THE IRONY OF THE COMMONS: CLIMATE GEOENGINEERING, CHRISTIAN REALISM, AND THE POLITICAL ECOLOGY OF HUMILITY

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ABSTRACT: 273 WORDS

Since Garrett Hardin's seminal contribution of the 'Tragedy of the Commons' in 1968, the concept of tragedy has been used by many as a master trope for analyzing ecological and political crises with global consequences. Perceiving conditions at a tipping point, many contemporary scientists and activists have begun reasserting this tragic narrative. In *The Irony of American History*, Reinhold Niebuhr asserts that the deep irony of post-war America was that Americans had sought isolation and entered world politics through the discovery of the atomic bomb. Today in discussions over global climate change, Americans are again awakening to ironic responsibility, and challenged by enduring conflicts between environmentalists over the content and distribution of 'modern' life. Recent discussions about adaptation have begun to represent the necessary change as a short-term need to adjust to emergency conditions. Solar Radiation Management and other geoengineering techniques are the vanguard of such emergency preparedness logics. I will argue through reference to Niebuhr that advocates for these technologies mistake conditions as tragic rather than ironic. Working through his Christian vocabulary, I propose an alternate ironic framing for climate change discussions which stresses humility, responsibility, and politics rather than denial or confirmation of climate doomsday. This ironic frame, I argue, better engages with the US public in particular, presenting the result of the realization gained from seeing the greater history of climate change as a choice between good and evil rather than an engineering problem to be solved. This perspective acknowledges the audience of such appeals and begins translating abstract global trends into the moral vocabulary of the democratic public which will debate things like Solar Radiation Management in the future.

CONTENTS

'How much is a blue sky worth?' – David Keith

'*God, grant me the serenity to accept the things I cannot change,*
the courage to change the things I can,
And the wisdom to know the difference.'
- Reinhold Niebuhr, the Serenity Prayer.

I. INTRODUCTION: DIAGNOSING LOGICS OF SURVIVAL

Since Garrett Hardin's seminal contribution of the 'Tragedy of the Commons' in 1968, the concept of tragedy has been used as a master frame for analyzing the social and political elements of crises in global social-ecological systems.[1] He and other 'survivalists' of the 1970s insisted that the ecological predicament could not be avoided in time by existing institutions, requiring a choice of a lesser evil, often a drastic authoritarian solution, such as Hardin's proposed restrictions on breeding and Tertullian welcoming of natural disasters.[2] This tragic logic, I will argue here, is not unique to Hardin and the survivalists, who take their name from the imperative to survive at all costs.

Facing a world of depleted richness and changing conditions of life, I will argue here that a new generation of survivalists has taken on the tragic framing of the population debate Hardin helped initiate. Today, this logic is increasingly mobilized in the debates surrounding political

[1] Garrett Hardin, 1968. 'The Tragedy of the Commons,' *Science*, Vol. 162, No. 3859, December, pp. 1243-1248.
[2] Hardin (1968; p. 1248) famously says: 'The most important aspect of necessity that we must now recognize, is the necessity of abandoning the commons in breeding. No technical solution can rescue us from the misery of overpopulation. Freedom to breed will bring ruin to all'.

responses to climate change, powerfully represented at its seeming logical extreme by global-scale climate geoengineering. The most controversial of these proposed approaches is a form of Solar Radiation Management (SRM), the most discussed of which proposes managing the incoming solar radiation from the sun by injecting reflective particles into the troposphere, mimicking the temporary cooling effect of a volcanic eruption.[3]

Given the various possible drawbacks associated with this kind of SRM, it is surprising to see it considered as seriously as it has been recently.[4] This, I'll argue, is due to increasing acceptance of the tragic frame in contemporary discourse which configures the choice to manage the climate as a kind of lesser evil, a last-ditch insurance plan against a catastrophic future.[5] This framing is attractive given the slow progress on carbon governance at the global and national scales and the perception that it may already be too late to prevent major change.[6] Presented as an unwanted but necessary step, the engineering perspective on climate change makes the argument that it is *prudent* to research and test techniques like SRM.

This paper attempts to move contemporary discussions over the technical feasibility of large-scale climate interventions common in both the sympathetic and critical literatures into a vocabulary capable of translating abstract global debates into meaningful political deliberation in the US. To do this, I will utilize insights from a parallel historical debate over nuclear technology to address the poverty of political concerns in contemporary rhetoric framing climate geoengineering

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[3] Reintroduced by Paul Crutzen, 2006. 'Albedo Enhancement by Stratospheric Sulfur Injections: A contribution to resolve a policy dilemma?' *Climatic Change,* Vol. 77.

[4] A comprehensive summary of most of these drawbacks can be found in: Alan Robock, May/June 2008. '20 Reasons Why Geoengineering May be a Bad Idea.' *Bulletin of the Atomic Scientists*, Vol. 64, No. 2, pp. 14-18.

[5] For instance, see: Kingsley Edney and Jonathan Symons, 2014. 'China and the Blunt Temptations of Geo-engineering: the role of solar radiation management in China's strategic response to climate change.' *The Pacific Review*, Vol. 27, No. 3, 307-332. Also: Scott Barrett, Timothy M. Lenton et al, 2014. 'Climate Engineering Reconsidered.' *Nature Climate Change*, Vol. 4, July 2014, pp. 527-530.

[6] In a paper from 2013, Jennifer Burney, Charles Kennel, and David Victor note how two decades of perceived failure have violated the trust in institutions necessary to create meaningful change, that 'while diplomacy hasn't been in short supply, it hasn't had much practical impact on the rate of emissions.' Jennifer A. Burney, Charles F. Kennel, and David G. Victor, 2013. 'Getting serious about the new realities of global climate change.' *Bulletin of the Atomic Scientists*, Vol. 69, No. 4, pp. 49-57; p. 49.

as emergency insurance. In contrast to the seeming novelty of the entrance into an era of social-ecological crisis defined by climate change, the concept of global tragedy is not new. While the tropes from past debates can be challenging to the understanding of seemingly new moral and political questions surrounding global climate management, they also represent a potential source of lessons and critical nuance for contemporary debates.

I'll argue here that theologian Reinhold Niebuhr represents a key example of such lessons. Framing a Christian interpretation of a similar debate over the new era of nuclear politics, Niebuhr's insights can help interpret the moral and political choices over greater and lesser evils entailed in the tragic framing of climate geoengineering. Steeped in Christian theology at the root of much of American public's framework for interpreting global change, Niebuhr stresses prudence balanced by humility and provides a complicated voice in the nuclear debates, understanding the power of atomic weapons as both evil and necessary. The tragic decision, in Niebuhr's formulation, was the choice of this lesser evil to avoid a greater evil, the USSR and threat of global communism.

What is most interesting for considering contemporary survivalism, however, is that beyond this tragic decision to retain nuclear weapons, Niebuhr saw that the greater historical framework of such a choice was deeply ironic. Irony, for Niebuhr, was the condition where intentional actions or apparently chaotic events have unintended but ordered results. For Niebuhr, it implies an observer and an unwitting agent, and elicits laughter rather than pity, encouraging understanding of how 'apparently fortuitous incongruities in life which are discovered, upon closer examination, to be not merely fortuitous.'[7]

My argument here is that understanding the complexity of Niebuhr's Christian Realism can place abstract-seeming global debates into a specific and historically-grounded moral vocabulary which Americans, by far most responsible as well as rich enough to act, can understand and debate. Niebuhr's faith, in stark relief to the dystopic scientific prophecies now dominating debates over

[7] Niebuhr, 1951; p. xxiv.

technological responses to climate change, preserves the potential for agency as a fundamental aspect of human life. This does not mean that tragic decisions are rendered impossible, but rather that *the decision itself is meaningful*, that it exposes the decider to moral and political judgment. My overarching argument is that many of the lessons of similarly 'new' earlier eras can help contemporary debates to examine both successes and failures, and that this effort to learn the lessons on offer in our own history can help the necessary process of translation of abstract global trends into meaningful cultural terms capable of facilitating debate and political deliberation.[8]

In what follows I will begin by exploring in greater detail the emergence of the geoengineering debate, linking it to debates over nuclear weapons as a resource for criticism. I will attempt to illustrate how tragic framings common since Hardin's publication of the 'Tragedy of the Commons' can be reconfigured in Niebuhr's terms as ironic, preserving responsibility for action and the sense that such action can make a difference. Considering the debates over climate change, I extend Niebuhr's analysis of atomic politics to suggest that climate crises are not tragic but rather ironic. On its face, asserting the need for a consideration of irony in the face of serious global-scale social-ecological crises appears frustratingly naïve regarding the pace of global change. I'll argue here that this is a shallow interpretation. Following the work of Bronislaw Szerszynski, I will show how philosophical irony drawing on Kierkegaard can inspire a ironic perspective, what Szerszynski calls 'a general philosophical stance,'[9] which can be fruitfully applied to some of the most urgent and complicated social-ecological issues now under debate.

Drawing on Niebuhr, I suggest this philosophical irony should also embrace the religious vocabulary implied in the extended reference to Kierkegaard. I conclude with a discussion of the role of humility in post-ironic political debate over whether to control the climate. Moving beyond

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[8] Susanne C. Moser, 2010. 'Communicating Climate Change: history, challenges, process and future directions.' *WIREs Climate Change,* Vol. 1, January/February.
[9] Bronislaw Szerszynski, 2007. 'The post-ecologist condition: Irony as symptom and cure.' Environmental Politics, Vol. 16, No. 2, pp. 337-355.

tragic prudence means slowing the urgency to act and recognizing the false certainty over future consequences which the tragic frame implies, insisting instead on the responsibility to act as a moral choice that must be made in conditions of uncertainty and uneven social and natural vulnerability. This is a form of humility, and is tied to the realization of the ironic circumstances which have generated the apparently tragic choice to research, test, and eventually implement climate geoengineering.

II. THE LESSER EVIL: CLIMATE GEOENGINEERING AS INSURANCE

Geoengineering can be defined as the intentional manipulation of biogeophysical systems to accomplish a finite goal.[10] As a term, the single word 'geoengineering' is misleading since it covers a vast array of interventions to modify Earth systems. Schemes like iron fertilization in the ocean, mirrors placed at LeGrange points in space, massive reforestation, genetic engineering of crops, and surface albedo enhancement have all been proposed under the name geoengineering.[11]

The debates considered here are focused on 'climate geoengineering,' but even this seemingly more descriptive category contains several schemes for affecting the climate at global scale. The most controversial one is a form of Solar Radiation Management (SRM) through aerosol injections in the upper atmosphere. Geoengineering the climate through management of incoming solar radiation has been proposed before, but rarely taken seriously in the scientific literature. Proposals for 'planetary sunscreen' in the late 1990s were put forward by people like Edward Teller, the father of the hydrogen bomb then in residence at Lawrence Livermore Labs.[12] David Keith from the Kennedy School at Harvard has made the case for research and situational

[10] There are several definitions in discussion. I use this as an approximation of the Royal Society and National Academy of Sciences definitions: The Royal Society, 2009. *Geoengineering the Climate –Science, Governance and Uncertainty.* London:; National Academy of the Sciences, 2015. *National Research Council Report on Climate Intervention: Carbon Dioxide Removal and Reliable Sequestration.* National Academies Press, DC.
[11] See the assessments in Royal Society, 2009 and National Academy of Sciences 2015 for more detail.
[12] E. Teller, L. Wood, and R. Hyde, 1997. 'Global warming and ice ages: Prospects for Physics-Based Modulatio of Global Change.' 22nd International Seminar on Planetary Emergencies, Erice, Italy, August 20-23.

deployment in a series of papers and books from 1992.[13] Climate modelers from Stanford, Govindasamy Bala and Ken Caldeira also initiated early research programs.[14] These authors and their students and colleagues are still highly active, serving on national scientific advisory bodies, and so central to the debate to be dubbed by skeptical critics the 'geoclique.'[15]

These types of strategies, given their inherent risks and the global uncertainty of their effects, have long been frozen from serious research by informal norms in the scientific community. Usually their advocates only argue for expanded research, understanding both the uncertain nature of intervening in complex systems like the climate and the general uneasiness of the public approaching a technology which is not well comprehended.[16] This, however, has changed significantly in recent years. In a now infamous special edition of *Climatic Change* in 2006, Nobel-prize winning atmospheric chemist Paul Crutzen suggested that unspoken taboos over large-scale climate manipulation should be broken.[17] His rationale for breaking these taboos depended on the frustration of political efforts to regulate carbon emissions—he insists that research should be encouraged into technological insurance plans meant to mitigate short term crises which could cause undue suffering.

As a response to novel social-ecological conditions, geoengineering is tied up in continued debates surrounding the construction of such a new world, including the renaming of the geological epoch to the 'Anthropocene,' a concept popularized by Paul Crutzen and Eugene Stoermer in the

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[13] David W. Keith and Hadi Dowlatabadi, 1992. 'A serious look at Geoengineering.' *Eos,* Vol. 73, No. 27, July, pp. 289-293. Also: David W. Keith, 2000. 'Geoengineering the climate: history and prospect.' *Annual Review of Energy Environment*. Vol. 25, 245-284.
[14] See: Govindasamy Bala, Ken Caldeira, and P.B. Duffy, 2003. 'Geoengineering Earth's radiation balance to mitigate climate change from a quadrupling of CO2. *Global and Planetary Change,* Vol. 37, pp. 157-168.
[15] Eli Kintisch, 2010. *Hack the planet: science's best hope-or worst nightmare-for averting climate catastrophe.* John Wiley & Sons, Hoboken, NJ. For a critical discussion: Jonas Anshelm and Anders Hansson, 2014. 'Battling Promethean dreams and Trojan Horses; Revealing the Critical discourses of geoengineering. *Energy Research and Social Science*, Vol. 2, pp. 135-144; p. 137.
[16] Crutzen, 2006; David W. Keith, 2001. 'Geoengineering.' *Nature,* Vol. 409, January, pp. 420-420.
[17] Crutzen 2006; see also Jennifer A. Burney, Charles F. Kennel, and David G. Victor, 2013. 'Getting serious about the new realities of global climate change.' *Bulletin of the Atomic Scientists*, Vol. 69, No. 4, pp. 49-57.

early 2000s.[18] The permeation of the concept of the Anthropocene across research programs has given form to many of the continuing debates over the shape of the future to be worked towards in the Age of Man. The overgeneral nature of the anthropos referred to by such narratives has been criticized by many, especially in the social sciences,[19] but it is in the emerging debates over geoengineering where one gets a sense of the rival values between discourses accepting the dawn of a new age of human mastery.

In these discussions, attitudes toward geoengineering reveal these rival visions of the future, one where modernists and pragmatists can claim that the misguided moral romanticism of their opponents is going to cause great suffering,[20] and one where romantics and skeptics can argue that the hubris of technical rationality is exposing the world to global risk without addressing the root cause of the problem.[21] So-called 'good Anthropocene' narratives[22] see the world as profoundly changed already, disqualifying romantic yearnings for restoration.[23] Instead, they insist that humans must act at the fullest of their technological capacities in the interest of the species and planet. In many cases, they maintain, this is inevitable and best embraced by responsible scientists under institutionalized norms rather than in the heat of a climate emergency. At their caricatured

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[18] See Paul J. Crutzen, 2002. 'Geology of Mankind.' *Nature*, Vol. 415, January.
[19] Pálsson, Gisli, Bronislaw Szerszynski, Sverker Sörlin, John Marks, Bernard Avril, Carole Crumley, Heide Hackmann, Poul Holm, John Ingram, Alan Kirman, Buendía Mercedes Pardo and Rifka Weehuizen, 2013. 'Reconceptualizing the 'Anthropos' in the Anthropocene: Integrating the Social Sciences and Humanities in Global Environmental Change Research." *Environmental Science and Policy* , Vol. 28, pp. 3-13.
[20] An early version from an economist: William D. Nordhaus, 1992. 'An Optimal Transition Path for Controlling Greenhouse Gases.' SCIENCE Vol. 258, pp. 1315-1317. A popular French version: Pascal Bruckner, 2013 [2011]. The Fanaticism of the Apocalypse: Save the Earth, Punish Human Beings. *Polity*, New York.
[21] Naomi Klein, 2012. 'Geoengineering: Testing the waters.' *New York* Times, Oct. 27, 2012. Accessed 2/27/16 at http://www.nytimes.com/2012/10/28/opinion/sunday/geoengineering-testing-the-waters.html?_r=0 . Clive Hamilton, 2013. *Earthmasters: The dawn of the age of climate engineering*. Yale University Press, New Haven.
[22] Simon Dalby, 2015. 'Framing the Anthropocene: The Good, the Bad and the Ugly.' *Panel on Planetary Politics*, Association of American Geographers Annual Convention, Chicago, April.
[23] Erle Ellis, 2013. 'Sustaining biodiversity and people in the world's anthropogenic biomes.' *Current Opinion in Environmental Sustainability*, Vol. 5, pp. 368-372.

extreme, such narratives may go further even than Crutzen's claim that 'nature is us'[24] and advocate the transcendence of the Earth itself and total detachment.[25]

Such science fiction narratives[26] are often more interesting than the extended conversation about the beginning of the Anthropocene under which much of the implicit debate over worldviews is conducted.[27] They show that the arrival of the Anthropocene can be a call to engineer the planet or an call for urgent reevaluation of social conditions, and which one chooses is signaled by positions on geoengineering. Since the Anthropocene, as a microcosm of the climate change debate it gets its impetus from, has brought together a diverse array of scholars and publics under the banner of the collapse of natural and social boundaries, geoengineering serves as a useful tool for understanding the serious differences in world views, visions of the future, and the 'tragic' decision to use tools like SRM represented but often obscured by the common acceptance of the arrival of a new era.

SRM through sulfate emissions can act as a lightning rod in this way because it has a wealth of associated problems. Because SRM does not affect carbon in the atmosphere but rather manages incoming radiation, ocean acidification and other serious effects of overloading the carbon cycle would continue.[28] Since atmospheric carbon concentrations will not be directly affected by this technique, any cessation of SRM would cause rapid warming, making it incredibly hard to stop.[29]

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[24] Crutzen and Schwagerl 2015.
[25] For a caricature of this viewpoint see: Rasmus Karlsson, 2013. 'Ambivalence, irony, and democracy in the Anthropocene.' *Futures*, Vol. 46, pp. 1-9.
[26] For an interesting recent contribution see: Heather Swanson, Nils Bubandt, and Anna Tsing, 2015. 'Less than one but more than many: Anthropocene as science fiction and scholarship-in-the-making.' *Environment and Society: Advances in Research*, Vol. 6, pp. 149-166.
[27] For a short summary of a very large literature from the perspective of archaeology, see: Michael Balter, 2013. 'Archaeologists say the Anthropocene is here—but it began long ago.' *Science*, Vol. 340, April 13, 2013.
[28] Naomi E. Vaughan, 'The Challenges of assessing the cost of geoengineering.' In Dawson RJ, Walsh, CL and Kilsby, CG (eds.), 2012. *Earth Systems Engineering 2012: A technical symposium on systems engineering for sustainable adaptation to global change*. Centre for Earth Systems Engineering Research, Newcastle University, U.K. p. 157.
[29] O. Boucher, J.A. Lowe, C.D. Jones, 2009. 'Implications of delayed actions in addressing carbon dioxide emission reduction the context of geoengineering'. Climatic Change, Vol. 92, pp. 261-273.

This 'termination effect'[30] incentivizes the continuing injection of particles to avoid the uncertain and geographically uneven effects, creating the fear of technological 'lock-in.'[31] The longer the intervention lasted, the greater this rapid warming would be upon stopping, something that few of the engineering-framed address beyond reserving SRM for emergencies.

The usual response to this criticism is that SRM would work as part of a larger portfolio, one which must include actions to reduce and capture atmospheric carbon.[32] What makes sulfate SRM appealing as a part of such a portfolio is that, relative to the cost of changing the global economy, the cost of geoengineering is said to be 'shockingly small.'[33] This is important, since SRM's perceived cheapness also encourages unilateral use and incentivizes global cooperation.[34] Most proponents of serious research, however, are wary of initiating a global conversation, fearing a ban due to poor understanding, unreflective moral opposition, or the caution of those countries which do not have the technical means to join in the eventual technological control of the climate.

Instead, they often propose an elite group of national research programs[35] and the 'bottom-up' establishment of norms against actual use, like the influential 'Oxford Principles' put forward by Steve Rayner and colleagues which insist that states and international organizations begin regulating geoengineering as a public good and that debates be opened to public participation to ensure legitimacy and address equity and justice concerns.[36] Despite stressing governance more, Rayner, a central author on the influential 2009 Royal Society report, and his colleagues from the

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[30] Andy Jones *et al*, 2013. 'The impact of abrupt suspension of solar radiation management (termination effect) in experiment G2 of the Geoengineering Model intercomparison Project (GEOMIP).' *Journal of Geophysical Research: Atmospheres*, Vol. 118, pp 9743-9752.
[31] Scott Barrett, 2014. 'Solar geoengineering's brave new world: thoughts on the governance of an unprecedented technology.' *Review of Environmental Economics and Policy*, Vol. 8, Issue 2, pp. 249-269.
[32] O. Bahn, M. Chesney, J. Gheyssens, R. Knutti, A.C. Pana, 2015. ' Is there room for geoengineering in the optimal climate policy mix?' *Environmental Science and Policy*. Vol. 48, pp. 67-760.
[33] David G. Victor, 2008. 'On the regulation of Geoengineering.' *Oxford Review of Economic Policy*, Vol. 24, No. 2, 2008, pp.322–336, p. 326.
[34] Jonas Anshelm and Anders Hansson, 2014. 'The Last Chance to Save the Planet? An analysis of the geoengineering advocacy discourse in the public debate.' Environmental Humanities, Vol. 5, pp. 101-123.
[35] Victor, 2008.
[36] Steve Rayner, Clare Heyward, Tim Kruger, Nick Pidgeon, Catherine Redgwell and Julian Savulescu, 2013. 'The Oxford Principles.' *Climatic Change*, Vol. 121, pp. 499-512

Oxford Geoengineering Program observe that 'a legal regime regulating computer simulations of stratospheric sulphate particle injection would be regulatory overkill,' but argue at the same time that 'voluntary regulation of large scale field testing seems to be inadequate.'[37] This is not so different from contemporary geoengineering advocates, some of whom argue that *because of the uncertainties* associated with albedo modifying aerosol injections, waiting for an inevitable climate emergency to begin testing them would be asking for great risks and even catastrophic failure.

Much of this uncertainty, reason research advocates, could be removed with further research and 'sub-scale' tests, the data from which could inform responses prompted by emergencies in the future. [38] Such an optimistic view has been criticized strongly. One example is the work of Marlos Goes, professor of Geosciences at Penn State and researcher with the National Oceanographic and Atmospheric Administration, who stresses the large uncertainty pertaining to assessing of damages when used in a portfolio.[39] Their biggest concern is that informal norms against premature trials will break down, noting that the National Academies of Science conditioned their early endorsement of geoengineering on 'broad understanding of the direct effects and the potential side effects, the ethical issues, and the risks.'[40] They conclude that this 'broad understanding' is still lacking in contemporary discussions.

Philosopher Stephen Gardiner, author of the popular *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*, has criticized the portfolio approach for several years. Gardiner is worried that geoengineering is presented as the only possible lesser evil to confront climate catastrophe, a point which he feels ignores the interests of future generations and potentially

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[37] Rayner et al, 2013; p. 508.
[38] Douglas MacMynowski , Keith Davis, Ken Caldeira. and HoJeong Shin, 2011. 'Can we Test Geoengineering?' *Energy & Environmental Science,* Vol. 4, pp. 5044–5052; also David W. Keith and Douglas G. MacMartin, 2015. 'A temporary, moderate and responsive scenario for solar geoengineering.' *Nature Climate Change*, Vol. 5, March 2015, pp. 201-206.
[39] Goes, Tuana, and Keller, 2011; p. 720.
[40] Cited in: Goes 2011; p. 740.

sidelines concerns about justice, ethics, and equity.[41] Instead, he argues that such approaches 'pass the buck' to future generations and fail to specify the conditions for deployment, circumstances which require agreement on the ranking of lesser and greater evils.

While Gardiner rejects the tragic framing of geoengineering as a lesser evil and dismisses the relevance of the commons example to Hardin's concept of tragedy, he retains the language of tragedy in a modified form. Despite finding Hardin's claims 'deeply flawed,' he agrees that some problems associated with population did have tragic structures.[42] This is because climate change has an added 'intergenerational aspect.'[43] As other have shown, repeated interaction is a key to solving prisoner's dilemmas like Hardin's imagined commons scenario. Gardiner sees this as damning for intergenerational problems like climate change, where there are no repeated interactions between parties to work out a solution.

Such ideas of tragedy are not simply strategic or ethical, but rather powerful framings of public outreach and political appeal. Violating Niebuhr's terms for a tragic decision, both Hardin and Gardiner's senses of tragedy depend on the reliable prediction of future costs. If future consequences are not clear or responsible people do not understand how they are implicated, both tragic structures become altered. I will not spend time 'disproving' either Hardin or Gardiner's theses, but will instead compare them to Niebuhr's Christian-inflected diagnosis of the deep irony of history behind such tragic decisions.

III. GEOENGINEERING AND THE NUCLEAR DEBATE

The ambiguity of the definition of geoengineering means that more specific research programs like sulfate injections have lacked a consistent framing capable of organizing meaningful public debate beyond the level of Promethean fantasy and uncritical moral rebuke. Many argue that the first

[41] Gardiner, 2011; p. 369.
[42] Gardiner, 2002; p. 387.
[43] Gardiner, 2002; p. 388.

framing, as it emerges into larger political debates, will be incredibly important in confronting this democratic deficit.[44]

The tragic framing of the need for climate geoengineering relies on ideas of emergency and insurance but rarely references lessons learned from earlier historical debates about the politics and ethics of novel technology with the potential to alter the planet. This absence is at least in part due to the profound ambivalence introducing nuclear parallels would impose on the generally optimistic and at times laudatory accounts of human ingenuity in general and geoengineering in particular. The sense that technology might worsen the situation rather than ameliorate it stands in stark contrast to the rhetoric of most geoengineering advocates and modernist narratives.

As many today consider our era new, and as Hardin clearly considered the epoch of world overpopulation novel, the advent of the nuclear era also created a feeling of living in unprecedented times. Michel Foucault would later call this 'the threshold of modernity,' the moment where humans gambled the species on their politics.[45] Given this realization, Foucault pushed for specificity, for a kind of intellectual who sought change for large systems through dedication and discipline at the scale of their own role. He names Robert Oppenheimer, the father of the nuclear bomb and eventual crusader against the development of the hydrogen bomb program under Edward Teller, as the exemplar of 'specific intellectuals,' as a man who acted at a specific scale and affected the global.[46] That Oppenheimer's opponent, Teller, continues to appear into the late 1990s in the geoengineering debate is a hint that something about the normative imperative which Oppenheimer felt, famously quoting the Bhavagad Gita at the first Trinity test in 1945 ('Now I am become destroyer of worlds…'), has been lost.

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[44] Adam Corner and Nick Pidgeon, 2015. 'Like artificial trees? The effect of framing by natural analogy on public perceptions of geoengineering.' *Climatic Change*, Vol. 130, pp. 425-438,
[45] Michel Foucault, 1980. *The History of Sexuality: Vol. 1*.
[46] Michel Foucault, . 'Two Lectures.' In *Power/Knowledge.*

Today, climate scientists have largely replaced the nuclear scientist as archetypical specific intellectual, working simultaneously at minute scientific and immense global scales. The global atmosphere presents the scale of global cooperation necessary in alarming relief against the calls for 50-80% cuts in carbon emissions to avoid projected warming. These represent costly and most likely painful adjustments. The atmosphere has in this way proven to be the most important test of Hardin's tragic metaphor, long after its general discrediting in common pool resource studies. The slow process and perceived failure of international agreements make such costly adjustment politically infeasible and an economically painful sell.

Noting the curious lack of reference to nuclear debates, it is interesting that Paul Crutzen remains a central figure in the geoengineering debates, as he spent much of the 1980s (before his oft-cited Nobel prize for work on the ozone hole) researching the cooling effects of nuclear fires, a research program which attempted to influence public debate over so-called 'strategic' nuclear wars with limited strikes by showing the consequences of nuclear war for the climate system. He was joined publicizing 'nuclear winter' by influential scientists and popularizers like Carl Sagan, Paul Ehrlich, and Richard Turco, amongst many others,[47] and opposed vehemently by nuclear advocates like Edward Teller[48] and professional skeptics like S. Fred Singer,[49] who anchors the core of obstructionary non-specialist scientists driving global warming denial strategies today.[50]

That today Crutzen opposes both Ehrlich and Turco,[51] and supports some of the same research proposals (if for different reasons) as Edward Teller, is demonstrative of the activating

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[47] R.P. Turco, O.B. Toon, T.P. Ackerman, J.B. Pollack and Carl Sagan, 1983. 'Nuclear Winter: Global consequences of multiple nuclear explosions.' *Science*, Vol. 222, No. 4630, December, pp. 1283-1292.
[48] Edward Teller, 1984. 'Widespread after-effects of nuclear war.' *Nature*, Vol. 310, Issue 5979, pp. 621-624.
[49] Singer, S. Fred, 1984. "The big chill? Challenging a nuclear scenario." *Wall Street Journal* 3; S. Fred Singer, 2003. 'Editor bias on climate change?' *Science* 301.5633, pp. 595-596.
[50] Eric Conway and Naomi Oreskes have coined the term 'merchants of doubt.'
[51] Richard Turco, 1995. Global Environmental Engineering: Prospects and Pitfalls. Jones and Bartlett Sudbury, MA.; Scott Barrett, Timothy M. Lenton, Antony Millner, Alessandro Tavoni, Stephen Carpenter, John M. Anderies, F. Stuart Chapin III, Anee-Sophie Crépin, Gretchen Daily, **Paul Ehrlich**, Carl Folke, Victor Galaz, Terry Hughes, Nils Kautsky, Eric F. Lambin, Rosamond Naylor, Karine Nyborg, Stephen Polasky, Marten

power of the sense of impossibility surrounding emissions reductions. The inevitability of the greater evil justifies actions to ensure survival which, on full accounting of all their externalities, likely would not be chosen under normal conditions.

The nuclear connection sits in the background of these debates, not simply through omission or the particular history of one atmospheric chemist, but as a fundamental prerequisite for the generation of the monitoring, processing, and modeling of climate data at all. It is not a coincidence, in this sense, to see Lawrence Livermore Labs at Berkeley, the one time home of Teller, Bala, and Caldeira, also involved in the debates over geoengineering. As historian Jacob Hamblin shows, concepts like geoengineering have deep roots in the US security structure and government science funding, related primarily to detecting radioactive evidence of nuclear tests and even including environmental modification schemes aimed at weaponizing the weather.[52]

As Spencer Weart notes, the entrance into the nuclear era created the need to generate a baseline knowledge of how climate and ocean systems circulated in order to detect nuclear tests and evaluate new weapons, a project which took on significance for people like ocean scientist and eventual director of Scripps Institution of Oceanography, Roger Revelle, coauthor of one of the first white papers on climate change in 1965. Revelle was tasked with assessing nuclear tests at Bikini Atoll in 1946 as the chair of the National Academy of Sciences committee evaluating the effect of radioactivity on fisheries. This line of research would eventually yield the lesson that oceans cannot infinitely absorb carbon, as many initial critics of Arrhenius and Callendar's first theories of the greenhouse effect assumed.

Beyond the fact of practical entanglement of nuclear and climate science funding, less conscious-seeming references abound in the geoengineering debates. In a paper in *Climatic Change*

Scheffer, James Wilen, Anastasios Xepapadeas, and Aart de Zeeuw, 2014. 'Climate Engineering Reconsidered.' *Nature Climate Change*, Vol. 4, July 2014, pp. 527-530.

[52] Jacob Darwin Hamblin, 2013. *Arming Mother Nature: The Birth of Catastrophic Environmentalism*. Oxford University Press, New York.

in 2009, Max Planck Institute for Meteorology professor Victor Brovkin and co-authors draw attention to the possibility of technological failure presented by SRM.[53] Noting the potential for 'termination effect,' Brovkin and colleagues draw on their expertise in land-climate interactions to present the possibility of tipping points and nonlinear change presenting rapid catastrophic change as an unintended result of technological intervention, sounding a particularly tragic note:

> The amplification of global warming through emissions of methane released from thawed permafrost regions and, later, from methane hydrates stored on the continental slopes in the ocean, would seem to be unavoidable. Coming generations would have to live with the danger of this "Sword of Damocles" scenario, the abruptness of which has no precedent in the geologic history of climate.[54]

The reference to the Sword of Damocles myth is not accidental. President Kennedy referred to the mythical sword hanging over one's head to communicate the precarity (and prudence) of holding atomic weapons. Survivalist political theorist William Ophuls self-consciously adapted this example to the ecological crisis as seen in the 1970s, adding that the tie holding the ecological sword, unlike its nuclear counterpart, had already been cut.[55]

The ambivalence of the atomic example, even indirectly referenced, balances the sense of urgency created by the tragic frame. By problematizing benign technological advance *by tacit example*, the atomic debate reflexively asks if engineering problem-solving itself is presenting a grave and dangerous risk. Brovkin and coauthors conclude that the long-term nature of the risks of climate engineering disqualify SRM from serious consideration as a solution to climate change. They fear, instead, that focus on developing short-term remedies will distract necessary research into energy and transportation solutions which can affect the source of the problem itself.

Sulfate climate geoengineering does not yet carry such a powerful framing. Cast as common sense insurance and last-ditch emergency measure in a diverse portfolio of actions to address

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[53] Victor Brovkin, Vladimir Petoukhov, Martin Claussen, Eva Bauer, David Archer, and Carlo Jaeger, 2009. 'Geoengineering climate by stratospheric sulfure injections: Earth system vulnerability to technological failure.' *Climatic Change*, Vol. 92, pp. 243-259.
[54] Brovkin et al, 2009; p. 255.
[55] William Ophuls, 1973. 'Leviathan or Oblivion?' in *Toward a Steady-State Economy*, ed. Herman Daly, WH Freeman Publishing Co., San Francisco.

climate change, it has not commanded the spectacle and terror which the actual use of nuclear weapons in Japan and threat of nuclear warfare throughout the Cold War inspired. Still, it is clear that critics of geoengineering borrow from the nuclear debate as commonly as scientific advocacy attempts to specifically avoid it. In a way, the proclaiming of new global eras consistently obscures this reference. Reinterpreting SRM through this lens problematizes its reality as a 'lesser evil' to be chosen tragically, drawing attention to the wildly uncertain outcomes possible from its initial development and eventual use, considerations which must also include broader concepts of political and ethical feasibility.

My overarching argument here is that many of the lessons of similarly 'new' earlier eras can help contemporary debates to examine both successes and failures, a kind of reflexive learning which will be increasingly necessary as ecological conditions become more variable and degraded, and that this effort to learn the lessons on offer in our own history can help the necessary process of translation of abstract global trends into meaningful cultural terms capable of creating useful debate.[56] As shown above, recent discussions about adaptation, in more or less sanitized language, have already begun to represent the necessary change as a short-term need to adjust to consequences of failure to act sooner. It announces that calls for precaution and prevention are now largely moot—the catastrophic future is already here. What remains to be discussed, in this tragic framing, appears to be only how to stop the worst consequences of such a change, choosing, tragically, the lesser evil of intentional modification.

Measuring the cost of transition against their sense of collective efficacy to act at an effective scale, many could be forgiven for framing the problem as Hardin and fellow survivalists did. Seeing geoengineering as a tragic choice in the sense that Hardin considered global population, however, would be as misleading as the over-general moniker geoengineering. Instead, by

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[56] Susanne C. Moser, 2010. 'Communicating Climate Change: history, challenges, process and future directions.' *WIREs Climate Change,* Vol. 1, January/February.

accessing the history of another debate over technology with global consequences, I will suggest that geoengineering be framed through an ironic perspective which acknowledges that those in the developed world did not know they were causing climate change, but also that they must accept responsibility anyway. On its face this can be ambiguous, but it should, I'll argue in greater detail below, inspire an active humility.

IV. CHRISTIAN REALISM: HUMILITY AND THE IRONIC PAST

Theologian Reinhold Niebuhr, like climate geoengineers, addressed the possibility global disaster—in his case, the possibility of atomic war and the nature of American authority in the Cold War. Niebuhr, who Time Magazine dubbed upon his death in 1971 'the greatest American Protestant theologian since Jonathan Edwards,' may have begun his career as a idealist and pacifist, but his experience of the 1930s and 1940s led him to describe himself as a 'Christian realist,' recognizing a vision of world politics anchored in a religious interpretation of human nature as inherently limited, even as it aims for universality.

In this context, Niebuhr is an important voice embracing seemingly contradictory values: for humility and deterrence, reflection and urgency. These values are never more evident in his work than in *The Irony of American History*, published in 1951, just after the entrance of the Soviet Union into the nuclear arms race. Delivered first as lectures in 1949 and 1951, Niebuhr explains in his introduction that *Irony* deals with 'the position of our nation in the present world situation, as interpreted from the standpoint of the Christian faith.'[57] Niebuhr asserts that the original sin that constitutes human nature is not based on evil intentions, but rather on the limited perspective through which humans perceive the world. This limit for Niebuhr, was based on a kind of rational humility before God, a humility which presents a stark contrast to the technological narratives around climate engineering and throughout modernist responses to climate 'problems.'

[57] Niebuhr, 1951; p. xi.

In *The Irony of American History*, Niebuhr asserts that the deep irony of post-war America was that, as a nation, Americans had long sought isolation from the turmoil of foreign conflicts. The war with the Nazis, dropping atomic bombs on Japan, and subsequent Cold War arms race with the USSR were events to which American moral philosophy was unprepared and yet needed to react to urgently by making hard choices. The choice to hold atomic weapons as deterrence against the spread of communism, for Niebuhr, represented a textbook tragic choice; he asks: 'could there be a clearer tragic dilemma than that which faces our civilization? Though confident of its virtue, it must yet hold atomic bombs ready for use so as to prevent a possible world conflagration.'[58] The problem was that surrendering the bomb while the USSR still held it, Niebuhr believed, was a kind of suicide. The tragic, in his typology, elicits both pity and admiration, and requires conscious responsibility as well as some certainty of the future evil to be avoided.

Sociologist Bronislaw Szerszysnki has suggested a rival framing for environmental crisis, a worldview which sees events, not action or communication, as ironic. Drawing on themes from Kierkegaard, Szerszynski's irony is both cautious, emphasizing reflexive thinking, and radical, calling for meaningful action. He claims:

> A reflexive stance towards one's beliefs and values which does not collapse into manipulative or quietistic cynicism requires a truly ironic world relation—an irony not just towards particular things but towards the world's totality, including oneself and one's irony. And such a stance would necessitate a less moralistic and self-satisfied political style, one which acknowledges that no one can know political truths perfectly or live blamelessly, especially under current circumstances.[59]

His idea that this reflexive stance would somehow be 'less moralistic,' though, seems under-qualified. Szerszynski's concern with what he calls 'post-modern irony' shows how the call for ironic humility, in parallel to the false certainty of Western scientific ontologies, lacks a moral anchor, i.e. a sense of choosing between good and evil to motivate the decision.

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[58] Niebuhr, 1951; p. 1.
[59] sz 352

In the search for such an active humility the sense that conditions are unchangeable is particularly dangerous. In *Irony of American History* Niebuhr suggests that avoiding such the temptation to pure negation and passivity was a chief benefit of his Christian worldview. He understands that:

> Naturally an interpretation of life which emphasizes the dire consequences of vain pretensions and sees them ironically refuted by actual experience must induce those who accept the interpretation to moderate the pretensions which create the irony. Consciousness of an ironic situation tends to dissolve it. It may be dissolved into pure despair or hatred.[60]

It is the avoidance of responsibility, sheltered behind manipulative irony, and the accompanied sense of resignation, which Szerszynski also seeks to avoid. But although Szerszynski insists on the ironic return to responsibility, it is not clear why this should happen, following Kierkegaard, barring a leap of faith. The question is deeper, it goes to the heart of debates over 'reflexivity' and social learning to ask 'reflexivity *towards what?*', to reposition the post-modern negation as a momentary pause rather than a creativity sucking whirlpool.

The question I want to ask is whether the lack of coherent normative frameworks disables effective debate necessary to collectively make such a choice. This is important to consider because the tragic engineering logic of insurance and lesser evils is enabled by the disconnection of global climate debates from markers of cultural meaning like religion. What losing these meaningful terms for debate does is create a gap between information and action which is crucial for climate change politics in the US. If becoming reflexive is the goal, the question is how this change in intellectual stance motivates moral or political action. In the largely secular discourse emerging from both scientific outreach and radical criticism this remains a particularly confusing leap in logic for much of the American public.

Drawing on Kierkegaard but neglecting the role of faith in this worldview is not a fault in Szerszynski's research, but rather a strategic accentuation of the generalized stance he proposes,

[60] Niebuhr, 1951; p. 168.

made to a secular academic audience. This modernist, secular tinge to the geoengineering debate is obvious and not surprising given the occupation of many of its main participants. It also neglects the fact that many of those in the target audience they seek to reach in the US are religious. Most of these debates, instead, are dominated by scientific experts explicitly disavowing moral or political concerns to project objectivity.

The need for humility in the face of a gap in moral and scientific reasoning has been sounded from many corners recently. One example is the work of Sheila Jasanoff in Science and Technology Studies. In 'Technologies of Humility,' Jasanoff asserts:

> There is a growing need, I shall argue, for what we may call the 'technologies of humility.' These are the methods, or better yet institutionalized habits of thought, that try to come to grips with the ragged fringes of human understanding—the unknown, the uncertain, the ambiguous, and the uncontrollable. Acknowledging the limits of prediction and control, technologies of humility confront 'head-on' the normative implications of our lack of perfect foresight. They call for different expert capabilities and different forms of engagement between experts, decision-makers, and the public that were considered needful in the governance structures of high modernity. They require not only the formal mechanisms of participation but also an intellectual environment in which citizens are encouraged to bring their knowledge and skills to bear on the resolution of common problems.[61]

Two things are especially notable here. One is that she separates issues clearly into institutional and cultural problematics. The other is that she recognizes internal limits on human cognition which require a new kind of capacity, and one which crucially must be public.

These technologies of humility are strictly opposed to 'technologies of hubris', or technologies of risk assessment to facilitate management and control claiming objectivity and normative perks of the scientific method.[62] Although these methods appeared to be scientific, Jasanoff wants to expose their limitations—they are blind to uncertainty and the non-quantifiable, which means short-term and concrete risks are foregrounded; scientific productions of risk analysis pre-empt political discussion because requiring expert credentials creates high entry

[61] Sheila Jasanoff, 2003. 'Technologies of Humility: Citizen Participation in Governing Science,' *Minerva*, Vol. 41, pp. 223-244; p. 227.
[62] See Merton, Popper, Dewey

barriers, threatening effective accountability; and methods like risk analysis and precaution are unable to internalize unforeseen challenges.

An ironic frame, in contrast to the popular tragic one increasingly marshaled in global climate response debates, recognizes responsibility for deteriorating trends at the global level and does not stop at the need for more information or education, but rather presents a serious choice with moral consequences as the culmination of this educational process. Critically, unlike the tragic version, an ironic frame does not rely on the perceived inevitability of the crisis for legitimation, but rather draws attention back to the moment of realization and, in Niebuhr's terms, the choice between good and evil.

V. ECOLOGY BEYOND TRAGEDY: THE IRONY OF THE COMMONS

Solar Radiation Management is growing in popularity because its advocates promise a source of active scientific research that escapes the usual inertia of political and economic systems. In this vein, Crutzen emphasizes the speed and urgency SRM would make available, that 'in contrast to the slowly developing effects of greenhouse warming associated with anthropogenic CO2 emissions, the climatic response of the albedo enhancement experiment would start taking effect within about half a year.' He insists that such a tactic was much cheaper than it seemed, noting that 'in comparison, current annual global military expenditures approach US$1000 billion, almost half in the U.S.A.'[63]

Most of those seeking expansion of SRM research and even small-scale trials make a similar argument. Caldeira and coauthors, with an indirectness characteristic of climate scientists, claim that while estimates are strictly provisional given the state of current research, 'it is not clear that either deployment or sustained operations of such systems would cost as much as billions of dollars

[63] Crutzen, 2006; 213.

per year.'[64] Crutzen goes further and makes an added value pitch, citing ability to reduce other aerosols which influence human health beneath the shield of sulfate particles in the troposphere. Pushing several of these responses together, Crutzen writes:

> Climatic engineering, such as presented here, is the only option available to rapidly reduce temperature rises and counteract other climatic effects. Such a modification could also be stopped on short notice, if undesirable and unforeseen side effects become apparent, which would allow the atmosphere to return to its prior state within a few years. There is, therefore, a strong need to estimate negative, as well as positive, side effects of the proposed stratospheric modification schemes. If positive effects are greater than the negative effects, serious consideration should be given to the albedo modification scheme.[65]

He makes several assumptions here which are not supported even by many of his scientific colleagues pursuing geoengineering research. He assumes that the atmosphere would return to 'its prior state' within a few years, when this 'prior state,' in the absence of carbon emissions reduction, would no longer exist. Essentially, he ignores the termination effect produced by rapid return to warming. He also assumes that interventions could be short-term and stopped quickly if negative effects were observed, ignoring political incentives for lock-in.

A textbook example of an engineering response giving policy instructions, Crutzen obliquely asserts a utilitarian calculus of positive and negative effects without any consideration of who would make the assessment or what kinds of costs would be counted. What this illustrates is that, lacking direct reference to the nuclear debate as a possible proxy for understanding problems of controlling novel technology with catastrophic potential, modern debates pushing geoengineering as a form of insurance or prudence lack the conceptual resources to address the debate over controlling the weather as more than a question of technical feasibility.

A reconsideration of the nuclear debate could act as a profound and morally ambiguous challenge to the framing of such debates in tragic terms, and be a powerful analytic resource for critiquing the growing power of survivalist anti-politics of technical administration common to

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[64] Ken Caldeira and Lowell Wood, 2008. 'Global and Arctic climate engineering: numerical model studies.' *Philosophical Transactions of the Royal Society A*. Vol. 366, pp. 4039-4056; p. 4052.
[65] Crutzen 2006.

modern debates. The question it raises is not about rejecting technology or accepting it fully in all forms, but rather about how we will actively deal with creating, managing, and distributing such technologies whose employment represents a compromise for the sake of the emergency. It is about understanding the choice of using such technology, of the uncertainty and potential disruption of controlling the weather in ethical and political terms as well as technical.

Niebuhr suggests that 'a religious sense of an ultimate judgment upon our individual and collective actions should create an awareness of our own pretensions of wisdom, virtue or power which have helped to fashion the ironic incongruity,' and that with this realization, 'the irony would tend to dissolve into the experience of contrition and to an abatement of the pretensions which caused the irony.'[66] Szerszynski proposed a similar argument advocating irony in ecological politics. Sorting through a menu of different definitions of irony, he insists that 'it is only by adopting a stance of generalized, philosophical irony, one which recognizes the impossibility of the subject escaping the contradictions of finite existence, that an authentic response to our predicament might be found.'[67]

This 'generalized' ironic frame, however, need not be secular, especially since he draws directly on Danish philosopher and theologian Soren Kierkegaard. The Kierkegaardian form of irony was also deeply influential for theologian Niebuhr. Niebuhr's call for humility was not based on ecocentric morals, but rather from a religious belief that:

> The God before whom 'the nations are as a drop in the bucket and are counted as small dust in the balances' is known by faith and not by reason. The realm of mystery and meaning which encloses and finally makes sense out of the baffling configurations of history is not identical with any scheme of rational intelligibility. The faith which appropriates the meaning in the mystery inevitably involves an experience of repentance for the false meanings which the pride of nations and cultures introduces into the pattern. Such repentance is the true source of charity' and we are more desperately in need of genuine charity than of more technocratic skills.[68]

[66] Niebuhr 1951; p. 169.
[67] Szerszynski, 2007; p. 340.
[68] Niebuhr, 1951; p. 149.

Niebuhr's God, like Kierkegaard and others in the Protestant tradition, is beyond rational. The original sin of man was to be partial, to be one perspective in the greater flux of the whole. This knowledge of man's fragile place, the acknowledgment of the limits to rational human enterprise, for Niebuhr required repentance and charity, driving a Christian-inflected socialist politics.

For Szerszynski and Niebuhr both, the goal of acknowledging ironic circumstances or events is not to remain unendingly in an ironic stance of negation, but rather the realization causes cessation of that irony, the end of the unintended responsibility and the choice of whether to continue after acknowledgment and risk judgment in moral terms of good and evil. Niebuhr's irony places religious judgment at the end of such moral decision-making. His strategy is not to live ironically but rather to cultivate the self-reflection and humility necessary to place limits on the risks and unintended consequences which tragic narratives tend to ignore. Unlike Szerszynski's account, then, I want to assert with Niebuhr that it is the potential for this dissolution of the irony which makes the ironic frame so powerful, and to move further than diagnosing philosophical irony to emphasis on the decision at the moment of realization, the moment where irony dissolves into despair or action, anger or contrition, denial or abatement.

Thus, Christian values can be important for interpreting the debate over global change and climate intervention through the historical experience of the United States. In fact, Christian-influenced concepts like stewardship, prudence, and humility have long been associated with the environmental movement. These values are important to consider, especially when the scale of analysis is much greater than the individual or regional levels at which most people act, especially in their emphasis on responsibility and collective change.

The atomic bomb, for Niebuhr, was not a story of technological progress, but rather a sad reality which accentuated the difference between the isolationist nostalgia of American myths and superpower status which World War II and the atomic bomb had inaugurated in the US. Attacking what he saw as the naïveté of idealists seeking a unilateral ban on nuclear weapons, Niebuhr's

vision of the inevitability of human error and sin led him to adopt a much more pragmatic stance. For Niebuhr, the reality of nuclear weapons was something which could not be changed, it was forever out of the bottle. The US, despite its old code of non-intervention, could oppose the USSR and stop its spread, which represented a threat to religion as well as world order. It is the quintessential tragic decision by his own definition.

To understand the atomic situation, though, as purely tragic makes little sense to Niebuhr, and is dangerous given the precarious state of mutually assured destruction. He sees the ambivalence of technology and its tragic potential, but insists that the Christian view point precludes this tragic framing. He says:

> A purely tragic view of life is not finally viable. It is, at any rate, not the Christian view. According to that view destructiveness is not an inevitable consequence of human creativity. It is not invariably necessary to do evil in order that we may do good.[69]

The questions this begs are clearly political: 1) 'How can we act urgently enough to stop the crisis but also slow enough to make sure we don't make things worse?'; 2) 'Who will the winners and losers of such action be?'; and 3) 'Who will get to decide when the emergency has arrived?'

The narrow, technical discussion of governance of technology is the target of many, such as Harvard professor and Science and Technology Studies scholar, Sheila Jasanoff. In a paper from 2003 she diagnoses the problematic removal of normative terms from public debate over climate change, noting that: 'participation in the absence of normative discussion can lead to intractable conflicts.'[70] Jasanoff insists that humility requires slowing the action to include the participation of a wider public than currently engaged in scientifically-framed climate change debates. Noting a lack of deep analysis or reflection, she insists that outreach must learn to avoid polarization and post-modern ennui and move to deliberation 'on the substance of decision-making.'

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[69] Niebuhr, 1951; p. 157.
[70] Jasanoff 243

Addressing geoengineering as a whole, and responding in particular to the controversial plans to test aerosol cooling in Britain,[71] the Oxford Principles represent the most accepted set of informal scientific norms and consider with some seriousness the need for governance identified by Jasanoff. At the same time, however, they are purposefully vague in a way that likely can be argued to support or condemn sulfate SRM based on the concerns the author values most and the relative senses of urgency and inevitability surrounding the arrival of emergency conditions. The Oxford Principles call for flexibility, intentionally ambiguous as to normative substance or specific local consequences of particular geoengineering schemes, but their relative focus on governance and public debate *during the research phase,* including both voluntary scientific norms and multi-level political institutions, is potentially more radical than many proponents would prefer.

For instance, international law professor and former IPCC author David Victor agrees with the need for open publication of research and the need for governance before the transition from research to deployment to assure accountability. The fear of Victor and others, however, is calling for expanded public debate will result in more failures like the SPICE program, that, essentially, more research is necessary before the case can coherently be made to the public.[72] The problem is that attaining the kind of certainty sought, by their own admission, will require small-scale tests,[73] introducing a Catch 22, what David Collingridge coined in 1980 as the 'technology-control problem,' where attempts to regulate technology in advance to protect safety are inherently inadequate because they cannot predict the full consequences of its eventual implementation.[74]

Ultimately, the great evil of runaway climate change has already begun to validate the pursuit of technological means which would once have been considered pure hubris, powerfully

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[71] The so-called 'SPICE' program was eventually canceled.
[72] SPICE is an acronym for the 'Stratospheric Particle Injection for Climate Engineering,' a set of SRM field trials proposed and later canceled by the UK Research Council. For a discussion see: Nick Pidgeon, Karen Parkhill, Adam Corner, and Naomi Vaughan, 2013. 'Deliberating stratospheric aerosols for climate geoengineering and the SPICE project.' *Nature Climate Change*, Vol. 3, May, pp. 451-458.
[73] Douglas MacMynowski , Keith Davis, Ken Caldeira. and HoJeong Shin, 2011. 'Can we Test Geoengineering?' *Energy & Environmental Science*. Vol. 4, pp. 5044–5052.
[74] David Collingridge, 1980. *The Social Control of Technology*. Frances Pinter, London.

represented by the efforts to develop SRM and the possibility of managing the global climate. Crutzen's infamous paper is representative of this change in pace and scale. In this controversial paper he goes as far as speculating about creating a 'minor' nuclear winter effect with soot to decrease temperatures, alongside mention of mirrors and sulfur injections, for which he cites both Teller[75] and Keith.[76]

There is some irony to found here: novel social-ecological crises drove Crutzen to seek an emergency fix so urgently that he considers a cognate for nuclear winter, despite his sustained work on the tragic prospects of 'darkness at noon' following a nuclear war.[77] Ironically, he eventually advocates for SRM research, despite its effect on the atmospheric ozone levels for which he earned his Nobel Prize studying.[78] As Jasanoff warned and influential commentators like Dipesh Chakrabarty have noted, global catastrophe scenarios have dangerously disconnected contemporary debates from historical comparison.

VI. CONCLUSION

The sum of these arguments is more qualified that it may first appear. Treatments of nuclear debates provokes adds ambiguity and nuance to discussions of technology, and in this case Niebuhr is an exemplar. Frustrated with what he saw as idealist naivete, Niebuhr attempted to treat the world as it had revealed itself in the early 20th century—as potentially catastrophic and bent by human ambition to universal power. Doing so, however, Niebuhr did not return to survivalist, Hobbesian power politics, but rather adapted his Christian moral vocabulary to the challenges of living in times of novel technological destruction. Seeing the greater evil revealed by

[75] E. Teller, L. Wood, R. Hyde, 1997. *Global Warming and Ice Ages: I. Prospects for Physics Based Modulation of Global Change*. Lawrence Livermore National Laboratory, Livermore.
[76] Crutzen, 2006; p. 214
[77] Paul J. Crutzen, 1984. 'Darkness after a Nuclear War.' *Ambio*, Vol. 13, No. 1, pp. 52-54.
[78] Paul J. Crutzen, 1996. 'My life with O3, NOx, and other YZOx compounds (Nobel lecture)." *Angewandte Chemie International Edition in English* Vol. 35, No. 16, pp. 1758-1777.

totalitarianism and the possibility of nuclear war, Niebuhr chose what he saw as the lesser evil: the maintenance of an atomic arsenal to check Soviet totalitarian atheism.

The 'evil' of geoengineering is not yet revealed, however. Atomic weapons were used and hydrogen bombs tested, missiles were eventually developed that could spread catastrophe to planetary proportions. Geoengineering remains 'in the box' so to speak, untested and uncertain. Prudence before inevitable crisis demands that techniques be investigated and the potential for unilateral use demands that some kind of governance be constructed. Its field testing and eventual entrance into public debate as a real mitigation measure remain highly problematic.. It seems impossible to prevent the research and stifling to assert a preemptive moratorium on computer modeling.

This paper has attempted to move contemporary discussions over geoengineering into a vocabulary capable of translating global catastrophe narratives into meaningful political debate in the US. I have attempted to show how the concept of global tragedy is not new, and that while the historical tropes from past debates are at times a challenge, they also represent a great source of lessons. I argued here that Reinhold Niebuhr represents a key figure in evaluating such lessons. If we today are 'too confident' and 'too blind,' his assertion of the 'ironic tendency of virtues to turn into vices' could equally describe the critique of unreflective climate engineering schemes. Niebuhr saw that:

> If we should perish, the ruthlessness of the foe would be only the secondary cause of the disaster. The primary cause would be that the strength of a giant nation was directed by eyes too blind to see all the hazards of the struggle; and the blindness would be induced not by some accident of nature or history but by hatred and vainglory.[79]

It is this humility, I think, which Jasanoff sought, here in its 'Christian realist' form. Understanding the ironic effects of tragic attitudes, Niebuhr identified a tension between humility and prudence—

[79] Niebuhr, 1951; p. 174.

between reflection and action—which is obscured by a truly tragic framing of the crisis. That this framing has become common again points to the usefulness of his example.

Niebuhr argues that Americans must make a choice to risk total annihilation for the sake of stopping evil, in the form of a confident totalitarian atheism, from spreading throughout the world. This choice is central—Niebuhr wonders if it can be asked in a way that acknowledges the responsibility to act and also the uncertainty of the future. He insists that there are certain limits within which human nature operates and that 'whenever judgment defines the limits of human striving it creates the possibility of a humble acceptance of those limits. Within that humility mercy and peace find a lodging place.'[80] Much of the humility traditionally cultivated in the environmental movement and green academic literatures, things like Leopold's 'Land Ethic,' Muir's 'wilderness,' and the philosophical rejection of human centered perspectives and ontologies, has clearly been lost from the debates over climate engineering. Survivalists like Hardin in the 1970s cultivated a form of this humility, the insistence on limits, but it was one conditioned by accepting tragedy, by realizing there was no good option and picking the lesser evil, making a tragic choice to preserve something in whatever reduced form rather than face the prospect of extinction.

From this perspective, although *prudent* in the face of the challenges presented by rapidly accelerating global ecological degradation, our contemporary survivalists often lack the humility expressed in earlier generations of technological debate. Integrating research programs like the turn from mitigation to adaptation or the popular Anthropocene discourse may represent a kind of historic awakening, but theorists accepting their integrating umbrella need to emphasize the necessity of choice following the ironic realization. Accepting such irony, for Niebuhr, was a call to make hard decisions and a sign of maturity.[81]

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[80] Niebuhr, 1951; p. 64.

[81] Here it is clear why Ulrich Beck, pitching his concept of collective irresponsibility, implores climate theorists to return to Weber. Ulrich Beck, 2010. 'Climate for Change, or How to Create a Green Modernity.' *Theory, Culture and Society*, Vol. 27(2-3); pp. 254-266.

Instead of understanding history as coming to a tragic end, Niebuhr wants to refocus on responsibility, an emphasis which requires free will and the potential for meaningful action. The difference he identifies between tragic and ironic in reference to the atomic stalemate emphasized here is instructive for thinking critically about climate engineering. Ironic framings do not eliminate tragic choices, but rather contextualize the development of the crisis necessitating the choice—they encourage reflexivity given the crisis itself may have roots in the preferred techniques and epistemologies now arrayed to confront it in the name of survival. The consequences of such a change in perspective may appear minor, but it signals a great shift. Perceiving the history of emissions as ironic emphasizes that rich industrial nations were unaware of the damage, but at the same time *still responsible*.

Once the realization is had, the resulting decisions can no longer be ironic—for Niebuhr decisions return to good and evil, and, potentially, tragic. This is important because, just as after the detonation of the first atomic bombs, Americans are again awakening to global responsibility, and challenged by enduring conflicts over the content and distribution of 'modern' life. Making SRM a part of a disaster preparedness toolkit arguably increases the response capacity of national governments, but put in the context of fractious social and political times, such a need for continuity to prevent catastrophic snap-back may be a serious problem.[82] Given these potential issues, sulfate SRM seems to make sense only as a response to the tragic framing of climate, as a form of preparedness for an uncertain future where meaningful political action cannot be guaranteed.

The tragic framing is thus about more than prisoner's dilemmas and abstract models of cooperation. It is a fundamental anchor for the introduction of plans which would appear unfavorable or even unethical in the name of avoiding the greater evil to come. Things like Hardin's tragic choices to give up the right to breed, harden borders, and end foreign aid are justified in this

[82] See: Victor Brovkin, Vladimir Petoukhov, Martin Claussen, Eva Bauer, David Archer, and Carlo Jaeger, 2009. 'Geoengineering climate by stratospheric sulfure injections: Earth system vulnerability to technological failure.' *Climatic Change*, Vol. 92, pp. 243-259.

framework of assumptions by the perceived certainty of the arrival of a greater evil. In the case of the population crash predicted by Hardin and the survivalists (to be overly charitable) this has not yet come the better part of fifty years later. The choices it justified as extra-ethical now appear in their original ethical complexity, stripped of their protective emergency.

The tragic frame radicalizes the uncertainties of ecosystem change, playing with the temporal scale of the catastrophic crisis predicted. Even arguments that begin in measured scientific tone often end in a more plaintive and urgent plea. The question, on these terms, is predicated on a utilitarian calculus which is both stacked on the cost side by inevitable environmental catastrophe, and also vastly underqualified for weighing cultural or moral concerns. For instance, how would one quantify the 'cost' of changing the color of the sky? How can one compare potential local tragedies against each other when weighing intervention? And, crucially, who will get to count in these calculations? What justice will be possible for those in the world majority who will have no access to such techniques yet share the globally-distributed consequences, good and bad?

The most qualified and sophisticated advocates for Solar Radiation Management shy from exactly this public engagement, fearing lack of understanding and unwarranted fears will prevent emergency measures that can save lives. Knowing that initial injections would be affordable for many national governments, the time for critical reflection, social learning, and public decision-making demanded by the 'technologies of humility' is strikingly absent from even the moderate public stances taken by advocates. The assertion of the climate change problematic should inspire a similar humility for modern policy, and, if indirectly, emphasizes approaches that can learn and actively disseminate information, that can flexibly adapt to the unexpected and maintain stability while actively pursuing necessary transformations revealed through critical public reflection and debate.