (warning against this trend); Reynolds, *supra* note 122.

228. *Climate Emergency Declarations in 2,012 Jurisdictions and Local Governments Cover 1 Billion Citizens*, CLIMATE EMERGENCY DECLARATION (Aug. 20, 2021), https://perma.cc/G6J9-5H9J; *see also ICEF - Governments Emergency Declaration Spreadsheet*, INNOVATION FOR COOL EARTH F., https://perma.cc/CU87-JC3L.

229. Resolution of 28 November 2019 on the Climate and Environment Emergency (2019/2930(RSP)), EUR. PARL. DOC. (P9_TA(2019)0078) (Nov. 28, 2019).

230. Sieg & Sheldrick, *supra* note 8.

231. *Spain Declares Climate Emergency, Gets Climate Plan Ready*, ABC NEWS (Jan. 21, 2020), https://perma.cc/3WSY-PV64; GOBIERNO DE ESPAÑA, ACUERDO DE CONSEJO DE MINISTROS POR EL SE APRUEBA: LA DECLARACIÓN DEL GOBIERNO ANTE LA EMERGENCIA CLIMÁTICA Y AMBIENTAL (2020), https://perma.cc/649D-CDZX.

232. Cristina Abellan Matamoros, *Ireland Becomes Second Country to Declare 'Climate Emergency'*, EURONEWS (July 26, 2019), https://perma.cc/7UV9-49YU.

Emergency declarations have also passed in at least one chamber in the United Kingdom,[235] Canada,[236] and Argentina.[237] Meanwhile thousands of sub-national and local jurisdictions worldwide have enacted emergency declarations of their own.[238]

These emergency declarations, at least the ones directly cited above, are symbolic resolutions—manifestations of intent to act urgently on climate but without grants of emergency powers. Typical of the form is a resolution introduced in the U.S. Senate, in 2019, by now-Vice President Kamala Harris, Senator Bernie Sanders, Senator Elizabeth Warren, and other hopefuls for the 2020 Democratic presidential nomination.[239] The emergency resolution did not pass;[240] it was very unlikely to do so given Republican control of the chamber at the time.[241] The resolution was a messaging statement released to communicate the urgency of the climate crisis and the resolve of the Democratic Party to meet it—and serve as a talking point for its sponsors on the campaign trail.[242]

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233. *See* Victoria Waldersee, *Portugal's Students March for Climate as Greta Visit Delayed*, REUTERS (Nov. 29, 2019), https://perma.cc/MT4S-9RBH; *see also Projeto de Resolução 2155/XIII/4*, ASSEMBLEIA DA REPÚBLICA PORTUGAL, https://perma.cc/K3KB-RWNJ.

234. N.Z. House of Representatives, Final Order Paper for Wednesday, 2 December 2020 ("Government Notice of Motion No. 1"); *see also* Nick Perry, *New Zealand Symbolically Declares Climate Emergency*, ABC NEWS (Dec. 1, 2020), https://perma.cc/L6MR-FCPN.

235. UK House of Commons, Business for Wednesday, 1 May 2019, https://perma.cc/42B4-T996 ("Environment and climate change"); *see also UK Parliament Declares Climate Change Emergency*, *supra* note 8.

236. Can. House of Commons, Vote No. 1366, 42d Parliament, 1st Session, Sitting No. 435, Government Business No. 29 (National climate emergency), https://perma.cc/6NLX-32TJ (reporting declaration text and vote tally); *see also House of Commons Declares a Climate Emergency Ahead of Pipeline Decision*, CAN. BROAD. CO. (June 18, 2019), https://perma.cc/Y9A2-LDGZ.

237. *See* Evangelina Himitian, *La Argentina Declaró la Emergencia Climática y Ecológica*, NACION (July 18, 2019), https://perma.cc/X75Y-JZZG.

238. *See ICEF - Governments Emergency Declaration Spreadsheet*, *supra* note 228.

239. *See* S. Con. Res. 22, 116th Cong. (2019).

240. *S.Con.Res.22 Actions Overview*, CONGRESS.GOV, https://www.congress.gov/bill/116th-congress/senate-concurrent-resolution/22/actions (last visited Dec. 10, 2021) (reporting the 116th Congress took no action on the resolution).

241. Rebecca Beitsch, *Ocasio-Cortez, Sanders Lead Push to Declare Climate Emergency*, HILL (July 9, 2019), https://perma.cc/YE9C-YMQA.

242. *See* Jeremy Gelman, *Rewarding Dysfunction: Interest Groups and Intended Legislative Failure*, 42 LEGIS. STUD. Q. 661, 662 (2017). Progressive Democrats took inspiration for their climate emergency from then-President Donald Trump's use of emergency authority to appropriate funds for a border wall along the U.S.-Mexico Border. *See* Beitsch, *supra* note 241 (quoting Congressman Earl Blumenauer, who introduced a companion resolution in the House); *see also* Peter Baker, *Trump Declares a National Emergency, and Provokes a Constitutional Clash*, N.Y. TIMES (Feb. 15, 2019), https://perma.cc/PN8T-U6WK.

Much like the U.N. Secretary-General's speech in December 2020,[243] the Senate resolution begins by observing record temperatures, mounting CO_2 atmospheric concentrations, and looming temperature targets set by the Paris Agreement.[244] It notes the observed natural disasters associated with 1°C warming and warns of worsening impacts across every aspect of the economy and environment if warming continues.[245] After several pages establishing the factual basis for the climate emergency, it resolves:

> That it is the sense of Congress that—
>
> (1) the global warming caused by human activities, which increase emissions of greenhouse gas, has resulted in a climate emergency that—
>
> (A) severely and urgently impacts the economic and social well-being, health and safety, and national security of the United States; and
>
> (B) demands a national, social, industrial, and economic mobilization of the resources and labor of the United States at a massive-scale to halt, reverse, mitigate, and prepare for the consequences of the climate emergency and to restore the climate for future generations.[246]

The draft resolution ends, however, with language expressly stating it does not declare a national emergency for legal purposes:

> (2) [N]othing in this concurrent resolution constitutes a declaration of a national emergency for purposes of any Act of Congress authorizing the exercise, during the period of a national emergency or other type of declared emergency, of any special or extraordinary power.[247]

If it had passed, this legislative statement would not have legally established a state of emergency for climate change. But even as a symbolic, dead resolution, its factual account and prominence could support efforts by the President to declare a climate emergency—an act that, in contrast, would have real legal effect.[248]

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243. *See supra* Introduction.

244. *See* S. Con. Res. 22, 116th Cong. 1–2, 5–6 (2019).

245. *Id.* at 2–6.

246. *Id.* at 9.

247. *Id.*

248. *See* J. Benton Heath, *The New National Security Challenge to the Economic Order*, 129 YALE L.J. 1020, 1037 (2020).

Congress, as is commonly seen within other wealthy constitutional democracies,[249] has delegated standing emergency powers to the Executive through more than 100 statutes.[250] These laws grant a wide range of powers to the President in case of emergency, with the circumstances justifying their use largely left to the President's discretion.[251] Formally, Congress retains supervisory authority under the National Emergencies Act over presidential emergency declarations and use of emergency powers.[252] However, it exercises this supervisory power rarely.[253] Courts have also largely accommodated wide-ranging use of executive power in emergencies, especially with purported national security dimensions.[254] The deferential mood has allowed some emergency declarations to last decades, granting the executive branch far-reaching powers over matters it designates as security threats.[255]

The U.S. executive branch could use its emergency powers with great effect to reduce GHG emissions and support adaptation efforts.[256] For example, the President could suspend offshore oil and gas leases and thus fossil fuel extraction.[257] The President could also intervene in industrial manufacturing to ensure essential production activities—say for batteries, electric vehicles, or transmission lines—kept pace with growing renewable electricity and zero-carbon transit.[258] The President may also be able to apply sanctions to GHG-intensive imports, characterizing climate change as a national security threat and invoking exceptions to international trade rules.[259] The President further

249. *See* Kanwar, *supra* note 209, at 572–73; *see also* Ferejohn & Pasquino, *supra* note 50, at 215–17.

250. *See* BRENNAN CTR. FOR JUST., *supra* note 15, at *3–4 (describing emergency authorities); *see also id.* at 1–42 (surveying statutes).

251. *See id.* at *3–4.

252. *See* Nevitt, *On Environmental Law, Climate Change & National Security Law*, *supra* note 15, at 352–54 (citing Pub. L. No. 94-412, 90 Stat. 1255 (1976) (codified at 50 U.S.C. §§ 1601–1651)).

253. *See id.*

254. *See* Gross, *supra* note 60, at 1858 (claiming such deference is "primarily derived from the notion that when the security and safety of the state are at stake, special rules must apply"); Mark Tushnet, *Defending* Korematsu*?: Reflections on Civil Liberties in War Time*, 2003 WIS. L. REV. 273, 283 (2003); *see also* Gross, *supra* note 60, at 1857–58 (reviewing the history of U.S. Supreme Court deference to presidential emergency powers); Scheuerman, *supra* note 60, at 1881.

255. *See* BRENNAN CTR. FOR JUST, *supra* note 15, at *3–4; *cf.* Gross, *supra* note 60, at 1836, 1839.

256. *See* Nevitt, *On Environmental Law, Climate Change & National Security Law*, *supra* note 15, at 354–58; Farber, *supra* note 15, at 1169–72.

257. *See* Nevitt, *On Environmental Law, Climate Change & National Security Law*, *supra* note 15, at 356 (citing 43 U.S.C. § 1341).

258. *See* Farber, *supra* note 15, at 1171 (citing 50 U.S.C. § 4533).

259. *See id.* (discussing the President's authority under the International Emergency Economic Powers Act, 50 U.S.C. §§ 1701–1707); *see also* Heath, *supra* note 248, at 1037, 1062 (noting this move could be legally contested).

has Article II powers as Commander-in-Chief of the U.S. military, creating additional avenues for unilateral action on climate.[260] Finally, the administrative state has emergency powers of its own to tap into, as recently seen under the Trump Administration during COVID-19.[261] For example, the Secretary of Transportation, at her own discretion or under instruction by the President, could use emergency authorities to order stricter controls on vehicle emissions.[262]

Some urge the Biden Administration to use its emergency powers, especially if ambitious climate legislation cannot pass in the Senate.[263] Given prominent calls for other countries to declare climate emergencies,[264] and the existence of standing emergency executive powers in other constitutional democracies,[265] this is a pattern that could unfold worldwide. It would be in line with broader trends observed by public law scholars, where governments use formally short-term and formerly unusual emergency powers to manage open-ended, complex crises for their duration.[266] Governing climate change by climate emergency would just be a continuation of the way governments already normally operate.

The President, however, could not shoehorn solar geoengineering deployment into legitimacy and lawfulness via emergency declarations. That is not to say *no* activities could be pursued. Emergency justifications could be invoked to research solar geoengineering, and indeed Congress appropriated federal funding for such activities a few years ago.[267] There may also be possible scenarios of decision-makers invoking emergency authorization to deploy solar geoengineering technologies over the short term or in relatively small areas.[268] But large-scale deployment presents too many challenges to fit the "ordinary"

260. *See generally* Nevitt, *The Commander in Chief's Authority to Combat Climate Change*, *supra* note 15.

261. *See, e.g.*, Press Release, EPA, EPA Announces Enforcement Discretion Policy for COVID-19 Pandemic (Mar. 26, 2020), https://perma.cc/KKJ2-8AHR.

262. *See* Nevitt, *On Environmental Law, Climate Change & National Security Law*, *supra* note 15, at 356 (citing 49 U.S.C. § 114(g)(1)(A)–(D)).

263. *See, e.g.*, Merkley, *supra* note 11; Lydia Millet, *Why Biden Should Declare a Climate Emergency*, New Republic (Dec. 7, 2020), https://perma.cc/ZY5E-ZEM4; Ctr. for Biological Diversity, The Last Decade to Save the Planet: Fifty Critical Environmental Reforms to Transform the Executive Branch 13–14 (2020).

264. *Secretary-General, Remarks at the Climate Ambition Summit*, *supra* note 3.

265. *See* Scheuerman, *supra* note 60, at 1869–70.

266. *See id.* at 1870–79.

267. Charles R. Corbett, *"Extraordinary" and "Highly Controversial": Federal Research of Solar Geoengineering Under NEPA*, 115 Nw. U. L. Rev. Online 240, 243–44 (2021) (describing the relationship between climate science, modeling, and solar geoengineering research). *See generally, e.g.*, Antara Banerjee et al., *Robust Winter Warming over Eurasia Under Stratospheric Sulfate Geoengineering—the Role of Stratospheric Dynamics*, 21 Atmospheric Chemistry & Physics 6985 (2021).

268. *See infra* Part III.A.

mode of emergency governance.[269] Even if a country invoked climate emergency to unilaterally launch a long-term, planetary program, it seems likely that international dynamics would result in normalized, multilateral governance.[270]

II. Solar Geoengineering as Climate Emergency Response

Part II introduces solar geoengineering and the current state of knowledge and scientific research activities, contextualizing it alongside emissions reduction, adaptation, and carbon removal. It then analyzes solar geoengineering's features to explain why it is most accurate to think of it as a proposed climate emergency measure.

A. Overview of Solar Geoengineering

Solar geoengineering describes proposals to counteract climate change by increasing Earth's reflectivity, thereby directly and rapidly influencing planetary flows of incoming and outgoing energy at a very large scale.[271] It is different from emissions reduction, which influences climate by avoiding anthropogenic GHG emissions in the first place,[272] and from carbon removal, which draws CO_2 from the air via reforestation or more artificial means.[273] It also differs from climate adaptation, which includes the projects that make humans and ecosystems more resilient to local climate impacts like flooding, drought, and heatwaves.[274]

Solar geoengineering can be thought of as a search for leverage.[275] What are the ways that humans could dexterously and adroitly counteract the greenhouse effect? Earth's climate is largely driven by radiative balance, the net flow of incoming solar energy and outgoing energy radiated from the surface as in-

269. *See infra* Part III.A.

270. Edward A. Parson & Jesse L. Reynolds, *Solar Geoengineering Governance: Insights from a Scenario Exercise*, 132 Futures 1, 9–10 (2021).

271. The Royal Soc'y, Geoengineering the Climate: Science, Governance, and Uncertainty, at ix, 3 (2009).

272. Nat'l Acads. of Scis., Eng'g, & Med., Negative Emissions Technologies and Reliable Sequestration: A Research Agenda 3 fig.S.1 (2019) (depicting avoided emissions in green).

273. *See* James Mulligan et al., *Carbonshot: Federal Policy Options for Carbon Removal in the United States* 1–2 (World Res. Inst., Working Paper, 2020), https://perma.cc/AE8C-Z2R6 (summarizing methods).

274. *See* IPCC, Global Warming of 1.5°C, *supra* note 23, at 542.

275. Morton, *supra* note 118, at 81 ("Archimedes is said to have said that, given a lever long enough and a place to stand, he could move the Earth . . . . Geoengineering is about finding levers with which to move the earthsystem. It is also about finding worldly fulcrums that can take the pressure of those levers, and guide their force with precision—that stop the lever from slipping and doing damage.").

frared light.[276] One way to help more energy *leave* the climate system could be to thin or dissipate cirrus clouds, the wispy, high-altitude clouds that absorb infrared and therefore prevent some energy from escaping back into space.[277] Other methods would reduce the amount of energy *entering* the climate system, such as marine cloud brightening, which would seed bright, shiny cloud cover over large areas of ocean to reflect sunlight away.[278] This and other albedo-enhancing measures could cool Earth much like the polar regions do, reflecting away large amounts of energy via their snow and ice.[279]

SAI, another method for making Earth more reflective, is the most researched, best understood, and most feasible-seeming method of solar geoengineering.[280] It takes inspiration from planetary cooling periods observed after some large volcanic eruptions, especially Mount Pinatubo in the Philippines in the 1990s.[281] Volcanic activity can send large amounts of sulfates and other fine materials high above into the stratosphere.[282] Because these aerosols are very light and the stratosphere relatively calm, they can linger there for years, reflecting away a small amount of sunlight in the meantime.[283] This process can result in substantial cooling at a planetary scale for a year or more.[284]

SAI would be an intentional and far more precise analog of this natural phenomenon, with aircraft introducing reflective aerosols directly into the stratosphere.[285] A summary of six high-level findings of SAI research follows below, with a few caveats. What scientists know about solar geoengineering mostly comes from about fifteen years of laboratory investigation, with researchers running SAI deployment scenarios in climate models.[286] While all climate science heavily relies on modeling, funding levels for SAI research are small com-

276. *See* THE ROYAL SOC'Y, *supra* note 271, at 3.

277. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 348 tbl.4.7.

278. *See* Eli Kintisch, *Technologies*, *in* CLIMATE ENGINEERING AND THE LAW: REGULATION AND LIABILITY FOR SOLAR RADIATION MANAGEMENT AND CARBON DIOXIDE REMOVAL 28, 34–37 (Michael B. Gerrard & Tracy Hester eds., 2018).

279. *See* IPCC, SPECIAL REPORT ON THE OCEAN AND CRYOSPHERE IN A CHANGING CLIMATE 78–79 (2019).

280. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 347–51.

281. *See* Kevin E. Trenberth & Aiguo Dai, *Effects of Mount Pinatubo Volcanic Eruption on the Hydrological Cycle as an Analog of Geoengineering*, 34 GEOPHYSICAL RSCH. LETTERS L15702, at 1 (2007); *see also* Reynolds, *supra* note 38, at 17–19 (providing an intellectual history of solar geoengineering).

282. *See* IPCC, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, *supra* note 90, at 691–93.

283. *See id.*

284. *See id.*; *see also, e.g.*, Katherine Kornei, *Ancient Rome Was Teetering. Then a Volcano Erupted 6,000 Miles Away*, N.Y. TIMES (June 22, 2020), https://perma.cc/B9Y9-ZTGM.

285. *See* IPCC, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, *supra* note 90, at 693 box 8.3.

286. *See* Reynolds, *supra* note 38, at 17–19. Additional research activities include observation of naturally occurring volcanism and two small-scale outdoor experiments. *See id.* at 18–20.

pared to other areas of climate research,[287] and research activities have been carried out by a small, decentralized network mostly based in the United Kingdom, the United States, and a few other countries.[288] The findings below therefore are not definitive. Scientific understanding of solar geoengineering will almost certainly change as investigation continues and grows.

(1) SAI could "work." A global SAI intervention would likely produce a substantial, rapid cooling effect worldwide.[289] It seems it could also reduce the rate of sea-level rise, sea-ice loss, heatwaves, extreme weather, and climate change–associated anomalies in the water cycle.[290] It thus is a potential tool for avoiding a very large amount of human suffering, ecosystem damage, and biodiversity loss.

(2) SAI would be imperfect. SAI would not clean the air of GHG pollutants nor decarbonize the human systems that emit them.[291] It would do very little to combat ocean acidification, another consequence of runaway CO_2 pollution.[292] It is therefore studied as a potential supplement to emissions reduction, adaptation, and carbon removal efforts.[293] SAI is no rational alternative to these pillars of climate policy and could not restore a pre-industrial climate system.

(3) The cooling effect would be temporary. SAI's cooling effect results from aerosols lingering in the stratosphere, so additional aerosols would need to be introduced as older injections cycle out.[294] If atmospheric concentrations of GHGs mount in the meantime, more SAI material would be required to produce the same cooling effect.[295] By

287. *Compare* Ella Necheles et al., *Funding for Solar Geoengineering from 2008 to 2018*, HARV. SOLAR GEOENG'G RSCH. PROGRAM (Nov. 13, 2018), https://perma.cc/PBA9-FP4C (reporting worldwide cumulative totals in the tens of millions), *with, e.g.*, U.S. GOV'T ACCOUNTABILITY OFF., GAO-18-223 (HIGHLIGHTS), CLIMATE CHANGE: ANALYSIS OF REPORTED FEDERAL FUNDING 1 (Apr. 2018), https://perma.cc/9AHF-QGQM (reporting billions of dollars in annual federal funding for climate research initiatives).

288. *See* Necheles et al., *supra* note 287 (listing institutions).

289. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 350 (reporting "*high agreement* that [SAI] could limit warming below 1.5°C").

290. *See id.* at 347; *see also* Peter Irvine et al., *Halving Warming with Idealized Solar Geoengineering Moderates Key Climate Hazards*, 9 NATURE CLIMATE CHANGE 295, 296 (2019).

291. *See* REYNOLDS, *supra* note 38, at 24 (describing the asymmetry between CO_2-driven warming and SAI-triggered cooling); *see also id.* at 28 (noting the risk that SAI regimes could undercut political will to reduce emissions).

292. *See id.* at 27.

293. *See* J. G. Shepherd, *The "Napkin Diagram" of Multiple Responses to Climate Change* (Jan. 28, 2016), https://perma.cc/9RPU-HWKR (as presented at the Asilomar Conference in 2010) (visualizing this policy integration).

294. *See* REYNOLDS, *supra* note 38, at 20–21.

295. *See* Daniele Visioni et al., *Seasonally Modulated Stratospheric Aerosols Geoengineering Alters the Climate Outcomes*, 47 GEOPHYSICAL RSCH. LETTERS e2020GL088337, at 4 fig.1(a) (2020) (illustrating this increase over time).

the same token, suddenly stopping SAI deployment could cause a rapid rise in temperature, proportionate to the level of cooling induced.[296]

(4) SAI could be "cheap." The estimated direct costs of deployment—collecting the precursor materials for aerosols, putting them into the sky, monitoring, and so on—would be small compared to the magnitude of the cooling effect, as low as several billion dollars a year.[297] The direct costs of injection therefore seem small compared to the potential benefits it could achieve.[298] That estimate, however, does not include the cost of potential negative impacts, nor the cost of a liability regime implemented in anticipation of those risks.[299]

(5) Global deployment patterns of SAI seem optimal. Earth's climate is an interconnected whole, and solar geoengineering could not target one region without influencing others. Scenario modeling indicates an intervention seeking to produce a global distribution of aerosols would therefore result in greater benefits and less severe side effects.[300] Yet a spatially uniform deposition would not cause a globally uniform change in climate. SAI cools by reflecting sunlight, so cooling would be stronger when and where there is more sunlight, such as at the tropics, during the day, and during the summer.[301] Conversely, cooling would be weaker at night, at higher latitudes, and during winter.[302] Aerosols distribution amounts could vary to account for these differences, but the effects would not be distributed perfectly evenly.

(6) Deployment would entail other physical risks. Certain aerosols, such as sulfates, could harm the ozone layer or cause health impacts as they make their way down to the surface.[303] Deployment could slightly change the sky's appearance and the quality of the light plants use for

296. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 351.

297. *See id.* at 348–49.

298. *Cf.* Andrew Parker et al., *Stopping Solar Geoengineering Through Technical Means: A Preliminary Assessment of Counter-Geoengineering*, 6 EARTH'S FUTURE 1058, 1059 (2018).

299. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 348–49.

300. *See* David Keith, *FAQ on Idealized Solar Geoengineering Moderates Key Climate Hazards*, HARV. UNIV., DAVID KEITH'S RSCH. GRP. (Mar. 11, 2019), https://perma.cc/XKW3-YGC2 (describing an ideal solar geoengineering deployment as imparting "reasonably uniform global [aerosol] coverage . . . in combination with strong emissions cuts"); *see also* Irvine et al., *supra* note 290, at 295 (explaining why uniform coverage is optimal but stressing possible side effects of stratospheric heating, ozone layer perturbation, and changes in light quality).

301. Reynolds, *supra* note 38, at 24.

302. *Id.*

303. *See id.* at 27; *see also* Peter J. Irvine et al., *Towards a Comprehensive Climate Impacts Assessment of Solar Geoengineering*, 5 EARTH'S FUTURE 93, 97 (2017) (noting the contribution to surface-level air pollution would be small).

> photosynthesis.[304] Its impacts may further be experienced non-linearly as a whole. For example, changes in rain, light, temperature, and stratospheric ozone could work together to impact agricultural activities in ways that are difficult to predict. Characterizing and assessing these physical and social risks and their interactions is a major topic of research in solar geoengineering.[305]

As is true in other areas of environmental policy, making sense of SAI's benefits and risks requires comparison to alternatives.[306] For example, SAI would likely have a more significant influence on the water cycle than on temperature, drying faster than it cools.[307] This means substantial SAI-driven cooling, say to restore pre-industrial temperatures, could increase risk of drought relative to a global-warming-without-SAI baseline.[308] Water-cycle impacts in moderate SAI-cooling scenarios, however, could be less severe than a global-warming-without-SAI baseline.[309] This is why researcher-advocates usually propose SAI as a method for "peak-shaving"—preventing temperatures from exceeding a certain target, like 2°C—or for slowing the rate of heating.[310]

Scientific uncertainty further complicates matters.[311] This uncertainty partly derives from how climate science produces new knowledge.[312] Climate scientists use models—computer simulations of potential climate states—to understand what drives climate change and how climate influences the world in return.[313] Models are imperfect tools. Their depictions rely on scientific understanding of the natural world and are vulnerable where knowledge is incorrect or incomplete. Approximations are necessary where a natural process is not well understood or where its complexity exceeds available computing power, such as with cloud formation and aerosol interactions. Climate models further do not simulate climate over a smooth and continuous timeline, leapfrogging instead

304. Kintisch, *supra* note 278, at 31–32; *see* L. Xia et al., *Stratospheric Sulfate Geoengineering Could Enhance the Terrestrial Photosynthesis Rate*, 16 Atmospheric Chemistry & Physics 1479, 1479–80 (2016).

305. *See* NAS Report 2021, *supra* note 33, at 15.

306. *See* Douglas G. MacMartin & Ben Kravitz, *Mission-Driven Research for Stratospheric Aerosol Geoengineering*, 116 Proc. Nat'l Acad. Scis. 1089, 1090–91 (2019) (surveying "risk-risk trade-offs").

307. *See* Reynolds, *supra* note 38, at 24.

308. *Id.*

309. *Id.*

310. *Id.* at 24–25.

311. MacMartin & Kravitz, *supra* note 306, at 1090–91. This is usually the case with environmental problems. *See* Richard J. Lazarus, The Making of Environmental Law 16–28 (2006).

312. *See* Corbett, *supra* note 267, at 247–50 (describing the relationship between climate science, modeling, and solar geoengineering research).

313. *See* Robert McSweeney & Zeke Hausfather, *Q&A: How Do Climate Models Work?*, CarbonBrief (Jan. 15, 2018), https://perma.cc/V4DV-7JBN.

from one static interval to the next, say by a few days or weeks, again to save computing power.[314] Finally, the inputs for their calculations require assumptions about human behavior, like the rate of future economic growth or emission reductions.

That said, scientific knowledge about climate and climate change, produced largely through climate modeling, is extremely robust. By the same token, climate modeling techniques can provide valuable knowledge about the potentials, limitations, and drawbacks of SAI.[315] Additional scientific research could further reduce many uncertainties within solar geoengineering modeling, though not all.[316] For example, current modeling uses rough approximations of aerosol deposition patterns to calculate cooling and regional impacts.[317] Small-scale field research could improve scientific understanding of how aerosols dissipate in the stratosphere and interact with their surroundings, which could lead to more skillful modeling.[318] On a different track, more computing power could allow for smoother and finer-grain modeling (in terms of the size of time and space intervals used) and fewer approximations for very complex natural processes, such as cloud formation.

But some uncertainties about solar geoengineering are unresolvable in advance for the simple reason that a model is not the real world, but a representation of it.[319] Were SAI deployment to proceed, it would be stepping into the unknown, albeit, hopefully, one informed by vigorous scientific and policy investigation in advance.[320]

B. Solar Geoengineering as Emergency Measure

This section argues solar geoengineering should be understood as a climate emergency measure and governed accordingly. Two points are worth emphasizing now. First, this section primarily considers governance of SAI activities risking significant impact on the environment across a large area, including planetary-scale deployment. Admittedly, what qualifies as *significant* is an open-ended judgment.[321] Wherever the line is drawn, though, it excludes research activities having no or low physical impacts on the environment. Those

314. *See* Corbett, *supra* note 267, at 248; *see also* IPCC, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, *supra* note 90, at 749–50.

315. *See* NAS REPORT 2021, *supra* note 33, at 9, 14, 24, 40–42.

316. *See* MacMartin & Kravitz, *supra* note 306, at 1089; *see also* NAS REPORT 2021, *supra* note 33, at 47 (listing limitations in climate modeling for solar geoengineering scenarios).

317. *See* Corbett, *supra* note 267, at 247–50.

318. *See id.* at 250–51.

319. *See id.*

320. *See* MacMartin & Kravitz, *supra* note 306, at 1090–91.

321. *Cf. id.* at 1092 (proposing a "detectable surface climate response" as a scientific threshold for significance). *But see* Daniele Visioni et al., *What Goes up Must Come down: Impacts of Deposition in a Sulfate Geoengineering Scenario*, 15 ENV'T RSCH. LETTERS 094063, at 4 fig.3(a)

activities can be governed by the ordinary tools of private, state, and intergovernmental actors.[322]

Second, detailed consideration of technology development and deployment governance is largely premature. Current understanding of solar geoengineering is limited, and research that does not pose significant physical risks to the environment may yet uncover drawbacks fatal to the idea.[323] Furthermore, governance flows in part from the politically possible, and we do not know what international relations will look like in ten, twenty, or thirty years. Yet research on solar geoengineering is not driven solely by curiosity; it seeks to investigate and potentially realize deployment systems.[324] So it is worth asking what fairly governing that system would require, even if the answers for now are guesses, or may be made irrelevant by later scientific investigation. The claim here is that emergency frameworks provide a useful way for doing that guesswork.

1. Solar Geoengineering Conflicts with Normalcy

Solar geoengineering proposes a regime of intentional, planetary climate modification, an idea at odds with familiar forms of government and common notions of human agency and ethics. These problems are developed below, making explicit the incongruity between deployment and normalcy, i.e., government as usual.

First, a system of planetary climate modification requires a planetary governance apparatus responsible for it. There is no "world government" that can will such an institution into existence.[325] Instead, international law is decentralized, relying on state cooperation to create new rules[326] and on state obedience and internalization of those rules for their enforcement.[327] To quickly summarize, states are formally recognized as equal sovereigns over their territories, largely free to do within their borders as they see fit, so long as they do not wrongfully interfere with the rights of other states or violate other obligations

(2020) (reporting background sulfates in the atmosphere could make subtle detection difficult).

322. *See infra* Part III.C. It is worth saying, however, that an international system of research governance does not yet exist. Establishing one should be a central priority of research and research governance efforts. *See* NAS REPORT 2021, *supra* note 33, at 7–12.

323. *See* Douglas G. MacMartin et al., *Geoengineering with Stratospheric Aerosols: What Do We Not Know After a Decade of Research?*, 4 EARTH'S FUTURE 543, 544–45 (2016).

324. *See* MacMartin & Kravitz, *supra* note 306, at 1090.

325. *See* MANN & WAINWRIGHT, *supra* note 10, at 127, 132–34.

326. RESTATEMENT (THIRD) OF FOREIGN RELATIONS LAW, ch. 1, intro. note (AM. L. INST. 1987) [hereinafter RESTATEMENT].

327. *See* Harold H. Koh, *Why Do Nations Obey International Law?*, 106 YALE L.J. 2599, 2601–03 (1997).

arising out of international law.[328] Where international law imposes obligation, a state typically must consent first, such as by ratifying a treaty.[329] Other sources of international law include customary international law, emerging from traditional practice between states,[330] and peremptory norms, prohibiting states from committing certain gross violations of human rights, without exception.[331] Over time, and especially after World War II, these systems have built a vast web of obligation and interdependence between states.[332] Still, creating new intergovernmental institutions for solar geoengineering would require a high degree of cooperation and consent.

This is not to say there are no available tools for governing solar geoengineering. Several treaty systems and international bodies have regulatory authority over some aspect of solar geoengineering research or deployment.[333] National authorities can also regulate geoengineering activities within their territories or otherwise under their jurisdiction.[334] But these systems were not designed with solar geoengineering, or anything like it, in mind.[335] Their oversight would be partial and scattershot, failing to amount to a cohesive whole.[336] For example, there is no agreed-upon body to determine what "significant" risks from research would look like, nor is there an international forum to establish research agendas, let alone handle disputes and injuries arising from uneven distribution of negative impacts.[337] Certainly, there is no high council prepared to set the temperature or the desired pattern of aerosol distribution in

328. *See* RESTATEMENT, *supra* note 326, ch. 1, intro. note; *see also* PHILIPPE SANDS & JACQUELINE PEEL, PRINCIPLES OF INTERNATIONAL ENVIRONMENTAL LAW 11–13 (3d ed., Cambridge Univ. Press 2012) (emphasizing the increasing salience of non-national actors within international law).

329. RESTATEMENT, *supra* note 326, § 102 cmt. f–h.

330. *Id.* § 102 cmt. b.

331. *Id.* § 102 cmt. k.

332. *See* Koh, *supra* note 327, at 2604–22; *see also* SANDS & PEEL, *supra* note 328, at 21–22 (summarizing this growth in the environmental context).

333. *See, e.g.*, Reynolds, *supra* note 38, at 92–100. For a survey of how existing international institutions and treaty-based authorities may regulate solar geoengineering research and deployment, see generally *id.*; CLIMATE ENGINEERING AND THE LAW, *supra* note 278 (focusing on U.S legal regimes).

334. *See, e.g.*, Albert Lin, *U.S. Law*, *in* CLIMATE ENGINEERING AND THE LAW, *supra* note 278, at 155–58.

335. *See* NAS REPORT 2021, *supra* note 33 at 96–105.

336. *See* Flegal et al., *supra* note 27, at 409–10, 412.

337. *See* Joshua B. Horton et al., *Liability for Solar Geoengineering: Historical Precedents, Contemporary Innovations, and Governance Possibilities*, 22 N.Y.U. ENV'T L. J. 225, 265–72 (2015); *see also* NAS REPORT 2021, *supra* note 33, at 182–90 (elaborating on the need for international research governance mechanisms, outlining their requirements, and proposing strategies for their development).

a deployment scenario.[338] New institutions would need to be created that lack clear precedent.

Second, a deployment program's design—including the amount of cooling desired—would be politically contested. Even in idealized scenarios, physical impacts of solar geoengineering would not be evenly distributed worldwide. Some countries could receive more benefits from a given design, while others could receive less.[339] The prospect of deployment may therefore spur formation of competing regional state coalitions to enact program preferences.[340] It is unclear how or where sufficiently powerful political factions could emerge peacefully, though one can imagine an international forum where states could begin to hash out these disagreements.[341]

It is even more daunting to imagine obtaining the consent necessary to make deployment lawful and legitimate. After all, states are obliged to refrain from substantial harmful interference with the environment within the territory of others.[342] Intentionally altering the climate at a planetary scale via solar geoengineering would cause impacts in every country on Earth: some beneficial, some harmful, and many of them significant. Some manner of assent would be required to make this interference lawful.[343]

Again, this is not to say widespread consent is impossible. For example, virtually all states have assented to the U.N. Charter and its obligations, with the handful of outliers recognizing its requirements.[344] Crisis, emergency, and

338. *See* Janos Pasztor, *The Need for Governance of Climate Geoengineering*, 31 ETHICS & INT'L AFFS. 419, 425 (2017).

339. *See* Horton et al., *supra* note 29, at 11.

340. *See, e.g.*, Katherine L. Ricke et al., *Strategic Incentives for Climate Geoengineering Coalitions to Exclude Broad Participation*, 8 ENV'T RSCH. LETTERS 014021, at 5–7 (2013) (arguing, however, that the differences in deployment preferences between sufficiently powerful coalitions may be relatively slight, making it difficult to justify the political and economic costs of exclusive control).

341. *See* Buck et al., *supra* note 28, at 502; *see also* Horton et al., *supra* note 29, at 10–13.

342. U.N. Conference on the Human Environment, *Declaration on the Human Environment*, U.N. Doc. A/CONF.48/14/Rev. 1, 5 princ. 21 (June 16, 1972) ("States have, in accordance with the Charter of the United Nations and the principles of international law . . . the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."); *see* Flegal et al., *supra* note 27, at 409–10; *see also* RESTATEMENT, *supra* note 326, § 601(1).

343. Convention on Long-Range Transboundary Air Pollution art. 2, Nov. 13, 1979, 1302 U.N.T.S. 219 ("[Parties] endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution."); *see* RESTATEMENT, *supra* note 326, § 601 cmt. b; *see also id.* § 602(1) (allowing an injured state to seek termination of the offensive activity); SANDS & PEEL, *supra* note 328, at 259–75 (discussing state obligations regarding transboundary pollution, including specific requirements to reduce sulfate emissions). Excuse or justification doctrines would be insufficient to legitimize unilateral deployment, especially over the long term. *See infra* Part III.A.

344. *See* RESTATEMENT, *supra* note 326, § 102 cmt. h.

necessity have a way of aiding the creation of new forms of government.[345] The proliferation of international institutions in the mid-twentieth century was partly a reaction to World War II and the Cold War, seeking to avoid repeating the atrocities of the former and to stave off nuclear destruction from the latter.[346] Worsening climate impacts may bring opposing factions to the table to negotiate new climate governance systems, even for as farfetched an idea as solar geoengineering.[347] The 2010s may prove to be only a low point in international cooperation, not destiny for the rest of the century.[348]

Third, solar geoengineering deployment would be accompanied by deep uncertainty, even assuming well-resourced research programs beforehand.[349] Due to natural variability and delayed response in climate systems, there would also be a significant lag between deployment and verifiable climate effect.[350] Local changes would be even more uncertain, with attribution of specific weather events to solar geoengineering very difficult or impossible.[351] That means that assessing the physical impacts political communities care most about, like rainfall in an agricultural basin, could be clouded by a high degree of uncertainty.[352] This in turn would inform the potential for geopolitical conflict already discussed. Of course, uncertainty is not unique to solar geoengineering. State economic policy, for example, can be highly centralized and ripple through the global economy in vast, profound, and sometimes unpredictable ways.[353] But economic management has been normalized within governments

345. *See* AGAMBEN, *supra* note 209, at 27 (describing necessity as "the first and originary source of law," with constitutional orders traceable to revolution and lawlessness amid crisis).

346. *See* Koh, *supra* note 327, at 2614–15.

347. Something similar may be underway regarding pandemics, with calls for stronger frameworks for international coordination in light of COVID-19. *See Committee to Review Global Treaty on Response to Health Emergencies*, U.N. NEWS (Aug. 27, 2020), https://perma.cc/74LM-9F4P; *see also* Eur. Council, Press Release, Press Release by President Charles Michel on an International Treaty on Pandemics (Dec. 3, 2020), https://perma.cc/8LDJ-BPN4.

348. *See* Jake Sullivan, *The World After Trump: How the System Can Endure*, 97 FOREIGN AFFS. 10, 10 (2018), https://perma.cc/L87C-R74J.

349. *See* Flegal & Gupta, *supra* note 34, at 53; *see also* MacMartin & Kravitz, *supra* note 306, at 1091 fig.2.

350. BLACKSTOCK ET AL., *supra* note 42, at 38, 42; Douglas G. MacMartin et al., *Technical Characteristics of Solar Geoengineering Deployment and Implications for Governance*, 19 CLIMATE POL'Y 1325, 1332–34 (2019).

351. *See* BLACKSTOCK ET AL., *supra* note 42, at 45; *see also* MacMartin et al., *supra* note 350, at 1332–34.

352. *See* Flegal & Gupta, *supra* note 34, at 56–57; *see also* Daniele Visioni et al., *Is Turning Down the Sun a Good Proxy for Stratospheric Sulfate Geoengineering?*, 126 J. GEOPHYSICAL RSCH. e2020JD03395, at 17 fig.11 (2021) (illustrating interactions between solar geoengineering and aspects of the climate system); MacMartin et al., *supra* note 350, at 1332–34.

353. *See* Alan Greenspan, *Risk and Uncertainty in Monetary Policy*, 94 AM. ECON. REV. 33, 36–39 (2004).

over many decades, and, even then, it is often initiated, deployed, and developed via emergency rhetoric.[354] Solar geoengineering, by contrast, would move from physical intervention to desired social and environmental impacts along more attenuated causal chains, and from within an entirely new, unfamiliar policy domain. This "uncertainty squared"—uncertain impacts within an unfamiliar area— would seem to require special justification, one that emergencies can provide.

Fourth, and related to these physical risks and uncertainties, there is a widespread sense that solar geoengineering violates basic principles of ethical conduct and reason.[355] Much skepticism within governance discourse seems to flow from this conviction:

> Listening [to geoengineering proposals], a grim picture emerges. Nothing on Earth would be outside the reach of humanity's fallible machines, or even fully outside at all. We would have a roof, not a sky—a milky, geoengineered ceiling gazing down on a dying, acidified sea.[356]

> These are the answers of, in a sense, junkies. I used to run a homeless shelter. And I knew about junkies. And their logic was universally the same. If some *deus ex machina* will come along to solve this problem before I have to deal with myself, before I have to make the changes, before I have to admit that things need to shift, and we're at that position now, we're at that moment of great promise when we could make that change, and I think probably geoengineering gets in the way of that change. It's an enabler for us to continue to stagger along a little while longer in the condition that we're in.[357]

There is a lot to unpack here. Industrialization and technological advancement have given a small number of humans an influence over the planet that is

354. *See* Scheuerman, *supra* note 60, at 1878–81.

355. *See* Stephen Gardiner & Catriona McKinnon, *The Justice and Legitimacy of Geoengineering*, 23 Critical Rev. Int'l Soc. & Pol. Phil. 557, 558–61 (2020); *see also, e.g.*, Jeff Goodell, *Can Geoengineering Save the World?*, Rolling Stone (Oct. 4, 2011) ("Think of climate as a small boat on a rather choppy ocean . . . . But now one of the passengers has decided to stand up and is deliberately rocking the boat ever more violently. Another passenger then proposes that with his knowledge of chaotic dynamics he can counterbalance the first passenger . . . . [I]s the answer to a known and increasing human influence on climate an ever more elaborate system to control the climate? Or should the person rocking the boat just sit down?" (quoting Gavin Schmidt, Climate Modeler, NASA Goddard Inst. for Space Stud.)).

356. Naomi Klein, This Changes Everything: Capitalism vs. the Climate 260 (2014); *see also* Purdy, *supra* note 5, at 1202.

357. Bill McKibben, Co-Founder, 350.Org, Remarks on Geoengineering at the Forum for Climate Engineering Assessment (Dec. 19, 2013), https://perma.cc/258K-5TZ3.

vast, clumsy, poorly understood, and often difficult to predict.[358] Some call this period the Anthropocene, an epoch marked by the intermingling of planetary-scale systems and human agency—but again, the agency of only some humans.[359] Climate change is just one problem to emerge from this new relationship.[360] Solar geoengineering would bring a level of intentionality to this influence, attempting to guide the Anthropocene rather than leave it, a situation which can be fairly described so far as exceedingly dangerous and unjust.[361] Hence intent distinguishes solar geoengineering from other human activities with planetary-scale impacts, such as use of nitrogen-based fertilizers or even fossil fuel energy systems.[362] There is thus a perversity to the proposal, answering the problem of inadvertent climate destabilization with ever-more deliberate interference.[363] That intent—arguably Promethean, hubristic, and colonial—seems to be what morally offends.[364]

In summary, a regime of active planetary climate modification would strain existing systems of international law and demand new institutions without clear precedent. It would be marked by high levels of scientific uncertainty, before, during, and after interventions. Its physical risks would be substantial and non-uniform. It also seems fundamentally wrong, at least to some. It is still possible, though, to imagine solar geoengineering as part of an adequately just system of climate management. Aggressive efforts to cut emissions and ramp up CDR infrastructure would work to zero-out emissions over the century. Adaptation investments would help make ecosystems, communities, and governments more resilient to climate impacts.[365] SAI programs, meanwhile, under

358. *See* ERLE C. ELLIS, ANTHROPOCENE: A VERY SHORT INTRODUCTION 12 (2018).

359. *See* PURDY, *supra* note 226, at 49 (calling for a "democratic Anthropocene"); Andrew M. Bauer et al., *Anthropocene: Event or Epoch?*, 597 NATURE 332, 332 (2021) (arguing the Anthropocene would be better categorized as a geologic event, like the Great Oxidation Event, than a geologic epoch, like the Holocene); *cf.* Donna Haraway, *Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin*, 6 ENV'T HUMANS. 159, 160 (2015) (proposing different names for the Anthropocene's dangers and inequalities).

360. ELLIS, *supra* note 358, at 18–20, 130–31.

361. *See id.* at 137; *cf.* Dipesh Chakrabarty, *The Climate of History: Four Theses*, 35 CRITICAL INQUIRY 197, 211–12, 221–22 (2009) (analyzing climate change's dangers and the need for greater political coordination).

362. *See* MORTON, *supra* note 118, at 177–83, 215–18, 220–22.

363. *Cf.* David Wallace-Wells, *After Alarmism*, N.Y. MAG. (Jan. 19, 2021), https://perma.cc/Q7UF-7UTT ("If there is to be an answer to the problem of control, it's going to be more control." (quoting Elizabeth Kolbert, Author)).

364. *See, e.g.*, Kevin Surprise, *Stratospheric Imperialism: Liberalism, (Eco)modernization, and Ideologies of Solar Geoengineering Research*, 3 ENV'T & PLAN. E 141, 142 (2019); MANN & WAINWRIGHT, *supra* note 10, at 139–42; Kyle Powys Whyte, *Indigeneity in Geoengineering Discourses: Some Considerations*, 21 ETHICS POL'Y & ENV'T 289, 297–98 (2018); Marion Hourdequin, *Geoengineering Justice: The Role of Recognition*, 44 SCI. TECH. & HUM. VALUES 448, 449–50 (2019).

365. *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 10.

the oversight of a yet-to-be governance apparatus, would slow or even halt warming above a temperature target, as visualized below. These policy systems could be orchestrated together to reduce climate harms as one.[366] But today's modes for doing government are not up to the task. How could the world get to that point?

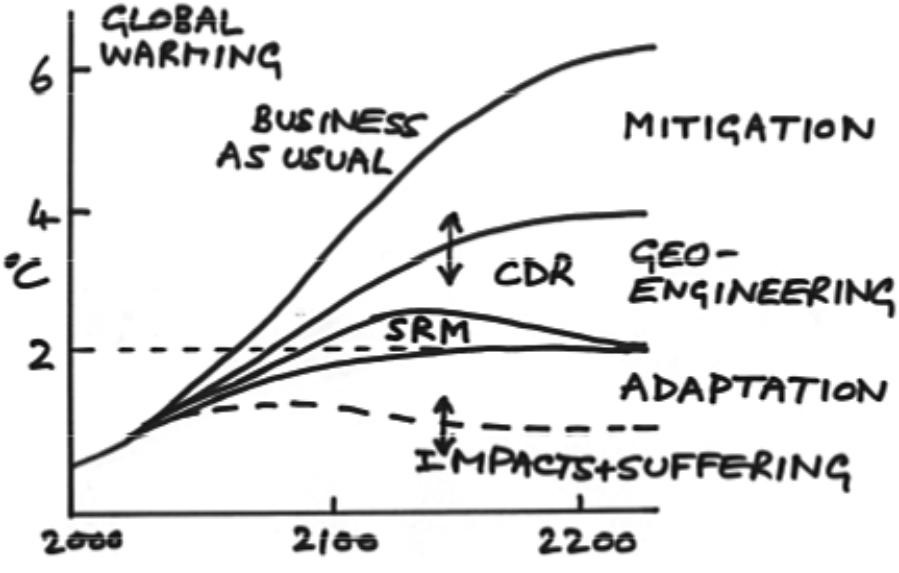

FIG. 1. "NAPKIN DIAGRAM" VISUALIZING SOLAR GEOENGINEERING (SOLAR RADIATION MODIFICATION, OR "SRM") IN HARMONY WITH THE REST OF CLIMATE POLICY.[367] THIS 2010 DIAGRAM PRECEDES THE MAINSTREAMING OF CDR AND THUS GROUPS THEM TOGETHER UNDER THE NAME "GEOENGINEERING."

The answer may come from emergency itself. A declaration of emergency is a method of persuasion, an attempt to justify departure from the norm by appealing to obvious necessity. By now many of us have firsthand experience with the phenomenon, having complied with extraordinary social distancing measures for more than a year to slow the spread of COVID-19. Likewise, the climate emergency contains the potential to justify policies currently considered out-of-bounds, or hardly considered at all. Central to this evolution of governance is the move from crisis to "necessity," and from "emergency" to policies

366. *See generally, e.g.*, Mariia Belaia, *Optimal Climate Strategy with Mitigation, Carbon Removal, Solar Geoengineering* (Working Paper, arXiv No. 1903.02043, Mar. 5, 2019), https://perma.cc/6N4L-B5YH (integrated modeling of interactions between emissions reduction, solar geoengineering, and CDR).

367. Shepherd, *supra* note 293.

once unthinkable. That appeal to necessity can override even well-founded legal, ethical, or policy concerns, much as a civil disobedient can invoke necessity to justify breaking the law.[368] The remainder of this Article charts how this legitimizing process might materialize for climate change and solar geoengineering. It is worth remembering throughout that emergencies are not given or obvious, but assembled, and that a similar method of justification could be applied to other types of climate response now seen as too extreme.

2. Approaching Emergency Governance

Solar geoengineering makes sense as an emergency response measure because it could rapidly and imperfectly reduce harm amid worsening climate change. Emergency-governance thinking also suggests ways to approach its many conflicts with legal and social norms. Indeed, it is difficult to imagine a system for solar geoengineering realized, at least initially, as anything other than an emergency measure. Conversely, a preemptive ban on the technology would seem to assert that there is no form the climate crisis could take that could justify deployment.

The case is clearest when considering solar geoengineering's technical features. Unique among the tools of climate policy, solar geoengineering could directly and rapidly slow global warming.[369] If widespread consensus emerged that the current or near-term climate impacts were "too" severe—again, a political judgment—solar geoengineering could act something like an emergency drag on runaway warming.[370] It could therefore be thought of as a preemptive tool, a way to prevent a bad situation from worsening too quickly.

It is important, though, not to make the geoengineer's dilemma too concrete. Even when considering as short a time span as a decade,[371] climate change's future dangers will likely be vague, incremental, probabilistic, and uncertain.[372] This is why climate tipping points cannot alone provide a sufficient

368. *See* discussion *supra* Part I.B.3.

369. *See* NRC REPORT 2015, *supra* note 142, at 7 (discussing Mount Pinatubo's climate impact). Emissions reductions, on the other hand, would take at least a decade to stop global warming, *see* Kirsten Zickfeld & Tyler Herrington, *The Time Lag Between a Carbon Dioxide Emission and Maximum Warming Increases with the Size of the Emission*, 10 ENV'T RSCH. LETTERS 031001, at 1–2 (2015) (modeling a large pulse of CO_2 emissions to find that "93% of the peak warming is realized [within] 10 years"), and only once emissions were near zero, H. Damon Matthews & Ken Caldeira, *Stabilizing Climate Requires Near-Zero Emissions*, 35 GEOPHYSICAL RSCH. LETTERS L040705, at 1 (2008).

370. *See* NRC REPORT 2015, *supra* note 142, at 6–7.

371. *Cf.* Zickfeld & Herrington, *supra* note 369 (describing a roughly ten-year lag between CO_2 emissions and realizing nearly all of the warming effect).

372. *Cf., e.g.*, IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 5, 7–11 (characterizing climate impacts in terms of risk).

basis for declaring climate emergency.[373] Tipping points describe possible rapid and catastrophic disruptions in planetary-scale natural systems due to climate change.[374] The sudden collapse of the West Antarctic Ice Sheet is one example, which could trigger abrupt sea-level rise and flooding worldwide.[375] Other examples include rapid changes in Atlantic Ocean circulation or sudden, widespread death of tropical forests.[376] Scientific uncertainties on the timing, triggers, and extent of climate tipping points prevent their confident prediction.[377] It is also unknown whether rapid cooling via solar geoengineering could stop or reverse a climate tipping point once it had begun.[378]

The climate emergency thus would not have an objective, concrete beginning. It would be a political determination made by states about their capacity to withstand the impacts of expected future warming.[379] That is another advantage of bringing emergency thinking to solar geoengineering: it centers the political nature of the triggers for deployment. Emergencies are politically determined categories, contestable and controversial in ways that scientific and expert technical recommendations sometimes avoid.[380] Characterizing solar geoengineering as an emergency measure places it into a suspect category, a thing to be locked away unless "necessary."[381] It positions solar geoengineering as a method of last resort, a far-from-perfect proposal done only if other efforts fail to prevent a greater evil. This recalls the "risk/risk" framework somewhat dryly used in much solar geoengineering governance scholarship: world leaders would be deciding, amid great uncertainty, between a geoengineered world and one with still-worsening climate impacts.[382] Emergency makes the geoengineer's dilemma explicitly political.

An emergency framework for solar geoengineering could also guard against the dangers posed by climate emergency declarations in general. The

373. *See* Jana Sillman et al., *Climate Emergencies Do Not Justify Engineering the Climate*, 5 NATURE CLIMATE CHANGE 290, 290–91 (2015).

374. *See id.* at 290.

375. *See* Horton, *supra* note 41, at 150.

376. *Id.*

377. *See* FOURTH NATIONAL CLIMATE ASSESSMENT, *supra* note 66, at 120; *see also* Horton, *supra* note 41, at 147–48.

378. Sillman et al., *supra* note 373, at 291.

379. *See* Jesse L. Reynolds & Gernot Wagner, *Highly Decentralized Solar Geoengineering*, 29 ENV'T POL. 917, 920–21, 928–29 (2020) (discussing centrality of states in solar geoengineering decision-making); *cf.* Horton, *supra* note 41, at 148 (concluding emergencies are "socially constructed"). Of course, declaring climate emergency could consider growing risk of tipping points. *See* Lenton et al., *supra* note 51, at 294.

380. *See* Flegal et al., *supra* note 27, at 401–06.

381. *See* Gabriel L. Negretto & José Antonio Aguilar Rivera, *Liberalism and Emergency Powers in Latin America: Reflections on Carl Schmitt and the Theory of Constitutional Dictatorship*, 21 CARDOZO L. REV. 1797, 1797–99 (2000).

382. *See, e.g.*, MacMartin & Kravitz, *supra* note 306, at 1090–91.

dangers of climate emergency governance—rash decision-making, concentrated power, unjust and cruel acts done with impunity—could arise whether or not governments reach for SAI.[383] The risks of solar geoengineering are readily apparent, but the dangers of other climate emergency measures may be more submerged. Characterizing solar geoengineering as an emergency measure would tightly link it to the climate emergency overall, placing solar geoengineering and climate emergency under the same seal and prompting wariness towards both.

Furthermore, doing so would merely recognize and make explicit today's dominant way of thinking about solar geoengineering. In fact, explicitly framing solar geoengineering as a climate emergency measure was somewhat common last decade.[384] The framing, however, was roundly critiqued for overreliance on tipping point risks, negative implications for democratic values, and perceived incoherence of the idea of "climate emergency."[385] It has since become more common to reject the emergency framing of solar geoengineering and characterize it as a supplementary measure for climate risk management instead.[386]

This rhetorical move seems to react to the problems that emergencies present for democratic principles of governance, or out of fear of rash decision-making amid crisis[387]—as if changing the problem's name would also change its nature. But scholarly papers and governance reports still almost always introduce solar geoengineering as a troubling idea made worth exploring by the accelerating climate crisis.[388] National governments that have launched solar

383. *See* Hine & McLaren, *supra* note 6.

384. *See* NRC REPORT 2015, *supra* note 142, at 9–10. *See generally, e.g.*, BLACKSTOCK ET AL., *supra* note 42. Oddly enough, these are among the earliest and most prominent calls for "climate emergency" in general that research for this Article was able to uncover. *See also, e.g.*, E. Teller et al., *Global Warming and Ice Ages: I. Prospects for Physics-Based Modulation of Global Change* 1–2 (22d Int'l Seminar on Planetary Emergencies, Preprint Paper, Aug. 15, 1996), https://perma.cc/G9B3-Y4LC (an early contribution to solar geoengineering, discussed in the context of climate change as a "planetary emergency").

385. Jonas Anshelm & Anders Hansson, *Has the Grand Idea of Geoengineering as Plan B Run Out of Steam?*, 3 ANTHROPOCENE REV. 64, 65 (2016) (summarizing criticisms).

386. *See* Flegal & Gupta, *supra* note 34, at 52; *see also* Anshelm & Hansson, *supra* note 385, at 68–70 (demonstrating this trend).

387. *See, e.g.*, NAS REPORT 2021, *supra* note 33, at 114–15 (distinguishing a destructive "emergency" deployment scenario for solar geoengineering from a safer "peak shaving" scenario). In reality, the emergency use of solar geoengineering could be done rashly and poorly, or it could be done measuredly to effect "peak shaving." This is because *emergency measure* describes the basis for justifying a policy and its relationship with ordinary legal and social structures, rather than the content of the policy or the way that policy is carried out. *See* discussion *supra* Part I.A, III.B.

388. *See, e.g.*, NAS REPORT 2021, *supra* note 33, at 5; Sourgens, *supra* note 22, at 114 ("[T]he moment of last resort is close at hand."); Hine & McLaren, *supra* note 6; MANN & WAINWRIGHT, *supra* note 10, at 139–42; PURDY, *supra* note 226, at 3 (connecting geoengineer-

geoengineering research programs invoke the same sense of crisis as justification.[389] Others still imagine a world *after* the need for geoengineering passes, revealing a desire to ensure a regime of intentional climate modification does not last forever.[390] This is an emergency measure in all but name. And as this Article has already shown, it is possible to declare an emergency encompassing climate change as a whole, so long as one remembers it is a political determination and not strictly a scientific question.[391]

There are problems, of course. Emergencies are supposed to be temporary, but a solar geoengineering deployment program would occur at least over several decades.[392] Emergencies further are not self-realizing; using "climate emergency" does not explain who will decide on these matters or how. *Who* and *how* are the nub of the geoengineering governance problem, less so the formal categories through which these questions might play out. The answers to these questions can be met now only with speculation, and there is more of that in Part III. To respond briefly here, though, states of emergency can provide paths toward establishing novel forms of government.[393] A genuine and pervasive sense of necessity, moreover, can legitimize policies and norms once thought impossible—for good or for bad.[394] These extraordinary measures can then be incorporated into ordinary governance-as-usual by democratic ratification or other means.[395] So even if an emergency framework cannot name actors, it provides a method of justification and a plausible mechanism for working toward governance.

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ing's salience to a sense of "near-perpetual crisis"); Kurzgesagt – In a Nutshell, *supra* note 23; Buck et al., *supra* note 28, at 499–500, 502–03 (analyzing solar geoengineering as a stopgap, i.e., "emergency repair" or "emergency intervention"); *cf.* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 23, at 349–52 (reporting researcher interest in SAI's deployment in temperature overshoot scenarios with insufficient mitigation).

389. *See, e.g.*, PAUL HARDISTY ET AL., REEF RESTORATION AND ADAPTATION PROGRAM, INVESTMENT CASE 12–13, 65–66 (2019); Kerryn Brent et al., *Putting the Greater Barrier Reef Marine Cloud Brightening Experiment into Context*, CARNEGIE CLIMATE GOVERNANCE INITIATIVE (2020), https://perma.cc/Z7Y6-DRKG (explaining the relationship between Australian government and scientists researching marine cloud brightening); *see also* Corbett, *supra* note 267, at 243–44 (describing the U.S. government's geoengineering research); Press Release, U.S. Congressman Jerry McNerney, Rep. McNerney Introduces Legislation to Authorize Atmospheric Climate Intervention Research (Dec. 19, 2019), https://perma.cc/RE7L-V8K5 (describing climate change as an "imminent threat" with potentially "catastrophic consequences").

390. *See* HOLLY J. BUCK, AFTER GEOENGINEERING: CLIMATE TRAGEDY, REPAIR, AND RESTORATION 206–12 (2019); *see also* Sourgens, *supra* note 22, at 118.

391. *See* discussion *supra* Part I.A.

392. *See* BUCK, *supra* note 390.

393. *See* AGAMBEN, *supra* note 209, at 26.

394. *See* Scheppele, *supra* note 60, at 837, 839.

395. *See* Ferejohn & Pasquino, *supra* note 50, at 223 n.33 ("Indeed, it is a common observation that serious constitutional reforms can only occur in circumstances of emergency.").

This criticism could also be turned on its head. If not an emergency measure, what else could solar geoengineering be? What climate emergency response could be more literal than SAI?[396]

III. Muddling Through Climate Emergency

This Part reviews legal scholarship and political theory on emergency governance in international and domestic contexts. It then uses lessons from that review to sketch out governance structures for solar geoengineering research, development, and deployment.

A. The Inadequacy of International Law's Exceptions

International law, as it exists today, offers little readily available basis for structuring emergency governance of solar geoengineering. The doctrine of necessity can legally justify some internationally wrongful acts by states, but unilateral deployment of SAI would be a poor fit for the defense. Other methods of seeking national security exceptions under international law would also be dead ends. This is because the technology is too disruptive to fit into the category of excuse, even if a state were facing devastating climate impacts.

National interests of the highest order, like winning a civil war, may require states to act in ways that conflict with international law.[397] The necessity defense emerged in recognition of this reality, allowing states to justify wrongful conduct where a choice-of-evils required it.[398] It is therefore a somewhat literal analog to necessity doctrines developed within national criminal law.[399] To raise the defense, a state must assert a significant national interest and show that interest was at grave, imminent risk.[400] It then must show the wrongful

396. *Cf.* Elizabeth Kolbert, Under a White Sky 200 (2021) (noting that solar geoengineering supposes "a world where deliberately dimming the fucking sun might be less risky than not doing it" (quoting Andy Parker, Director, Solar Radiation Management Governance Initiative)).

397. *See, e.g.*, Quincy Wright, *International Law and the American Civil War*, 61 Proc. Am. Soc'y Int'l L. 50, 53–54 (1967).

398. *See* Int'l L. Comm'n, *Draft Articles on Responsibility of States for Internationally Wrongful Acts, with Commentaries*, Rep. on the Work of Its Fifty-Third Session, U.N. Doc. A/56/10 (2001), *reprinted in* [2001] 2 Y.B. Int'l L. Comm'n 31 U.N. Doc. A/CN.4/SER.A/2001/Add.1 (Part 2) [hereinafter ILC Draft Articles].

399. *See* Roman Boed, *State of Necessity as a Justification for Internationally Wrongful Conduct*, 3 Yale Hum. Rts. & Dev. L.J. 1, 4–5 (2000) (tracing its origins to analogies to Roman and Jewish law recognizing a threat to self-preservation could legally "justif[y] . . . any steps necessary to preserve one's existence even if . . . unlawful"); Robert D. Sloan, *On the Use of Necessity in the Law of State Responsibility*, 106 Am. J. Int'l L. 448, 458, 472–74 (2012) (criticizing this development); *cf. supra* Part I.B.3.

400. *See* ILC Draft Articles, *supra* note 398, at art. 25(1)(a) cmt. 15 (elaborating on the interests and dangers that may justify necessity).

conduct was proportionate and appropriate for that danger, among other things.[401] Prevailing on necessity can excuse a state from a legal obligation or even justify harm done to another state, though it may still be required to compensate others for injury.[402] Though the doctrine originated in consideration of situations where a state's existence was purportedly at risk, it has since been used for economic crises, environmental threats, and other smaller emergencies.[403]

The necessity doctrine is a poor fit for unilateral deployment of solar geoengineering. Climate change certainly presents a grave threat to "essential" national interests.[404] But the future hazards are uncertain, making it hard to show imminent harm and therefore justify preemptive deployment of SAI.[405] It is also unclear whether deployment could stop certain climate harms as they unfolded, for instance catastrophic destabilization of an ice sheet, making it difficult to justify reactive use in an emergency.[406] Difficult does not mean impossible, however.[407] Climate change increases the risk of severe heatwaves,[408] and heatwaves are especially deadly in areas with little cooling infrastructure.[409] Local deployment of atmospheric aerosol injection, meanwhile, say over an area the size of Los Angeles, could provide rapid reduction in local temperature.[410] Thus the threat of a severe, imminent heatwave in a vulnerable area could potentially justify local emergency deployment of some solar geoengineering techniques.[411]

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401. *See id.* at art. 25(1)(b).

402. *See id.* at art. 27(a) (instructing states to resume compliance with obligations if the exigent circumstances pass); *id.* at art. 27(b) (allowing injured states to seek compensation); *id.* at art. 27 cmt. 2–4.

403. *See* Sloan, *supra* note 399, at 454–58; ILC Draft Articles, *supra* note 398, at 80–83 (reviewing cases); Scheuerman, *supra* note 60, at 1869–70 (describing the tendency of national governments to use emergency powers to manage problems).

404. *See* ILC Draft Articles, *supra* note 398, at art. 25 cmt. 15 (defining "essential"); *supra* Part I.A (characterizing climate risk).

405. *See, e.g.*, Nils Markusson et al., *'In Case of Emergency Press Here': Framing Geoengineering as a Response to Dangerous Climate Change*, 5 WIREs Climate Change 281, 281–84 (2014); *see also* Sillman et al., *supra* note 373, at 292; Horton, *supra* note 41, at 147–50.

406. Sillman et al., *supra* note 373, at 291.

407. *See* Sourgens, *supra* note 22, at 120–23.

408. IPCC, Global Warming of 1.5°C, *supra* note 23, at 11.

409. *Id.* at 9; *see also, e.g.*, Eric Klinenberg, *Denaturalizing Disaster: A Social Autopsy of the 1995 Chicago Heat Wave*, 28 Theory & Soc'y 239, 239–42 (1999).

410. *See* D.N. Bernstein et al., *Could Aerosol Emissions Be Used for Regional Heat Wave Mitigation?*, 13 Atmospheric Chemistry & Physics 6373, 6388–89 (2013); *see also* Andrew Lockley, *Geoengineering: A War on Climate Change?*, 26 J. Evolution & Tech. 26, 37 (2016).

411. *See* Stephan Wittich, *The International Law Commission's Articles on the Responsibility of Internationally Wrongful Acts Adopted on Second Reading*, 15 Leiden J. Int'l L. 891, 897 (2002) ("Article 25 allows a state to invoke necessity . . . also in cases of grave danger to the

The bigger problem is categorical, even for this hypothetical, recalling flaws with the political necessity defense in U.S. criminal law discussed earlier.[412] Necessity under international law developed in consideration of relatively self-contained disputes between a small number of states: One state destroying another's ship to avoid a military strike or an oil spill.[413] A state failing to make a debt payment because of a beleaguered national treasury.[414] A state backing out of an infrastructure project claiming potential harm to ecosystems.[415] These cases are nothing like a state unilaterally deploying SAI, which would implicate the entire planet indefinitely and entail far more substantial risk.[416] It therefore would be naïve to propose that third-party states would respect even the most ironclad necessity claim of a unilateral deploying state on its own merits, especially on a planetary scale.[417] Even in a local cooling emergency scenario, an attempt to temporarily alter the climate of one nation's territory could risk altering the climate of many others.[418] The problems for this approach would only multiply when considering that many states might try pursuing emergency regional cooling programs at once. Because planetary climate is an interconnected whole, these interventions would very likely interfere with one another and with the territories of non-geoengineering states. The incoherence of the whole would undermine the asserted "need" for the constituent parts.

Climate emergency frameworks could filter through international law in other ways, but these would also be poor channels for governing and legitimizing solar geoengineering. Some of climate change's impacts can be characterized as national or international security risks.[419] "Securitizing" climate change opens up new opportunities for legal maneuvers given the deference to national

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interest of another state or event of the international community as a whole."). *But see* Bernstein et al., *supra* note 410 (noting trade-offs).

412. *See supra* Part I.B.3.

413. *See* ILC Draft Articles, *supra* note 398, at art. 25 cmt. 5, 9 (discussing the *"Caroline"* incident of 1837 and the *Torrey Canyon* incident of 1967).

414. *See* ILC Draft Articles, *supra* note 398, at art. 25 cmt. 7, 8 (discussing the *Russian Indemnity* case (Russ. v. Turk.), 11 R.I.A.A. 421 (1912), and *Société Commerciale de Belgique*, Judgment, 1939 P.C.I.J. (ser. A/B) No. 78, at 160).

415. *See id.* at art. 25 cmt. 11 (discussing *Gabčíkovo-Nagymaros Project* (Hung. v. Slovk.), Judgment, 1997 I.C.J. 7, 40–41 (Sept. 25)).

416. *See supra* Part II.A.

417. *Cf.* Bernstein et al., *supra* note 410, at 6388–89. As an aside, the likelihood of unilateral planetary deployment seems small, especially long term. *See* Edward A. Parson & Lia N. Ernst, *International Governance of Climate Engineering*, 14 THEORETICAL INQUIRIES L. 307, 332–34 (2013). Deployment activities are too vulnerable to countermeasures by other states for a rogue cooling regime to last long.

418. *See* Toby Svoboda et al., *The Potential for Climate Engineering with Stratospheric Sulfate Aerosols Injections to Reduce Climate Injustice*, 12 J. GLOB. ETHICS 353, 358 (2018).

419. *See* Brian La Shier & James Stanish, *The National Security Implications of Climate Change*, 10 J. NAT'L SEC. L. & POL'Y 27, 28, 32–34 (2019); *see also* Gross, *supra* note 60, at 1858 (describing national security as "a geometric point of convergence of emergency and nor-

security interests within international law.[420] It is possible, for example, that a state might assert climate emergency to excuse itself from trade obligations and impose tariffs on carbon-intensive imports.[421] It seems unlikely, though, that one could find a mousehole in any treaty system big enough for solar geoengineering deployment.[422]

A more extreme possibility would be the U.N. Security Council characterizing climate change as a threat to international peace.[423] The Security Council is the permanent organ of the United Nations tasked with identifying and managing security threats.[424] It can authorize military strikes, peacekeeping operations, and other coercive means of threat management.[425] Given climate change's physical risks and the deference afforded to the Security Council in defining security threats, characterizing climate change as such seems legally plausible.[426] Doing so could allow the Security Council to promulgate binding climate rules on U.N. member states; similar rulemakings have happened before to advance antiterrorism initiatives following 9/11.[427] It could also use its security authority to create new courts to enforce climate obligations,[428] authorize force against noncompliant states,[429] or convene meetings between states to coordinate climate response.[430]

The same reasoning could extend to solar geoengineering as a climate emergency measure, allowing the Security Council to create forums, rules, and courts for its governance. Again, this would be an unlikely and ungraceful way to govern geoengineering proactively. The Security Council is an anti-democratic body dominated by its permanent member states, each holding veto power over its actions.[431] Due to geopolitical rivalries between permanent mem-

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malcy"); MANN & WAINWRIGHT, *supra* note 10, at 14 (arguing climate may be particularly suited to security thinking).

420. *See* Heath, *supra* note 248, at 1021, 1037, 1069.

421. *See id.* at 1037, 1091.

422. *See, e.g.*, Reynolds, *supra* note 38, at 92–99 (examining provisions of multilateral agreements on atmospheric pollution for applicability to solar geoengineering); *cf.* Whitman v. Am. Trucking Ass'ns, Inc., 531 U.S. 457, 468 (2001). "Climate emergency" claims may anyway ultimately invite more stringent judicial and arbitral examination of state use of security exceptions. *See* Heath, *supra* note 248, at 1071–72.

423. *See* Scott & Ku, *supra* note 18, at 2, 3–4.

424. *See id.* at 3–9.

425. *See id.*

426. CHRISTOPHER K. PENNY, *Climate Change as a 'Threat to International Peace and Security', in* CLIMATE CHANGE AND THE UN SECURITY COUNCIL, *supra* note 16, at 25, 25–26, 34–36; *see also* Martin, *supra* note 17, at 335.

427. *See* Scott & Ku, *supra* note 18, at 7–8.

428. Scott et al., *supra* note 16, at 66–68.

429. Martin, *supra* note 17, at 335, 374–76.

430. *See, e.g.*, Francesco Sindico, *Climate Change: A Security (Council) Issue?*, 1 CARBON & CLIMATE L. REV. 29, 30–34 (2007) (in-depth analysis of one such meeting).

431. *See* Scott & Ku, *supra* note 18, at 3 (describing voting requirements).

bers, sustained and meaningful leadership by the Security Council on climate seems unlikely.[432] Even if it were politically feasible, the narrow focus on security would risk collapsing climate change into a zero-sum threat analysis, its policies backed by the too-ready threat of violence.[433] This may be why securitizing complex international problems has a poor track record: it may make cooperation and long-term thinking harder.[434] It would be especially unwise with solar geoengineering, which brings with it additional fears of militarized or coercive use.[435]

B. Lessons from Constitutional Theory on Emergencies

This section reviews legal and philosophical literature analyzing emergency powers within constitutional democracies, revealing a few principles helpful for governing solar geoengineering and the climate emergency as a whole.

1. Need

States use emergency powers because exigency is inevitable.[436] Sooner or later, governments encounter situations of grave peril like war, acts of terrorism, economic depressions, and natural disasters.[437] Some problems will be so exceptional that adequate response is somehow beyond or at odds with the current legal system.[438] This conflict can derive from a limitation of ex ante law making: legislative rulemaking and planning cannot anticipate all future situations a society will encounter.[439] Other times the legislature may simply have failed to legislate adequately in anticipation of a foreseeable problem, or a measure may be seen as so extreme that only the direst set of circumstances could justify its

432. *See* Betz, *supra* note 17, at 235 (arguing veto power held by the United States and other high-emitting states makes action unlikely); *see also* Stephen M. Walt, *Who Will Save the Amazon (and How)?*, Foreign Pol'y (Aug. 5, 2019), https://perma.cc/2CTZ-88QX (arguing Brazil, a state without veto power in the U.N. Security Council, is more vulnerable to coercion on climate).

433. *See, e.g.*, Gilley & Kinsella, *supra* note 16, at 9.

434. *See, e.g.*, Frédéric Mégret & Benoît Mayer, *Climate Migration and the Security Council*, *in* Climate Change and the UN Security Council, *supra* note 16, at 85, 85–86, 93–95.

435. *See* Craig Martin, *Geoengineering and the Use of Force*, OpinioJuris (Jan. 20, 2021), https://perma.cc/2HA8-6K7C.

436. Venice Commission, *supra* note 48, at 4; *see also* The Federalist No. 23 (Alexander Hamilton); Pasquino, *supra* note 209, at 201–02.

437. *See* Gross, *supra* note 56, at 1025 n.44.

438. *See* Gross, *supra* note 60, at 1831–32; *see also* Vermeule, *supra* note 57, at 172 ("Whether an emergency exists is shorthand for a longer question: whether there is a temporary dislocation between the legal rules and the wishes or desires of the dominant forces of the community.").

439. Gross, *supra* note 60, at 1828.

use. As a consequence, problems will necessarily arise that the normal legal order does not adequately account for, requiring emergency governance.

The emergency mode of government is sometimes enacted through a formal state of emergency.[440] These drastic procedures can suspend normal legislative activities, and indeed normalcy itself, concentrating power in a few hands for the duration of the crisis. More common today, though, are issue-specific emergency statutes.[441] With these, the legislature delegates authority to an executive body to act on an emergency, subject to legislative oversight and judicial review.[442] However they are enacted, emergency powers are justified by the need to preserve some higher value or interest, with a severe threat to that value or interest legitimizing whatever is needed to stop it.[443] Accordingly, they resemble necessity doctrines under national and international law.[444] Emergencies hence are also conservative in a literal sense: they do the extraordinary to preserve or restore something of higher value.[445]

2. Dangers

Emergency powers are vulnerable to abuse.[446] Their watchwords are vague—"the necessary," "essential interest"—as indeed they must be to encompass the uncertainty and variety that emergencies present.[447] Vagueness grants declarers of emergencies a wide degree of discretion, even though those political determinations are factual and informed by expertise.[448] Use of emergency power is therefore a trust-bound exercise, relying on public officials to use their discretion in good faith.[449] Sometimes that power is misused. The Obama and

440. AGAMBEN, *supra* note 209, at 4–5. They are also sometimes called martial law or states of exception. *Id.*

441. Ferejohn & Pasquino, *supra* note 50, at 216–17; *see also* Scheppele, *supra* note 60, at 861 (arguing this is the traditional scheme for emergency powers in the U.S. legal system and arguing against a President's inherent Article II emergency powers).

442. Ferejohn & Pasquino, *supra* note 50 at 217, 229.

443. *Id.* at 231; Scheppele, *supra* note 60, at 837.

444. *See supra* Part I.B.3, III.A. "Emergency powers" does not describe all major government enactments justified by appeal to necessity. Major legislative changes almost always respond to perceived crises of some kind. *See* Scheuerman, *supra* note 60, at 1871.

445. Ferejohn & Pasquino, *supra* note 50, at 223; *see also* THOMAS HOBBES, LEVIATHAN 169 (Richard E. Flathman & David Johnston eds., Norton Critical ed. 1997) (1651) ("The office of the sovereign . . . consisteth in the end, for which he was trusted with the sovereign power, namely the procuration of the safety of the people."); JOHN LOCKE, THE SECOND TREATISE OF GOVERNMENT 74 (Dover Publ'ns 2002) (1690).

446. David Cole, *The Priority of Morality: The Emergency Constitution's Blindspot*, 113 YALE L.J. 1753, 1755 (2004).

447. VENICE COMMISSION, *supra* note 48, at 7–8 ("[I]t is hard to predict and describe an emergency situation exactly; a degree of vagueness in definition would thus appear unavoidable.").

448. Farber, *supra* note 15, at 1143.

449. Gross, *supra* note 56, at 1134; *see* Negretto & Aguilar Rivera, *supra* note 381, at 1822–23.

Trump Administrations arguably abused their emergency authorities to pursue policy objectives stymied by ordinary politics.[450] The opposite can also be true. Discretion risks public officials failing to act on an emergency when there genuinely is one.[451]

Emergencies can also foster mindsets harmful to efforts to solve complex problems or manage nebulous threats.[452] They can lead to antagonistic thinking, privileging the security and comfort of a privileged class while cruelly mistreating marginalized groups.[453] By the same token, emergency governance can re-entrench unjust power structures or wrongfully justify their expansion. They can shut down legislative deliberation and expert assessment, and they can squash critique and opposition within civil society.[454] On a more meta level, they also invite theoretical and semantic debate over the use of emergencies when attention would be better spent on the policies themselves.[455]

Then there is the problem of the ever-growing emergency. Many security threats to the modern state arise unexpectedly, lack a defined end date, and do not invite obvious solutions.[456] Today, "[m]ost emergencies . . . last not months, but years and even decades; they poison constitutional systems by normalizing practices that were unthinkable before the dark days of terror."[457] These circumstances demand an approach to emergency governance beyond the traditional mindset of switching back and forth between normalcy and emergency.[458] Needed instead are institutions for the oversight of extraordinary power and the development of relevant expertise, subject to clearly defined requirements under law.[459]

The potential scope of emergency powers is also expanding, with new types of problems classified and governed as emergencies. Economic management is one example.[460] What began as tools for crisis response became methods to preempt future crises and, eventually, permanent fixtures of economic management.[461] National security issues are another, where complex problems

450. *See* BRENNAN CTR. FOR JUST., *supra* note 15, at *4.

451. Farber, *supra* note 15, at 1147; Adrian Vermeule, *Self-Defeating Proposals: Ackerman on Emergency Powers*, 75 FORDHAM L. REV. 631, 635 (2006).

452. *See* Cole, *supra* note 446, at 1753–55.

453. *See* Cole, *supra* note 58, at 291–92.

454. Farber, *supra* note 15, at 1146; *see also* Scheuerman, *supra* note 60, at 1880–81.

455. *Cf.* Eric A. Posner & Adrian Vermeule, *Accommodating Emergencies*, 56 STAN. L. REV. 605, 626 (2003) (pushing back on abstract analysis of emergency powers and arguing for a return to policy analysis).

456. *See* Scheuerman, *supra* note 60, at 1879.

457. Kim Lane Scheppele, *We Are All Post-9/11 Now*, 75 FORDHAM L. REV. 607, 628 (2006).

458. *See id.*

459. *See id.*

460. *See* Scheuerman, *supra* note 60, at 1873.

461. *Id.* at 1875.

are "securitized" and subjected to militarized response.[462] The judiciary in turn tends to defer to executive action on national security matters, accommodating more expansive use of power.[463] Both examples are directly relevant to climate change, which can fit smoothly, if disconcertingly, into national security frameworks and which also has vast implications for economic planning.[464] The result is a general trend within liberal democracies toward governing via emergency-enabled executive power, with those maneuvers in turn permanently altering the normal order.[465] Constitutional norms are fragile, and they can give way suddenly under stress or from erosion over time.[466] The liberal constitutional tradition is therefore skeptical of emergency powers, and examples of their abuse are well known.[467]

3. Design

If emergencies are not accounted for in advance, necessity amid crisis can threaten the legal order itself.[468] An idealized design for emergency powers has emerged in response, seeking to subject their use to the rule of law to the greatest extent possible. These design features guide the initiation, use, expiration, and long-term management of emergency power, dividing authority between formally separate institutions.[469]

The first design element locates the power to recognize emergencies.[470] This *epistemic* function involves factfinding on the severity of the risk and a political determination regarding the capacity of government-as-usual to meet it.[471] Ideally, the epistemic function rests with the legislature, claiming legitimacy from being a democratically elected and deliberative body. If a legislature concludes there is an emergency, it may be a good indication of widespread consensus on that point.[472] The legislature is also usually entrusted with the *authorizing* function, determining the scope of emergency powers and delegating those powers by statute.[473] The third function is *executive*: a person or group

462. Gross, *supra* note 60, at 1858, 1860–61.
463. Tushnet, *supra* note 254, at 283; LOCKE, *supra* note 445, at 74 (justifying the practice).
464. *See* Martin, *supra* note 17, at 333.
465. Gross, *supra* note 60, at 1857; Scheppele, *supra* note 60, at 836; *see* Ferejohn & Pasquino, *supra* note 50, at 223 n.33.
466. Gross, *supra* note 56, at 1019–20.
467. Scheuerman, *supra* note 60, at 1878. *But see* Negretto & Aguilar Rivera, *supra* note 381, at 1799 (arguing this skepticism began with Montesquieu's rejection of Locke's theory on the king's prerogative).
468. *Id.* at 1804.
469. VENICE COMMISSION, *supra* note 48, at 10.
470. Ferejohn & Pasquino, *supra* note 50, at 217.
471. *See id.* at 226.
472. *Id.* at 219.
473. *Id.* at 217.

wields the emergency powers, subject to the conditions of the delegation and the needs of the emergency itself.[474] This person or body can also derive legitimacy from being democratically elected.[475] The fourth function is *monitoring*, ensuring the use of emergency powers complies with the law and is appropriate to the needs of the crisis.[476] It is a duty usually shared by the legislature, the judiciary, and arguably civil society and the people themselves.[477]

This legislative mode of emergency governance has become the norm across liberal democracies, including those with constitutional provisions allowing for formal states of emergency and suspension of regular government.[478] The changing nature of emergencies partly explains the shift. Ideally, the crisis is temporary and exceptional, the restoration of ordinary government and the lapse of emergency powers the very goal of their use.[479] It is an ideal of emergency governance that early modern and Enlightenment political theorists consciously derived from study of the Roman Republic's office of the Dictator.[480] Ancient Rome used a complex array of separated powers and term limitations to create a form of emergency government that coexisted with the Republic for nearly 300 years.[481] But the threats that faced the Roman Republic, like invasions and insurrections, typically corresponded with warm weather, called for straightforward military responses, and reliably subsided by the beginning of winter.[482] This allowed the office of the Dictator to be reliably term- and cause-limited. Emergencies facing modern democracies, on the other hand, are often indeterminate and long lasting. With the climate emergency, it is weather itself that poses the threat.

The design response to this problem has been managerial—developing institutions to handle emergency response, cultivating expertise to aid in the exercise and oversight of emergency powers, and setting forth governance by law, subject to court review.[483] The legislative mode of emergencies is therefore a sort of extraordinary governance by ordinary means.[484] Ideally, these institutions are formally separated from the mechanisms of "ordinary" government and ulti-

474. *See id.* at 217–18.

475. *See* Farber, *supra* note 15, at 1172–73.

476. Venice Commission, *supra* note 48, at 15.

477. *Id.* at 19; Ferejohn & Pasquino, *supra* note 50, at 229.

478. Ferejohn & Pasquino, *supra* note 50, at 215.

479. *Cf.* Gross, *supra* note 60, at 1838 (discussing the limits on temporal duration of emergency dictatorial powers in ancient Rome).

480. Ferejohn & Pasquino, *supra* note 50, at 211 n.3; *see also* Niccolò Machiavelli, Discourses on Livy 94–96 (Julia Conway Bonadella & Peter Bonadella trans., 1997); The Federalist No. 70 (Alexander Hamilton).

481. Ferejohn & Pasquino, *supra* note 50, at 226–27.

482. *Id.*

483. *See* Scheppele, *supra* note 457, at 615–28.

484. *See* Ferejohn & Pasquino, *supra* note 50, at 216–17.

mately subject to democratic control.[485] Judicial review is especially important here.[486] If the legislature fails to act promptly on an emergency, the executive may use existing statutory delegations or constitutional authorities to assert the needed power to respond.[487] It is left to the judiciary then to ensure the need is real and the asserted powers are appropriate and lawful.[488] Even where emergency powers are dutifully enacted by the legislature, in practice, the monitoring role is left almost exclusively to the judiciary.[489]

C. Emergency Governance of Solar Geoengineering

A few lessons have emerged to aid in approaching geoengineering governance. One concerns program mission. Emergency measures are fundamentally conservative; they wish to preserve a significant existing interest from substantial peril.[490] A stable climate capable of sustaining humanity and the natural world is what all climate policy works toward, including solar geoengineering. Solar geoengineering, for all its difficulties, can therefore claim a worthwhile purpose, making its prospect more conscionable. Another lesson is the ability of crisis to motivate cooperation and coordinated action capable of realizing new and possibly more just forms of government. The corresponding danger, of course, is the potential within crisis for further cruelty, marginalization, and domination. Put generally, emergencies can facilitate new norms and new ways of doing government—a quality certainly needed to imagine a just manner of using solar geoengineering.

A third lesson is that modern-day emergencies are often long-term crises. Because they lack reliable endpoints, emergency programs themselves require management via formal institutional control, specialized expertise, and vigorous oversight.[491] A fourth lesson involves inevitability. Though it is reasonable to fear the abuse of emergencies, it is impossible to wish away necessity and exigency on the basis of that fear. Readers unpersuaded by the thrust of this Article should still be prepared to imagine what a climate emergency might look like to them and what might be appropriate in response.

The emergency literature also suggests concrete design choices for geoengineering governance. This is not a prompt to look for literal analogs to

485. *See* Scheppele, *supra* note 457, at 628.

486. Ferejohn & Pasquino, *supra* note 50, at 229; VENICE COMMISSION, *supra* note 48, at 19 (reasoning judicial review is a necessary consequence of the rule of law).

487. *See* BRENNAN CTR. FOR JUST., *supra* note 15, at *4 (demonstrating this is so in the United States).

488. Ferejohn & Pasquino, *supra* note 50, at 229.

489. *See* Vermeule, *supra* note 57, at 164–65, 195; *see also* VENICE COMMISSION, *supra* note 48, at 10.

490. Ferejohn & Pasquino, *supra* note 50, at 210.

491. Scheppele, *supra* note 457, at 628.

"the Legislature" or "the Judiciary" within international law.[492] Instead attention should be paid to governance functions vis-à-vis emergencies: *epistemic*, *authorizing*, *executive*, and *monitoring*, as well as the mechanisms for legitimizing the bodies entrusted with those functions. These functions in turn can be applied to research and potential development of solar geoengineering technologies.

An emergency governance mindset recognizes the implications of current research activities and becomes a powerful argument for more oversight. Current research on solar geoengineering is justified in terms of potential necessity—arming future decision-makers with the knowledge they might need to meet a future climate crisis.[493] There is the epistemic act: climate change may one day boil over into a situation where rapidly slowing the rate of warming may seem warranted. Then there is the authorizing act: this risk justifies limited, small-scale research activities. This research, mostly computer modeling in labs, presents very low physical risk to the environment and lacks a clear path toward technology development or expansion.[494] National governments and non-state actors therefore seem capable of carrying this task out and managing the direct risks of these programs[495]—assuming, over the long term, they function as stopgaps and catalysts for international governance.

Further bounding the scope of research are informal or implicit assurances that these activities will not get "too big" ahead of governance structures. Governance of current research activities would therefore benefit from formal international cooperation that explicitly sets limits on the current phase of exploratory research. The cap would necessarily be vague, but could, for example, prohibit solar geoengineering research activities having "significant" impacts on climate or the environment. A formally separate body to monitor research activities would help ensure they do not exceed the reach of their authorizing rationale. Establishing a separate monitoring body could also prevent placing too many functions—epistemic, authorizing, executive, monitoring—in the same hands.

The advantages are even clearer when considering intermediate-scale research activities risking significant, direct physical impacts on the environment. Unlike the amorphous, unbounded emergency states that characterize modern crisis management, framers could define clear cause- and time-limitations ex ante. As is the case with low-risk exploratory research, the objective would be to produce scientific knowledge and technological know-how, ultimately to facilitate potential deployment of solar geoengineering should a climate emergency

492. *See* Sloan, *supra* note 399, at 458 (warning against too-literal analogizing between national and international law).

493. *Cf.* NAS REPORT 2021, *supra* note 33, at 8–9 (describing rationale for proposed federal geoengineering research).

494. *See* Corbett, *supra* note 267, at 247–51.

495. *See* Jesse L. Reynolds & Edward A. Parson, *Nonstate Governance of Solar Geoengineering Research*, 160 CLIMATIC CHANGE 323, 324, 334–37 (2020).

arise. Furthermore, the authorization to pursue intermediate activities could be time-limited: say, two years to pursue research, subject to monitoring, assessment, and re-authorization.

This scheme requires a few institutions: an authorizing body, a scientific and technology development body, a forum to raise disputes, and mechanisms for public education and stakeholder engagement.[496] Formation of these institutions would be voluntary, perhaps via a group of willing, curious, or concerned states. Again, the use of hard time limits for authorizations may help assuage concerns that this project may get too big, too fast. The authorizing function may further require a supermajority voting requirement among state participants to ensure there is widespread agreement that the research is proportionate to the proposed need.[497] Many states may be inclined to join, given how impactful solar geoengineering would be, both in terms of risk and potential relief from warming-caused harm. Joining early, furthermore, may give more influence over the rules and therefore the outcomes. The more states join, the more other states may want to join so as not to be left out, and the more legitimate the organization may become as a result.

That legitimacy in turn could be leveraged to make the limitations and jurisdiction of the governance platform more effective. A condition of joining, for example, could be to agree to be bound by the research limitations set forth by the authorizing body. Parties could further assent to the jurisdiction of a dispute-resolution forum to preside over solar geoengineering–related conflicts. Breaching these obligations, say by conducting research outside the ambit of the rules, could thereby delegitimize those activities. A voluntary system could therefore give rise to hard obligations, especially if those rules are internalized into national law regulating development activities.[498] The mounting climate crisis, in turn, could motivate increased cooperation and enforcement of rules. Similarly, given that solar geoengineering activities risk transboundary impacts, the rise of "local" solar geoengineering trials—like the example of rapid-cooling Los Angeles—may motivate robust international governance.[499]

Long-term deployment is harder to visualize, but not impossible. It is a question of how to preserve norms while waging "a serious fight against a threat over the long haul."[500] That work is done through expertise and detailed regulation, housed in permanent institutions and held accountable via sincere public

496. *See* NAS Report 2021, *supra* note 33, at xi (justifying the report and its recommendations by appealing to the urgency of the climate crisis); *cf. id.* at 82–90 (proposing elements of a system of international governance of solar geoengineering research).

497. *Cf.* Bruce Ackerman, *The Emergency Constitution*, 113 Yale L.J. 1029, 1047–50 (2004) (proposing supermajority requirements in Congress to authorize emergency powers).

498. *See* Koh, *supra* note 327, at 2599–2603.

499. *See* Bernstein, *supra* note 410, at 6388–89.

500. Scheppele, *supra* note 457, at 614.

engagement.[501] For solar geoengineering, it seems to require a sort of limited-purpose charter, a new kind of artificial sovereignty for the Anthropocene's atmosphere.[502] Emergency hints at a path to get there.[503] For instance, the time- and cause-limited authorizations of deployment activities applicable to intermediate-scale activities could also apply to initial planetary-scale deployment.

The history of emergency powers tells us that extraordinary means of governance can become ratified and then incorporated into the normal mode of doing government.[504] Something like the idealized Napkin Diagram therefore might be possible, with the technocratic management of solar geoengineering's cooling harmonized with deep decarbonization, carbon removal infrastructure, and adaptation investment. The work of this new kind of governance could be to realize the transformation of an emergency measure into a mode of long-term risk management.[505]

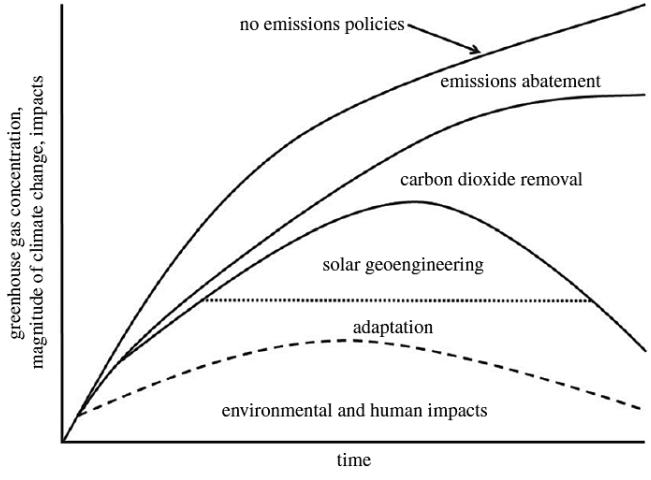

FIG. 2. A MORE DETAILED "NAPKIN DIAGRAM" IMPROVED BY EXPERIENCE, DELIBERATION, AND EXPERTISE.[506]

501. *See id.*

502. *See* LATOUR, *supra* note 39, at 149, 245.

503. *See* Donald V. Kingsbury, *Sovereignty, Capital, and Justice in the Warming World: Mann and Wainwright's* Climate Leviathan, 21 THEORY & EVENT 993, 995 (2018).

504. *See, e.g.*, Scheuerman, *supra* note 60, at 1878–81 (describing the evolution of U.S. economic regulatory authority through use of emergency powers).

505. *Cf.* Federico Luisetti, *Geopower: On the States of Nature of Late Capitalism*, 22 EUR. J. SOC. THEORY 342, 347 (2018) (analyzing "geopower" and political theory responding to climate change).

506. Jesse L. Reynolds, *Solar Geoengineering to Reduce Climate Change: A Review of Governance Proposals*, 475 PROC. ROYAL SOC'Y A 1, 5 (2019) (adapting a visual in Shepherd, *supra* note 293).

This is speculation. Before anything can begin, states must first acknowledge the depth of the crisis and talk to one another about solar geoengineering. "Climate emergency" offers a way to justify those explorations, while keeping the specter of deployment at bay. In this regard, its most valuable contribution to governance may be conceptual and political, not legal.

Conclusion

Treaties place their loftiest language in the preamble. There the framers of international law announce the moral and philosophical justifications for the rules they have arrived at. What would the preamble for solar geoengineering's treaty say? How could framers justify the realization of this gloomy science? I now think the answer could be: "Amid *emergency* and *necessity*, and as a matter of *last resort*, the parties resolve to *preserve* the climate."

Emergencies are frightening. They risk erosion of democratic norms, abuse of power, and the exercise of brute force, to say nothing of the underlying threat itself. That may be why some prefer to imagine solar geoengineering as just another potential tool in the climate policy portfolio—or prohibited entirely. But denying the emergency framing distorts the problem and elides its difficulties. If we can characterize solar geoengineering correctly, it is possible to begin negotiations toward an adequate design for control. So too with climate change as a whole. Recognizing its potential to provoke an emergency response allows for a better understanding of the risks it poses, the forms that governance could take, and its potential to transform the status quo. Sometimes a crisis becomes a genuine emergency, calling on people and governments to do the extraordinary.