



The Last Chance to Save the Planet? An Analysis of the Geoengineering Advocacy Discourse in the Public Debate

Jonas Anshelm and Anders Hansson

Unit of Technology and Social Change, Department of Thematic Studies, Linköping University, Sweden

ABSTRACT Geoengineering, i.e., the deliberate manipulation of the global climate using grand-scale technologies, poses new challenges in terms of environmental risks and human–nature relationships. Until recently, these technologies were considered science fiction, but they are now being reconsidered by researchers, leading to an emerging public debate. Our aim is to improve our understanding of the public discourse on geoengineering in mass media. We analyze 1500 articles published from 2005 to 2013, constructing four coherent storylines that represent most of the geoengineering advocacy in the public discourse in mass media. We scrutinize inconsistencies in this discourse and argue that geoengineering may be the first example of a grand-scale technology that in some important respects has clear postmodern tendencies: geoengineering advocacy, for example, is not based on objective truth claims of the natural sciences and does not promise a better world.

Introduction

Geoengineering, i.e., the deliberate manipulation of the global climate using grand-scale technologies, includes a wide range of proposed methods that vary greatly in their technical aspects, temporal and spatial scales, and potential environmental impacts. The two major categories of methods are solar radiation management (SRM) and carbon dioxide (CO₂) removal (CDR). SRM measures reflect sunlight and thus reduce global warming without addressing the concentration of CO₂ in the atmosphere; they consists of options such as injecting aerosols into the stratosphere, orbiting space mirrors, creating artificial clouds from seawater, or painting roofs white. In contrast, CDR addresses the amount of CO₂ already in the atmosphere, for example, using air capture technologies or sequestration of CO₂ to the deep ocean by the fertilization of high nutrient.¹

Since the publication of Nobel laureate Paul Crutzen’s seminal and polemic paper on geoengineering in *Climatic Change* in 2006, these options have gained increased attention,

¹ John Shepherd, Ken Caldeira, Joanna Haigh, David Keith, Brian Launder, Georgina Mace, Gordon MacKerron, John Pyle, Steve Rayner and Catherine Redgwell, *Geoengineering the Climate – Science, Governance and Uncertainty* (London: The Royal Society, 2009).

primarily in the research community but also among politicians. What was previously generally considered merely science fiction is now being reconsidered and assessed by prominent researchers, leading to an emerging debate.² The Intergovernmental Panel on Climate Change is also assessing geoengineering in its upcoming assessment report; its examination of this formerly rejected option raises geoengineering's profile in the broader public debate on climate change. Geoengineering is not only a set of novel methods for managing climate change; it also poses new challenges concerning global governance, human–nature relationships, ethics, risk assessments, and public deliberation. Geoengineering has the theoretical potential to enable humanity to alter global climate according to its needs and desires, though at the cost of enormous environmental risk, political conflict, and potentially irreversible unintended consequences. Consequently, geoengineering evokes both hopes and fears as for example a technological fix that saves humanity from climate catastrophe or an overly complex technology that interferes with sensitive and unpredictable Nature.

In this paper, we aim to improve our understanding of the public discourse on geoengineering in mass media. We focus on how various storylines and metaphors are interrelated in mass media, constituting a general discourse favouring more research into and testing or deployment of geoengineering. Unlike previous research, which has concentrated on mapping, identifying, and quantifying various aspects of this discourse,³ we use textual analysis to explain the rationales of specific storylines and the roles they play in the discourse, discerning and interpreting the key aspects and overall pattern of the public debate on geoengineering. In line with Nigel Clark, we claim that the geoengineering debate has the potential to foster critical and progressive debate that goes beyond present discussions of the pros and cons of various geoengineering options. A point of departure in the environmental humanities that Rose *et al.* emphasize is the need to go beyond reductive accounts of rational decision making and instead to study the making of meaning and values in historical and

² Preston Christopher, "Re-thinking the Unthinkable: Environmental Ethics and the Presumptive Argument against Geoengineering," *Environmental Values* 20, (2013): 457–479.

³ Holly Jean Buck, "Climate Engineering: Spectacle, Tragedy or Solution? A Content Analysis of News Media Framing," in *(De-)Constructing the Greenhouse: Interpretative Approaches to Global Climate Governance*, ed. Chris Methmann, Delf Rothe and Benjamin Stephan (Abingdon: Routledge, 2013), 166–181; Matti Loukkanen, Suvi Huttunen and Mikael Hildén,, "Geoengineering, Newsmedia and Metaphors: Framing the Controversial," *Public Understanding of Science* 36, (2014): 3–29; Birgitte Nehrlich and Rusi Jaspal, "Metaphors we Die by? Geoengineering, Metaphors and the Argument from Catastrophe," *Metaphor and Symbol* 27, (2012): 131–147; Kate Porter and Mike Hulme, "The Emergence of the Geoengineering Debate in the UK Print Media: A Frame Analysis," *The Geographical Journal* 179, (2013): 342–355; Samantha Scholte, Eleftheria Vasileiadou and Arthur Petersen, "Opening up the Societal Debate on Climate Engineering: How Newspaper Frames are Changing," *Journal of Integrative Environmental Sciences* 10, (2013): 1–16; Tina Sikka, "A Critical Discourse Analysis of Geoengineering Advocacy," *Critical Discourse Studies* 9, (2012) :163–175; Stephanie Uther, *Diskurse des Climate Engineering: Argumente, Akteure, Koalitionen in Deutschland und Großbritannien* (Wiesbaden: Springer VS, 2014).

cultural contexts.⁴ Clark argues that geoengineering is currently the most obvious example of humanity's trespassing on the thresholds of global earth systems—it is both a trigger and (ultimate) response to the Anthropocene. This awareness may radically reconfigure our view of the Earth and consequently our political agendas as the old imaginaries of geological politics are unlikely to lead the way in solving the new planetary quandaries.⁵ Hopefully, an understanding of the present geoengineering discourse can provide valuable insights into the soon-to-be-global geopolitics, or at least indicate what needs to be pinpointed in order to endorse a sound and reflexive debate, whether this means “joining the natural scientists in confronting the full range of geological forces” in line with Clark’s argumentation,⁶ opening up the public debate as Scholte *et al.* suggest,⁷ or supporting deliberation on democratic governance as Macnaghten and Szerszynski emphasize.⁸ This paper is based on the most extensive empirical mass media material so far amassed on this discourse. Roughly 1500 newspaper articles from all over the world, published between 2005 and 2013 in English, German, Swedish, Danish, and Norwegian, have been analyzed to identify coherent storylines that constitute most of the public discourse advocating geoengineering.⁹

Several studies have examined geoengineering discourses, framings, and storylines in public debate and/or the scientific community. Unlike the present study, most of these apply content analysis methods to map the geoengineering discourse, quantify the number of positive and negative articles, and consider how various frames correspond to negative or positive statements and whether or not the debate is opening up. Furthermore, previous research has primarily been based on English-language material, and in some cases only on articles in major, influential newspapers in the UK or USA, and generally examines samples of only 50–350 articles. Buck clarifies that it is important to study specific portrayals of environmental issues, because these may change the course of national and international policies, governance, and public opinion. That point of departure is shared by the present paper, and by those of

⁴ Deborah Bird Rose, Thom van Dooren, Matthew Chrulew, Stuart Cooke, Matthew Kearnes and Emily O’Gorman, “Thinking Through the Environment, Unsettling the Humanities,” *Environmental Humanities* 1, (2012): 1-5; see also David Nye, Linda Rugg, James Fleming and Robert Emmett, *The Emergence of the Environmental Humanities*, Background Paper: The Swedish Foundation for Strategic Environmental Research (MISTRA).

⁵ Nigel Clark, “Rock, Life, Fire: Speculative Geophysics and the Anthropocene,” *The Oxford Literary Review* 34, (2012): 259-276; Nigel Clark, “Geoengineering and Geological Politics,” *Environmental Planning A* 45, (2013): 2825-2832; Sverker Sörlin, “Environmental Humanities: Why Should Biologists Interested in the Environment Take the Humanities Seriously?” *BioScience* 62, (2012).

⁶ Nigel Clark, “Rock, Life, Fire,” 260.

⁷ Samantha Scholte, Eleftheria Vasileiadou and Arthur Petersen, “Opening up the Societal Debate on Climate Engineering.”

⁸ Phil Macnaghten and Bronislaw Szerszynski, “Living the Global Social Experiment: An Analysis of Public Discourse on Solar Radiation Management and its Implications for Governance,” *Global Environmental Change* 23, (2013): 465-474.

⁹ In another paper also based on these 1500 newspaper articles, we have analyzed the discourse critical of geoengineering and discussed the differences between the two discourses (Jonas Anshelm, and Anders Hansson, “Batting Promethean Dreams and Trojan Horses: Revealing the Critical Discourses of Geo-engineering,” *Energy Research and Social Science* 3, (2014): 135-144.

Loukannen *et al.*, Nehrllich and Jaspal, Porter and Hulme, Scholte *et al.*, and Sikka.¹⁰ Unlike Buck, we do not analyze how the frames enable or hinder specific forms of climate governance, though we agree that the news media can substantially influence these frames.

Methodology

Discourse and storyline

Geoengineering is a narrative that is constantly framed and reframed, and according to Rayner, there are no strong scientific claims to hide behind in articulating the values in the public geoengineering debate. Currently, most actors seem to acknowledge that very little is known and that the conflicts in the public debate over geoengineering do not primarily concern facts; rather, the split between advocates and critics seems to be a matter of contrasting worldviews and understandings of the human–nature relationship.¹¹ If large-scale geoengineering research is initiated, the debate over the science could displace the debate over these values, which we argue are much more important to scrutinize and discuss. Rayner claims we have only a brief moment of clarity before major research efforts start.¹² As discussed above, at least seven studies have analyzed the public debate on geoengineering in the news media by applying the concepts of metaphors, storylines, frames, and discourses, either alone or in combination. However, none of these studies has applied a more interpretative approach, instead primarily quantifying, categorizing, and surveying the debate.

In line with Stirling, we argue that discourse analysis is a productive method for deepening our understanding of how objects and concepts mutually create meaning, values, and narratives.¹³ As explained by Rayner, geoengineering research is not merely a technical debate about the safety or efficacy of the proposed technology but is, at heart, a debate over the kind of society we want to live in and how we imagine humanity and our place in the world.¹⁴

We will use *discourse* to denote statements directed towards a particular object or part of the world and that are situated within a specific field of knowledge. Discourses are

¹⁰ Jean Holly Buck, “Climate Engineering: Spectacle, Tragedy or Solution?; Mattis Loukkanen *et al.*, “Geoengineering, Newsmedia and Metaphors”; Birgitte Nehrllich and Rusi Jaspal, “Metaphors we Die by?; Kate Porter and Mike Hulme, “The Emergence of the Geoengineering Debate in the UK Print Media”; Samantha Scholte *et al.*, “Opening up the Societal Debate on Climate Engineering”; Tina Sikka, “A Critical Discourse Analysis of Geoengineering Advocacy”; Stephanie Uther, *Diskurse des Climate Engineering*.

¹¹ Jonas and Anders Hansson, “Battling Promethean Dreams”; Clive Hamilton, *Earthmasters: The Dawn of the Age of Climate Engineering* (New Haven & London: Yale University Press, 2013); Steve Rayner, *To Know or Not to Know? A Note on Ignorance as a Rhetorical Resource in Geoengineering Debates* (Oxford: Climate Geoengineering Governance Working Paper Series: 010, 2014).

¹² Steve Rayner, *To Know or Not to Know?*

¹³ Andrew Stirling, “Transforming Power: Social Science and the Politics of Energy Choices,” *Energy Research & Social Science* 1, (2014): 83-95; see also: Jonas Anshelm and Anders Hansson, “Battling Promethean Dreams.

¹⁴ Cf. Mike Hulme, *Can Science Fix Climate Change?* (Cambridge: Polity Press, 2014); Steve Rayner, *To Know or Not to Know?*

expressed in specific ways to speak about and represent the world.¹⁵ The actors within a specific discourse use a particular kind of language that rests on common definitions, judgments, assumptions, and contentions when addressing a topic.¹⁶ In this paper, we will analyze only discourses represented in texts that form part of the public debate. Our intention is to use the concept analytically to structure and order the extensive body of texts to be examined. This means that we do not understand discourses as inherent to and waiting to be discovered in the text material. Instead, discourses are constructed in the research process to make it possible to speak of patterns in a heterogeneous and complex reality.

One point of departure is the storyline approach, which is suitable when studying narratives in a milieu characterized by uncertainty and change,¹⁷ such as the geoengineering debate. Storylines are narratives that allow actors to draw on various and sometimes very distinct aspects of the discourse of which they are part and to confer meaning on a specific phenomenon. The storyline is therefore, in relation to discourse, a mid-range concept focusing on the intra-discursive characteristics of the examined issue. Furthermore, storylines are simplified explanations in that they do not contain all the uncertainties and diversity of the enveloping discourse. However, in addition to constructing the problem, storylines also play a key role in creating the social and moral order in a given terrain.¹⁸

The storyline concept commonly works in tandem with the concept of discourse coalition;¹⁹ however, we intend neither to map the actors nor scrutinize the practices in which the discursive activities take place.²⁰ Our aim is not to identify specific actors or to pinpoint the discourses to which they belong.²¹ Lovell *et al.* claim that it is sometimes not even possible to identify distinct groups of actors within discourse coalitions.²² In this case, we assume no strong link between storylines and discourse coalitions. In the geoengineering discourse, a specific actor may make statements that rest on several storylines, and that shift with time. Furthermore, we argue that geoengineering's novelty, the lack of formal political processes for its development, and the limited number of relevant field experiments raise problems for

¹⁵ Norman Fairclough, *Analysing Discourse Textual Analysis for Social Research* (London: Routledge, 2003).

¹⁶ Ove Hansen Heitmann, Olaf Langhelle and Robert Anderson, "Framework and Methodology: Regulation and Discourse Analysis as a Research Strategy," in *Arctic Oil and Gas: Sustainability at Risk*, ed. Aslaug Mikkelsen and Oluf Langhelle (New York: Routledge, 2008), 87-108.

¹⁷ Heather Lovell, Harriet Bulkeley and Susan Owens, "Converging Agendas: Energy and Climate Change in the UK," *Environment and Planning C: Government and Policy* 27, (2008): 90-109.

¹⁸ Maarten Hajer, *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process* (Oxford: Clarendon, 1995) Hansen Ove Heitmann *et al.*, "Framework and Methodology: Regulation and Discourse Analysis as a Research Strategy."

¹⁹ Maarten Hajer, *The Politics of Environmental Discourse*; Hansen Ove Heitmann *et al.*, "Framework and Methodology."

²⁰ See Heather Lovell *et al.*, "Converging Agendas."

²¹ Hamilton (2013) divides the geoengineering actors into two categories, the Prometheans (supporting geoengineering) and Soterians (sceptical or opposed to geoengineering), based on differences in worldviews. The Prometheans have a technocratic rationalist worldview and believe in humanity's ability to control nature, while the Soterians consider mastery over nature as both hubris and unnatural. In contrast to our study, Hamilton specifies the group to which specific actors belong.

²² Heather Lovell *et al.*, "Converging Agendas."

identifying or constructing discourse coalitions. We also claim, as will be illustrated in the analysis, that actors' statements are often contradictory in important respects. It is not easy to find "pure" advocates, and storylines promoting geoengineering may also include the severest critiques of its deployment. Though in our analysis we occasionally select specific actors to exemplify a specific discourse or storyline, we claim that they do not necessarily agree on the range of views expressed in that discourse. We also want to clarify that by "advocate" we primarily mean that the person supports more geoengineering research, though that does not exclude the possibility that the person also advocates the deployment of geoengineering. However, the vast majority of the advocates do primarily support research and not implementation, at least according to what is explicitly expressed in the public debate.

Material and Method

The concept geoengineering has been criticized for being too inclusive which confuses our understanding of the geoengineering discourse.²³ The various options are heterogeneous in important respects, which sometimes may have consequences for our analysis. However, for the purpose of this paper we argue that it is fruitful to analyze geoengineering on an aggregated level, as primarily a grand global project and an idea of humanity's ultimate control over our planet. Also, in the analyzed newspapers geoengineering is mostly discussed on an aggregated level, leaving specific options out. However, when specific options are discussed, sulphur aerosol injection (SAI) is paid most attention, and when the technical distinctions are important for our analysis we inform the reader.

To collect our empirical material, we used the Retriever database²⁴ and the search strings "climate engineering" and "geoengineering AND climate" between January 2005 and March 2013. Retriever provides access to several thousand sources globally. We limited the search to the English, German, Swedish, Norwegian, and Danish languages simply because these are the only languages in which we are fluent; however, we covered a large number of countries by including these languages. More than 75% of the retrieved articles were in English and published in either the USA or the UK.

The texts were chronologically ordered and read several times to select the most relevant passages with regard to the geoengineering discourse. Specific texts and passages were selected and read closely with the intention of identifying central meaning clusters and storylines. The texts were then coded and categorized, though the analytical process entailed ongoing recoding and recategorization.²⁵ In this way, the examined texts were finally clustered

²³ Olivier Boucher *et al.*, "Rethinking Climate Engineering Categorization in the Context of Climate Change Mitigation and Adaptation," *WIREs Climate Change* 5, 2014: 23-35; Björn-Ola Linnér and Victoria Wibeck, "Climate Engineering as Emerging Technologies: A Review of the Literature," Forthcoming in *WIREs Climate Change*.

²⁴ The database consists of more than 12 000 newspapers, magazines, business press from all over the world and includes in total 270 million articles. Printed articles are available in the PDF-format and also include the original graphics and pictures.

²⁵ cf. Amanda Coffey and Paul Atkinson, *Making Sense of Qualitative Data – Complementary Research Strategies* (Thousands Oaks: SAGE Publications, 1996).

and a coherent discourse emerged that gave meaning to a specific aspect of the world. Our reference list contains 103 articles that we believe best support our interpretations.

The Analysis

The storylines analyzed here constitute the backbone of the public geoengineering discourse. Together they constitute a group of central, well-disseminated, and influential clusters of meaning that, intentionally or not, make a strong case for geoengineering research. The first storyline, of the scientists' "double fear," presents the problem, i.e., the apocalyptic situation and dilemma that humanity must confront. The second storyline conveys the view that no solution can be expected from international political negotiations, while the third storyline conveys the notion that pure technology is the only possible solution and that it is an adequate substitute for politics. Finally, the fourth storyline describes this solution in the form of grand-scale technological enterprises, as something that nature has tried out for eons, and accordingly as something that works in line with natural processes and will therefore ensure our survival. These four storylines all point in the same direction, favouring the testing or deployment of geoengineering.

The scientists' double fear

The point of departure for the storyline of the scientists' double fear is the claim that climate researchers, who until very recently had rejected geoengineering as "bizarre" or "foolish," considering the various alternatives "taboo," "anathema," or a "distraction" from dealing with climate mitigation, now have re-evaluated the situation and that most of them have started to advocate immediate research into various geoengineering options.²⁶

This shift is claimed to exist because the severity of climate change now justifies the assessment and investigation of all means that might be able to counteract it. Climate scientists have become desperate and reached their "social tipping point."²⁷ Climate change is depicted as catastrophic in this storyline: the end of the world as we know it is approaching, and scientists are shocked by new scientific findings and observations. The alternatives, as they are presented, are either to inactively wait for the catastrophe or to explore the final option: geoengineering.²⁸

To further emphasize the gravity of the situation, the time constraints, and the pressing need for geoengineering, it is claimed that it might already be too late. The catastrophe is upon us and its negative effects are accumulating in the Earth's ecosystems. Even though it is too late to prevent all the negative effects, because of the delayed impact of already released greenhouse gases, geoengineering offers the possibility of removing CO₂ from the atmosphere and helping create a new balance.²⁹

Fear of the consequences of climate change is therefore an asset in the geoengineering discourse. The more alarmingly global warming is presented, the greater the need for geoengineering and, consequently, the less noteworthy criticism of it becomes. The fear that the geoengineers, popular science journalists, and editors writing and talking in this discourse

²⁶ See Appendix A for the empirical references: 10, 15, 23, 27, 29, 38, 48, 79.

²⁷ Appendix A, 4, 18, 29, 38.

²⁸ Appendix A, 6, 10, 15, 23, 24, 26, 28, 31, 35, 79, 81, 86.

²⁹ Appendix A, 33, 36, 86.

evoke is their main resource. In some cases, this fear is expanded to include the deployment of geoengineering. The president of the Royal Society's panel of experts, John Shepherd, declared that he did not favour geoengineering but "feared" that it would likely be needed as a complementary method.³⁰ At the prospect of failure of COP15 in Copenhagen, he declared that it would be "scary" if humanity were obliged to resort to "geoengineering solutions."³¹ His co-author Ken Caldeira stated that, in his personal capacity, he disliked geoengineering because of the substantial environmental risks, but that as a scientist he would prefer sulphur particles in the atmosphere to the drastic melting of Greenland's ice sheet.³² Another co-author, Jason Blackstock, labelled geoengineering "terrifying," but added that the scientists did not develop these ideas "because of hubris, but because of fear."³³

The double fear expressed in interviews by these and other researchers is reiterated by journalists and constitutes a powerful rhetorical resource. If the researchers responsible for developing geoengineering admit fear of their creation's consequences for the environment but, in view of approaching climate catastrophe, also advocate the necessity of geoengineering, how can citizens question their willingness to expose the environment to risks? In line with Clark's claim, the scientists have already admitted the risks and taken the lead among those warning of the consequences of both geoengineering and climate change. This technocratic "emergency framing" —or "politics of emergency," as Clark puts it—exerts a "depoliticizing" influence.³⁴ Hamilton extends the argument and even claims that geoengineering advocates seem to approve a world of technocratic control: they apparently believe that a separation can be sustained between pure science and technology, on one hand, and the politics threatening to mar it, on the other, aiming to create a "world without politics" characterized by scientists' just and objective management of the global climate. This position, Hamilton maintains, is naïve: science cannot be isolated, at least not when political, corporate, and military actors also aspire to exert influence over this powerful tool to regulate the conditions of life.³⁵ These warnings combined with the admitted fear constitute a solid approach to creating legitimacy for these technologies. The more the risks of geoengineering are emphasized, combined with advice to consider geoengineering options, the more inevitable tests and deployment seem. When the problem is formulated, as it is by Stephen Schneider, for example, as a choice of "the lesser of two evils," who can advocate choosing "the most evil"?³⁶ The implication of these confessed fears is that geoengineers, unlike most other scientists and engineers, have both understood and emphasized the risks and side effects of the technologies they are developing, so they do not need to be criticized by environmentalists. This does not change

³⁰ Appendix A, 42, 43.

³¹ Appendix A, 7, 4.

³² Appendix A, 25.

³³ Appendix, 75, cf. 4, 5.

³⁴ Nigel Clark, "Geoengineering and Geological Politics"; cf. Stephanie Uther, *Diskurse des Climate Engineering*.

³⁵ Clive Hamilton, "Geoengineering and the Politics of Science," *Bulletin of the Atomic Scientists* 70 (2014): 17-26.

³⁶ Appendix A, 6. cf. Matti Loukkanen *et al.*, "Geoengineering, Newsmedia and Metaphors" who claim that this is not necessarily the case in this discourse.

anything, however, because there exist no alternatives in view of impending climate catastrophe.³⁷

In light of this understanding, a *Time* journalist's declaration that "the real disaster" would be to delay developing geoengineering until climate change had assumed catastrophic proportions seems consistent.³⁸ Geoengineering is, unlike other large-scale technologies, not accompanied with promises of a better world. The spokespeople of geoengineering do not offer future prosperity; instead, their legitimacy is based on negative expectations.

These negative expectations are, as illustrated, related to both global climate conditions and the direct consequences of geoengineering, in accordance with the logic that the more severe the global climate crisis is expected to become, the more environmental degradation and risks must be accepted as a consequence of geoengineering. In addition, several leading researchers in the field openly affirm the inadequacy of our present and future knowledge of geoengineering. This is seldom made into an objection to these technologies in spite of the repeatedly declared acuteness of the need to come to terms with global warming. On the contrary, this knowledge deficit is used as an argument for intensified efforts to test and evaluate geoengineering, about which researchers know almost nothing apart from its indispensability for saving the planet.³⁹

In this light, contradictory geoengineering stands out in some important respects as the first grand-scale technology with clear postmodern tendencies.⁴⁰ It differs from CO₂ capture and storage, for example, in that it has abandoned linear modernity's promises of a prosperous future and technological development controlled by the natural sciences. Such promises of progress and objective truth are no longer the legitimation grounds for research into and deployment of the technology. Geoengineering is guided by a promise to attempt, in a situation characterized by despair and uncertainty, but not necessarily to succeed.⁴¹ This is also why geoengineering's proponents do not have to outline the advantages of actual grand-scale deployment, but can restrict themselves to making a case for intensified research into the potential of these technologies, although history indicates that research and deployment are seldom strictly demarcated. However there seems to be a contradiction between the lack of promises and the absent belief in progress on the one hand and the totalizing, modern ambition to manage climate change with the help of grand-scale global deployment of technologies amplifying the notion that scientific engineering carries the only possibility to save the planet. This grand narrative is surely not compatible with the epistemologically humble position that is central to the discourse advocating geoengineering.

Accordingly, the storyline about scientists' double fear includes the vague notion of a solution to the problem.⁴² The climate situation is described as so alarming that it has become

³⁷ For a discussion of geoengineering and the "lesser evil," see Christopher Preston, "Re-thinking the Unthinkable: Environmental Ethics and the Presumptive Argument against Geoengineering."

³⁸ Appendix A, 86.

³⁹ Appendix A, 4, 5, 6.

⁴⁰ cf. Jean Holly Buck, "Climate Engineering: Spectacle, Tragedy or Solution?"

⁴¹ cf. Kate Porter and Mike Hulme, "The Emergence of the Geoengineering Debate" and Jean Holly Buck, "Climate Engineering" who, in contrast to our claim, say that the ecological modern, or innovative, frame was dominant.

⁴² Appendix A, 30, 51, 59, 70, 94, 99, 100.

urgent to take “extreme,” “extraordinary,” “risky,” or even “dangerous” measures to make the “survival of civilization” possible.⁴³ Implicit in this storyline is the notion that climate researchers and geoengineering scientists are the world’s saviours, acting like gods by creating new atmospheric and planetary conditions to benefit all organisms. The notion of humble, self-critical scientists aware that their knowledge and ability to understand the complexity of the environment are greatly limited stands in sharp contrast to the claim, usually made by journalists, that geoengineers are in a position to save the world, if only they are allowed to develop and deploy the lifesaving technologies they are advocating. This tension is fundamental to the storyline, yet never explicitly touched on.

The failure of politics and cynical industrial fatalism

The storyline of the failure of international climate negotiations and political initiatives to reduce global CO₂ emissions constitutes a point of departure for the geoengineering discourse as important as alarm concerning climate change. Amidst an increasingly pressing climate situation, national governments and international institutions are repeatedly judged unable to implement relevant measures. Accordingly, both scientists and popular science journalists have concluded that international political negotiations have come to the end of the road, and that other options for managing climate change must now be considered. Geoengineering is stressed as the most promising such option. This argument emphasizes that researchers believe that they must develop geoengineering because politics has failed and can no longer reverse the situation.

Matthew Watson, the principle investigator of the SPICE project,⁴⁴ notes that every time the politicians, in the context of international climate negotiations, prioritize economic growth or their own re-election, they also indirectly make intensified geoengineering efforts more necessary. This creates antagonism between political negotiations regarding cuts in CO₂ emissions and geoengineering, the latter being assumed to replace the former. Some actors frame geoengineering and its consequences as the price to be paid for political failure.⁴⁵ It is claimed to be possible to replace political solutions with what are depicted as non-political and purely technical solutions. Politics is seen as obstructing efficient climate change management, while technology and science are depicted as unproven but uncomplicated, although this picture is supplemented by the reservation that geoengineering can only complement reduced CO₂ emissions.⁴⁶

In particular, the Kyoto Treaty and UN processes are described as toothless. The Treaty is seen as not having helped reduce global emissions, as its signatories have not fulfilled their commitments. It is concluded that the Kyoto process is more or less a waste of time and that the international negotiations are far too slow. Even if a new and substantially more ambitious UN climate treaty were agreed on, it would take decades for net global emissions to decrease,

⁴³ Appendix A, 6, 10, 20, 23, 26, 28, 29, 31, 48, 50, 61, 72, 77, 82, 86.

⁴⁴ Stratospheric particle injection for climate engineering (SPICE) was a project in the UK to assess the feasibility of injecting particles into the stratosphere from a tethered balloon.

⁴⁵ Appendix A, 49, 53.

⁴⁶ Appendix A, 6, 7, 10, 16, 18, 23, 24, 33, 40, 44, 46, 47, 79, 88.

so faster-acting measures are needed.⁴⁷ In particular, this rationale was made explicit before and during the UN negotiations in Copenhagen in December 2009. Before the conference, several sources claimed that the Royal Society had announced a warning that geoengineering was the only alternative if negotiations did not result in a treaty on significant reductions in CO₂ emissions.⁴⁸ Another way to put it was that failure in Copenhagen would result in a “big breakthrough” for geoengineering.⁴⁹ Logically, in the wake of the vague accord formulated at Copenhagen, some journalists drew the radical conclusion that “we will have to engineer the climate.”⁵⁰

The resignation evident in this storyline rests on fatalism at the impossibility of changing industrial society’s aspirations for economic growth. Despite the alarming projections of climate change, it is claimed that world electricity use will increase by 50% by 2030, and that 77% of this increased power will be produced by fossil fuels. The International Energy Agency projects that coal and oil use will continue to rise, as if there were no choice despite the greenhouse gas emissions. The governments of the world, it is said, are not prepared to compromise their economic growth rates; in particular, countries such as India and China are claimed to be far from accepting expensive emissions cuts. There are also severe doubts as to what Caldeira calls “the transcendent human capacity for self-sacrifice.”⁵¹ All these factors emphasize the need for geoengineering, a solution that does not interfere with the contemporary industrial rationality. Accordingly, the question is not whether geoengineering should be done, but how.⁵² Given the socio-economic structure of contemporary industrial capitalism, there is really no choice. Ulrich Beck calls this position industrial fatalism, and it is usually combined with an optimistic belief that things will turn out well in the end.⁵³ However, when it comes to the geoengineering discourse, there are no such reassurances. Instead the future is described as insecure and threatening. The discourse is permeated by a cynical industrial fatalism, which claims that there is no other choice than deploying geoengineering, even though such technologies might have environmentally devastating consequences and worsen an already catastrophic situation.

The scientists and journalists advocating geoengineering are not forced to describe the future in glowing terms, as proponents of grand-scale technologies usually do, because they benefit from the despair and desperation evoked by climate change. For example, John Shepherd declared that it had become necessary to invest in geoengineering research since there were strong reasons to be “less optimistic” about reducing CO₂ levels.⁵⁴ Geoengineering was a “price” to be paid, not a promise.⁵⁵ Geoengineering has made the fatalism of industrial society cynical.

⁴⁷ cf. Sikka Tina, “A Critical Discourse Analysis of Geoengineering Advocacy.”

⁴⁸ Appendix A, 46, 74.

⁴⁹ Appendix A, 75.

⁵⁰ Appendix A, 77.

⁵¹ Appendix A, 8.

⁵² Appendix A, 7, 8, 40, 64, 80, 98, 99.

⁵³ Ulrich Beck, *Ecological Politics in an Age of Risk* (Cambridge: Polity Press, 1995).

⁵⁴ Appendix A, 46, 47.

⁵⁵ Appendix A, 6, 8, 10, 23, 24, 29, 44, 49, 53, 79.

Pure technology: a bridge to a sustainable future

The geoengineering discourse is overflowing with metaphors and figurative language. The development of geoengineering is referred to as “plan B”;⁵⁶ it constitutes a “last-ditch” alternative,⁵⁷ “parachute,”⁵⁸ “airbag,”⁵⁹ and “last resort.”⁶⁰ These expressions and metaphors suggest that there is a technological way out of a political dilemma and that geoengineering is pure technology, unlike carbon emissions cuts, which are complicated political measures that raise severe conflicts of interest. This storyline is also commonly spelled out in the geoengineering discourse, which depicts geoengineering as a technological fix. These strictly technological measures will not solve the problem, but they could “buy time,” which is found to be absolutely necessary, since the international political process is so inefficient.⁶¹

This notion is closely related to the idea that geoengineering will serve as a “bridge” to a future carbon-free society based on renewables, buying time for the countries of the world to transform their energy systems. Problems related to this claim that are not touched on concern whether it really will be easier to develop renewables in the future, once geoengineering is deployed, and whether it will be possible to stop geoengineering once these technologies are implemented. Another lacuna in the discourse is the implicit assumption that geoengineering will not generate the same type of political conflicts of interest and deadlocks as the calls for renewables and CO₂ emission decreases have. Geoengineering is without argumentation or problematization assumed to be pure technology devoid of all political considerations. The question of political tensions that may arise if geoengineering is deployed is avoided, as if there were any such thing as a politically neutral technology or engineering practice. In rare cases, governance issues are mentioned, but are not considered serious problems.⁶²

This view of technology is dependent on the commonly proclaimed idea that it is possible to test, study, and identify the environmental consequences of geoengineering in advance. At first sight this idea appears to contradict the storyline about the scientists’ double fear and warnings that geoengineering may cause harmful side effects, but intensified research is supposed to ensure that the ecological impacts of geoengineering are understood and under control before deployment, enabling the “fine-tuning” of various technologies. Field tests are said to guarantee this, and grand-scale research programmes are implemented to insure against “unanticipated side effects.”⁶³ The potential risks are cited to underscore the urgent need for considerable research, and carrying out tests in due time will, according to the pure technology storyline, enable the slow and cautious deployment of various geoengineering technologies, while maintaining the possibility of reversing the process if something goes wrong. The

⁵⁶ Appendix A, 8, 10, 27, 46, 47, 48, 65, 73, 84, 86; cf. Stephanie Uther, *Diskurse des Climate Engineering*.

⁵⁷ Appendix A, 6, 10, 27, 85, 92.

⁵⁸ Appendix A, 2, 43.

⁵⁹ Appendix A, 57.

⁶⁰ Appendix A, 44, 45, 67, 73, 74.

⁶¹ Appendix A, 3, 10, 11, 14, 27, 30, 33, 39, 51, 52, 56, 58, 64.

⁶² Appendix A, 12, 14, 30, 33, 48, 55, 64, 67.

⁶³ Appendix A, 19, 22, 23, 43, 52, 63, 99, 102, 103.

alternative of introducing the technology under panic conditions, without careful testing, should be avoided.⁶⁴

The technological rationality on which this storyline rests is strictly instrumental and presupposes that it is possible to project the complex reactions of global ecosystems over several coming centuries by conducting minor field tests, although at the same time it is repeatedly admitted that such assumptions are highly problematic. Although there is an explicit awareness that the ecological side-effects are unknown, they are not perceived as beyond the scope of contemporary engineering science but as calculable and knowable.

However, the discourse also contains some accounts of the new technology that threaten to undermine the image of geoengineering as purely science based. Some journalists enthusiastically speak of their “personal favourite” geoengineering techniques, fascinated by the *Blade Runner* atmosphere and praising the “beauty of this system.” This “boyish sci-fi feel” reveals that there might be other grounds for developing these “wild ideas” than strictly scientific ones.⁶⁵ An aesthetics of technology and a fascination with the sublime aspects of the grand-scale enterprise of altering the planet’s climate are echoed in some of the texts advocating geoengineering. This is counteracted by declarations that geoengineering is absolutely not a “science-fiction playground for imaginative scientists and engineers,” although some of the suggestions might evoke a Jules Verne novel or Mary Shelley’s *Frankenstein*. The need for such demarcations indicates a worry among geoengineering advocates that this new set of technologies might be associated with romantic fantasies and praised for the wrong reasons. This explicit technological romanticism that tries to slip in through the back door is immediately refused entrance and shown away, but is there not a kind of romanticism hidden even in the hard-headed geoengineering schemes chosen to save the planet? We would argue that this is the case and that this is a strong reason to dismiss all aesthetic praise of geoengineering schemes. Is not the idea of a pure and politically unpolluted technology, saving the world from its final destruction in the spirit of Jules Verne, truly romantic at heart, no matter what the scientists and engineers claim? Would not Captain Nemo have felt fairly comfortable in that company?⁶⁶

Just mimicking nature

In the geoengineering discourse, even scientists and journalists advocating the technologies in question highlight the methods’ controversial character. Geoengineering is said to be “rife with controversy” or to involve “highly controversial proposals,” but what the controversy is all about is seldom discussed. Instead, as noted above, the matter of controversy is subordinated to the overwhelming global environmental problems that the technologies are supposed to

⁶⁴ Appendix A, 6, 8, 40, 71, 78, 80.

⁶⁵ Appendix A, 9, 21, 31, 32, 34, 49, 83, 100.

⁶⁶ See also: James Rodger Fleming, *Fixing the Sky: The Checkered History of Weather and Climate Control* (New York: Columbia University Press, 2010) and Jeff Goodell, *How to Cool the Planet: Geoengineering and the Audacious Quest to Fix Earth's Climate* (Houghton Mifflin Harcourt, 2010) and Clive Hamilton, *Earthmasters: The Dawn of the Age of Climate Engineering* and Clive Hamilton, “Geoengineering and the Politics of Science,” trace the organizational and ideological roots of contemporary geoengineering science back to the utopian, grandiose but naïve ideas of mastering or terraforming the Earth (and Mars) in order to suit humanity’s needs in the post-war era.

solve and to the urgency of this task. In this way, the contentiousness of the subject is both recognized and downplayed or disregarded.⁶⁷

This is why John Shepherd, in sharp contrast to scientists promoting technologies in several other areas, emphasizes that geoengineering is no “silver bullet” or “magical bullet.”⁶⁸ It will not solve all our problems and it will not be without considerable costs—to use a common expression, it is no “get-out-of-jail-free card.”⁶⁹ Geoengineers are not forced to promise anything and they can even stress the uncertainties and risks of their technology without losing support. On the contrary, this is a way of gaining credibility.

However, the storyline of geoengineering as a way of mimicking nature tends in quite the opposite direction. As early as 2007, Kurt Zenz House declared that some geoengineering technologies just used the “cleaning process that Nature herself uses for greenhouse gas accumulation.”⁷⁰ In this storyline, scientists artificially made natural processes more efficient, but in principle there was no difference between, for example, volcanic eruptions and human efforts to release huge volumes of sulphur aerosols into the atmosphere.⁷¹ The implied meaning of this storyline was that geoengineering was not a hazardous human endeavour.⁷² How could it be hazardous if nature had used the same processes before humans existed? This storyline stands in sharp contrast to the one emphasizing the double fear of scientists or the contentiousness of geoengineering, downplaying the extraordinary aspects of the actual technologies. In 2009, several journalists, referring to declarations of scientists, argued that the most promising geoengineering technologies obtained their “proof of concept from nature,” explicitly mentioning that the 1991 volcanic eruption of Mount Pinatubo in the Philippines had a cooling effect on the planet for more than two years. This leads to the conclusion that injecting sulphur aerosols into the stratosphere is nothing but “mimicking nature,” implying that there is nothing strange, unnatural, or even hazardous about geoengineering.⁷³

Since the end of 2011, this storyline has steadily gained influence. Mimicking nature is repeatedly characterized as a natural and logical scientific activity, as almost inevitable.⁷⁴ Nature has shown the way and humanity just has to follow.⁷⁵

Ken Calderia even argues that “geoengineering concepts have been tested by nature,”⁷⁶ implying that geoengineers have an ally in nature and that technologies that cannot be tested in laboratories can be understood as safe and having been tested in full-scale experiments by nature for eons. Accordingly, no other technologies have been as thoroughly tested as have some of the geoengineering technologies that the researchers know so well. If we cannot trust nature, what or who can we trust?

⁶⁷ Appendix A, 10, 33, 54, 60, 66.

⁶⁸ Appendix A, 30, 41, 42.

⁶⁹ Appendix A, 6, 17, 65, 100, 28.

⁷⁰ Appendix A, 104.

⁷¹ Appendix A, 3.

⁷² cf. Matti Loukkanen *et al.*, “Geoengineering, Newsmedia and Metaphors.”

⁷³ Appendix A, 32, 34, 69, 75, 76, 77.

⁷⁴ See also Clark Nigel, “Rock, Life, Fire: Speculative Geophysics and the Anthropocene.”

⁷⁵ Appendix A, 87, 89, 90, 91, 92, 93, 95, 96, 97, 98, 99, 101, 102.

⁷⁶ Appendix A, 103.

Over the last two or three years, this storyline has more or less come to replace the storyline of the scientist's double fear. The naturalness of and consequent trust in certain geoengineering technologies have increasingly been emphasized, in other words, geoengineering is increasingly depicted as a positive solution, and less as a desperate measure.

Concluding Discussion

The public debate on geoengineering is dominated by the advocacy discourse, which in turn is dominated by natural scientists and engineers.⁷⁷ In a previous paper Anshelm and Hansson have demonstrated that the public debate on geoengineering is permeated by an unusual degree of critical reflexivity, and that problems with geoengineering in several cases were highlighted by the advocates before they reached the discourse critical of geoengineering.⁷⁸ Clark claims that social scientists have been quick to consider this critique akin to their own. As mentioned, Clark explains that, in light of the emergency, there is a risk of retreating from the political. It may be too obvious to state the importance of the environmental humanities' avoiding too uncritically advancing the depoliticized emergency framings in the storyline or merely reacting to initiatives or arguments made by engineers and natural scientists. A not too obvious step could be, as Clark argues, to use geoengineering to sensitize the dynamics of the geological and earth systems thresholds or even intentional human geoclimatic agency. We do not dismiss that idea but claim that a preceding step should be to scrutinize and understand the present discourse, and as a first step we attempt to find inconsistencies in the storylines. A discourse cannot be expected to be coherent and free of inconsistencies. The aim of analyzing the inconsistencies in the storylines examined here is not to claim that geoengineering advocates' statements are less trustworthy or more dishonest than statements made in more consistent discourses. Instead, by analyzing these inconsistencies we hope to create a richer understanding of this public discourse. The inconsistencies become more obvious when comparing or combining the different storylines, analyzing what is omitted or marginal in the discourse and making comparisons with what is claimed in other contexts.⁷⁹

A recurrent claim made in the advocacy discourse is that politics has failed, in particular the UN-led Kyoto negotiations, strengthening the case for geoengineering. The Kyoto Protocol is intended to govern conventional and far more proven and familiar methods and technologies than geoengineering. Several important geoengineering options are truly global in terms of both their effects and risks. In addition, the side effects of geoengineering will, according to several scientific claims, not be evenly distributed, either intra- or inter-generationally. Some regions may enjoy all the benefits (if any) of geoengineering, while others will inevitably be burdened primarily with the severe negative side effects or, in the worst-case scenario, only negative effects.⁸⁰ Governing a global risk trade-off situation that can hardly be

⁷⁷ According to our preliminary analysis of the debate in 2014 the advocacy discourse is no longer dominant, and the storylines of the scientists' double fear and emergency framings are less frequent.

⁷⁸ Jonas Anshelm and Anders Hansson, "Battling Promethean Dreams."

⁷⁹ cf. Rob Bellamy, Jason Chilvers, Naomi E. Vaughan and Timothy M. Lenton, "A Review of Climate Geoengineering Appraisals," *Advanced Review* 3, (2012): 597-615 for an analysis of inconsistencies in scientific appraisals of geoengineering.

⁸⁰ e.g., Juan Moreno-Cruz and David Keith, "Climate Policy under Uncertainty: A Case for Solar Geoengineering," *Climatic Change* 121, (2013): 431-444.

depicted as a win–win situation and is also associated with negative expectations cannot easily be assumed to be a lesser governance challenge than the ongoing UN negotiations. Geoengineering may generate new forms of conflict and rearrange global geopolitics. The global fine-tuning and calibration of technology and nature require a centralized and stable governance structure. Clark explains that geoengineering promises the worst of all worlds, overriding democracy and undermining nascent environmental governance structures as well as unpredictable and catastrophic global environmental change.⁸¹

A closely related issue is the development of geoengineering. On one hand, it is claimed that geoengineering is a purely technological matter comprising mechanisms already tested by nature. The geoengineering discourse frequently portrays geoengineering as a purely technological fix. On the other hand, this position stands in stark contrast to frequent claims in scientific journals about the limited value of geoengineering field experiments and even about inherent scientific knowledge gaps.⁸² Paradoxically, as we have illustrated, the common metaphors denoting the new technologies as really trustworthy and safe are used by the same scientists and journalists who declare that it is impossible to know beforehand the complex environmental consequences of geoengineering. If living a full-scale experiment is the only way to gain reasonable control over the large-scale deployment of geoengineering and the climate,⁸³ the value of geoengineering as insurance against escalating climate change, as commonly claimed in the discourse, is limited. Who would rely on parachutes if that technology were never tested in advance and nobody could guarantee its feasibility? What's more, who would rely on a technology if, in the worst-case scenario, it might create an even worse situation than if it had never been deployed? Consequently, can geoengineering, as is so often claimed, really be "plan B"? How can geoengineering be "plan B" if tests and experiments can only either dismiss geoengineering altogether or reaffirm that knowledge gaps are still inherent to it? A common stance in the discourse is that geoengineering advocacy is explicitly limited to favouring more research; however, if satisfactory scientific knowledge cannot be gained by small-scale experiments and modelling, but only by full-scale deployment, the boundary between research and deployment becomes unclear or may even be erased.

Another inconsistency appears in this discourse when it is maintained that there are no guarantees concerning the future environmental consequences of geoengineering, at the same time as this set of technologies is promoted as the only way to save the planet, the only way to combat climate change when international negotiations have failed. An atmosphere of doom is juxtaposed to the hope of salvation from the horrors of climate change. This juxtaposition is

⁸¹ Nigel Clark, "Geoengineering and Geological Politics," and Clare Heyward and Steve Rayner, *A Curious Asymmetry: Social Science Expertise and Geoengineering* (Oxford: Climate Geoengineering Governance Working Paper Series: 007, 2013) have criticized Macnaghten and Szerszynski's (2013) work and other work adopting similar positions. They claim that the critical attitudes towards geoengineering are based on a particular and contestable essentialistic view of democracy "rooted in the ideal of a tight-knit community of highly engaged citizens, where intense deliberation is possible." Heyward and Rayner claim that "a technology does not automatically require a certain political set-up in order to operate," (2013): 18.

⁸² e.g. Douglas MacMynowski, Keith Davis, Ken Caldeira, and Hojeong Shin, "Can we Test Geoengineering?" *Energy & Environmental Science* 4, (2011): 5044–5052.

⁸³ cf. Phil Macnaghten and Bronislaw Szerszynski, "Living the Global Social Experiment."

not contradictory, but the unusual mixture of deep pessimism concerning international politics and nearly light-hearted technological optimism, despite all the reservations and acknowledgments of unresolved major scientific uncertainties, creates a dissonance in the discourse. Since nobody knows whether geoengineering will offset climate change or possibly even amplify it, there is inconsistency between the knowledge claims and the groundless, but commonly declared, beliefs. However, the critical and advocacy discourses draw opposite conclusions regarding how to approach the uncertainties and ignorance. Rayner argues that ignorance may be rhetorically deployed in two directions: either straightforward—initiating research is the only way to reduce ignorance, or the opposite—since the knowledge gaps are inherent we cannot know, making ignorance into a resource or main argument against wasting time and effort on a dead end.⁸⁴

It is maintained that the final catastrophe can be postponed with the help of geoengineering, but only for a limited time and with strong reservations that the rescue operation might well fail. When the continuation of modern industrial society can no longer convincingly be guaranteed by modern technologies, backed by objective natural scientific truth claims that promise a better world, a postmodern set of technologies, geoengineering, enter the stage as a substitute, in accordance with the explicit conviction that there is no alternative. The real purpose of these new postmodern technological solutions is to save both the climate and the modern project from human-inflicted destruction, and thereby, without promising a better world, uphold unsustainable and self-destructive societal structures and ways of life, when these are deemed inescapable. However, by the end of the studied period, considerable efforts are being made to enact geoengineering as a set of technologies based on mimicking nature. This can counteract the previously declared uncertainty concerning the environmental consequences of geoengineering, the risks having been brought under scientific control again, the environmental dangers tamed, and the promises of a controllable, secure, and prosperous future re-established. Future prospects for development and the avoidance of environmental catastrophe are emphasized as the fundamental motive for investing in geoengineering. This marks an attempt to integrate geoengineering into the logic of industrial modernity, and to adjust our understanding of the technologies to the rationality that, in any case, seems unavoidable and fated. This implies that the postmodern character of geoengineering might be heading towards dissolution and so too the ironic relationship between geoengineering and the unsustainable societal structures that it is said to be able to preserve, while saving the planet's climate and ecosystems. There is an important divide in the public debate on geoengineering and nature. The eco-pragmatic stance maintains that all natural systems already are seriously, and irreversibly, affected by human activities, leaving no choice but to take control of or even enhance them. Geoengineering would only be one of many already ongoing projects of earth systems management. Furthermore, even if it did exist, a pristine nature or a Holocene climate would in any case have no intrinsic value and would not provide a better environment for humanity.⁸⁵ This is in stark contrast to the view that humanity is not prepared to take full ethical responsibility for our planet's development. Besides the contested arguments that geoengineering is depoliticized and inherently bound to

⁸⁴ Steve Rayner, *To Know or Not to Know?* See also Jonas Anshelm and Anders Hansson "Battling Promethean Dreams."

⁸⁵ David Keith, *A Case for Climate Engineering* (Boston: MIT Press, 2013).

democratic deficits and knowledge gaps, at least one additional question should receive more attention, especially within the environmental humanities: Why should one strive to limit humanity's interference with the global climate systems? Turning to Hans Jonas for guidance would possibly lead to the conclusion that, although natural systems are not necessarily better, they develop and adapt slowly over long time periods and are therefore at least in relative balance. On the other hand, substantial and human-induced changes within a short period will result in consequences impossible to anticipate and could result in catastrophic outcomes. Global ecosystems could be thrown out of balance, without anyone knowing how to restore them. This creates unacceptable global risks, and humanity has no right to experiment with either our or other species' survival.⁸⁶ As discussing geoengineering inevitably entails negotiation of what it is to be human on a truly grand scale,⁸⁷ as Pálsson *et al.* claim, engaging in public and scientific debates on geoengineering provides an excellent opportunity to strengthen a "planetary humanities" concerning the new human conditions in the Anthropocene.⁸⁸

Jonas Anshelm is a professor in the Unit of Technology and Social Change at Linköping University, Sweden. He has conducted research related to environmental controversies, energy technologies and discourses since the early 1990s. His most recent book is *Discourses of Global Climate Change: Apocalyptic framing and political antagonism*, published by Routledge in November 2014. Email: jonas.anshelm@liu.se

Anders Hansson is a senior lecturer in the Unit of Technology and Social Change at Linköping University, Sweden. His main research area is grand scale and controversial technologies, and his dissertation, published in 2008, is a critical investigation of carbon capture and storage. Email: anders.n.hansson@liu.se

ACKNOWLEDGEMENTS We would like to thank the seminar group Green Critical Forum at Linköping University and Duncan McLaren at Lancaster University for valuable comments on early drafts of this paper. This work is a part of the Linköping University Climate Engineering Programme (LUCE) and was funded by the Swedish Research Council Formas and the Swedish Research Council (VR). Finally we would like to thank the editors and the anonymous reviewers for constructive suggestions and support that helped to improve the paper.

⁸⁶ Hans Jonas, *The Imperative of Responsibility: In Search of an Ethics for the Technological Age* (Chicago & London: The University of Chicago Press, 1985).

⁸⁷ Mike Hulme, *Can Science Fix Climate Change?*

⁸⁸ Pálsson *et al.*, "Reconceptualizing the 'Anthropos' in the Anthropocene: Integrating the Social Sciences and Humanities in Global Environmental Change Research," *Environmental Science and Policy* 28, (2013): 3-13.

Bibliography

- Anshelm, Jonas, and Anders Hansson. "Battling Promethean Dreams and Trojan Horses: Revealing the Critical Discourses of Geo-engineering." *Energy Research and Social Science* 3, (2014): 135-144.
- Beck, Ulrich. *Ecological Politics in an Age of Risk*. Cambridge: Polity Press, 1995.
- Bellamy, Rob, Jason Chilvers, Naomi E. Vaughan and Timothy M. Lenton. "A Review of Climate Geoengineering Appraisals." *Advanced Review* 3, (2012): 597-615.
- Boucher, Olivier, Piers M. Forster, Nicolas Gruber, Minh Ha-Duong, Mark G. Lawrence, Timothy M. Lenton, Achim Maas and Naomi E. Vaughan. "Rethinking Climate Engineering Categorization in the Context of Climate Change Mitigation and Adaptation." *WIREs Climate Change* 5, 2014: 23-35.
- Buck, Holly Jean, "Climate Engineering: Spectacle, Tragedy or Solution? A Content Analysis of News Media Framing." In *(De-)Constructing the Greenhouse: Interpretative Approaches to Global Climate Governance*, edited by Chris Methmann, Delf Rothe and Benjamin Stephan, 166-181. Abingdon: Routledge, 2013.
- Coffey, Amanda, and Atkinson Paul. *Making Sense of Qualitative Data – Complementary Research Strategies*. Thousands Oaks: SAGE Publications, 1996.
- Clark, Nigel. "Rock, Life, Fire: Speculative Geophysics and the Anthropocene." *The Oxford Literary Review* 34, (2012): 259-276.
- Clark, Nigel. "Geoengineering and Geological Politics." *Environmental Planning A* 45, (2013): 2825-2832.
- Fairclough, Norman. *Analysing Discourse Textual Analysis for Social Research*. London: Routledge, 2003.
- Fleming, James Rodger. *Fixing the Sky: The Checkered History of Weather and Climate Control*. New York: Columbia University Press, 2010.
- Goodell, Jeff. *How to Cool the Planet: Geoengineering and the Audacious Quest to Fix Earth's Climate*. Houghton Mifflin Harcourt, 2010.
- Hajer, Maarten. *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Oxford: Clarendon, 1995.
- Hamilton, Clive. *Earthmasters: The Dawn of the Age of Climate Engineering*. New Haven & London: Yale University Press, 2013.
- Hamilton, Clive. "Geoengineering and the Politics of Science." *Bulletin of the Atomic Scientists* 70, (2014): 17-26.
- Heitmann, Hansen Ove, Oluf Langhelle and Robert Anderson. "Framework and Methodology: Regulation and Discourse Analysis as a Research Strategy." In *Arctic Oil and Gas: Sustainability at Risk*, edited by Mikkelsen Aslaug and Oluf Langhelle, 87-108. New York: Routledge, 2008.
- Heyward, Clare and Steve Rayner. *A Curious Asymmetry: Social Science Expertise and Geoengineering*. Oxford: Climate Geoengineering Governance Working Paper Series: 007, 2013.
- Hulme, Mike. *Can Science Fix Climate Change?* Cambridge: Polity Press, 2014.
- Jonas, Hans. *The Imperative of Responsibility: In Search of an Ethics for the Technological Age*. Chicago & London: The University of Chicago Press, 1985.
- Keith, David. *A Case for Climate Engineering*. Boston: MIT Press, 2013.
- Linnér, Björn-Ola and Victoria Wibeck. "Climate Engineering as Emerging Technologies: A Review of the Literature." Forthcoming in *WIREs Climate Change*.
- Loukkanen, Matti, Suvi Huttunen and Mikael Hildén. "Geoengineering, Newsmedia and Metaphors: Framing the Controversial." *Public Understanding of Science* 36, (2014): 3-29.
- Lovell, Heather, Harriet Bulkeley and Susan Owens. "Converging Agendas: Energy and Climate Change in the UK." *Environment and Planning C: Government and Policy* 27, (2008): 90-109.
- MacMynowski, Douglas, David Keith, Ken Caldeira and HoJeong Shin. "Can we Test Geoengineering?" *Energy & Environmental Science* 4, (2011): 5044-5052.

- Macnaghten, Phil and Bronislaw Szerszynski. "Living the Global Social Experiment: An Analysis of Public Discourse on Solar Radiation Management and its Implications for Governance." *Global Environmental Change* 23, (2013): 465-474.
- Moreno-Cruz, Juan and David Keith. "Climate Policy under Uncertainty: A Case for Solar Geoengineering." *Climatic Change* 121, (2013): 431-444.
- Nehrlich, Birgitte and Rusi Jaspal. "Metaphors We Die By? Geoengineering, Metaphors and the Argument from Catastrophe." *Metaphor and Symbol* 27, (2012): 131-147.
- Nye, David, Linda Rugg, James Fleming and Robert Emmett. *The Emergence of the Environmental Humanities*. Background Paper: The Swedish Foundation for Strategic Environmental Research (MISTRA).
- 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.. "Reconceptualizing the 'Anthropos' in the Anthropocene: Integrating the Social Sciences and Humanities in Global Environmental Change Research." *Environmental Science and Policy* 28, (2013): 3-13.
- Porter, Kate and Mike Hulme. "The Emergence of the Geoengineering Debate in the UK Print Media: A Frame Analysis." *The Geographical Journal* 179, (2013): 342-355.
- Preston, Christopher. "Re-thinking the Unthinkable: Environmental Ethics and the Presumptive Argument Against Geoengineering." *Environmental Values* 20, (2013): 457-479.
- Rayner, Steve. *To Know or Not to Know? A Note on Ignorance as a Rhetorical Resource in Geoengineering Debates*. Oxford: Climate Geoengineering Governance Working Paper Series: 010, 2014.
- Rose, Deborah Bird, Thom van Dooren, Matthew Chrulaw, Stuart Cooke, Matthew Kearnes and Emily O'Gorman. "Thinking Through the Environment, Unsettling the Humanities." *Environmental Humanities* 1, (2012): 1-5.
- Shepherd, John, Ken Caldeira, Joanna Haigh, David Keith, Brian Launder, Georgina Mace, Gordon MacKerron, John Pyle, Steve Rayner and Catherine Redgwell. *Geoengineering the Climate – Science, Governance and Uncertainty*. London: The Royal Society, 2009.
- Scholte, Samantha, Eleftheria Vasileiadou and Arthur Petersen. "Opening up the Societal Debate on Climate Engineering: How Newspaper Frames are Changing." *Journal of Integrative Environmental Sciences* 10, (2013): 1-16.
- Stirling, Andrew. "Transforming Power: Social Science and the Politics of Energy Choices." *Energy Research & Social Science* 1, (2014): 83-95.
- Sikka, Tina. "A Critical Discourse Analysis of Geoengineering Advocacy." *Critical Discourse Studies* 9, (2012): 163-175.
- Sörlin, Sverker. "Environmental Humanities: Why Should Biologists Interested in the Environment Take the Humanities Seriously?" *BioScience* 62, (2012).
- Uther, Stephanie. *Diskurse des Climate Engineering: Argumente, Akteure, Koalitionen in Deutschland und Großbritannien*. Wiesbaden: Springer VS, 2014.

Appendix A: News Articles

1. *The Boston Globe*. Don't like the weather? Change it 2005-07-03
2. *Wired News*. Climate Engineering is doable, as long as we never stop 2007-07-25
3. *Terra Daily*. Engineered Weathering Process Could Mitigate Global Warming 2007-11-08
4. *Science Magazine*. Panel discussion. 2007-11-16
5. *CNET News.com*. "Geoengineering": Space mirror over Greenland? 2007-11-19
6. *The Independent*. Can engineering the earth save it from catastrophe? 2008-09-01
7. *The Guardian*. Geoengineering: The radical ideas to combat climate change 2008-09-01
8. *Science Daily*. World Needs Climate Emergency Backup Plan, Says Expert 2008-11-08
9. *LiveScience.com*. World Needs a Backup Plan 2008-11-14
10. *The Independent*. Climate scientists: it's time for "Plan B" 2009-01-02
11. *The Independent*. What can we do to save our planet? 2009-01-02
12. *Houston Chronicle*. Are climate scientists coming around to geoengineering? 2009-01-06
13. *New Scientist*. "Climate fix" ship sets sail with plan to dump iron 2009-01-09
14. *The Guardian*. Paint for victory: new weapon in climate war is brilliant white roofs 2009-01-16
15. *DagensETC*. 2009-01-16
16. *Science Daily*. Geoengineering Projects That Could Offset Global Warming 2009-01-28
17. *The Guardian*. Climate change: Are we between the devil and the deep blue sea? 2009-01-28
18. *New Scientist*. Most effective climate engineering solutions revealed 2009-01-28
19. *The Times*. They're coming to save the world: plankton plan to sink carbon in oceans. 2009-01-28
20. *The Times*. Breeding to save the world - plankton 2009-01-29
21. *The Telegraph*. Can geoengineering rebuild the planet? 2009-02-16
22. *Stavanger*. Aftenblad Aftenbladet. Kan ingeniørane fiksa klimaet? 2009-02-21
23. *New Scientist*. Hacking the planet: The only climate solution left? 2009-02-25
24. *New Scientist*. Editorial: The time has come to re-engineer the planet 2009-02-25
25. *Christian Science Monitor*. Could technology repair Earth's climate? 2009-03-06
26. *The Guardian*. Obama can lead us to a green economy 2009-03-12
27. *The Sydney Morning Herald*. The bizarre ideas that could help the world 2009-03-12
28. *New Scientist*. We need a another kind of scientist to save the world 2009-03-18
29. *Newsweek*. How to Fix a Climate Emergency MSNBC 2009-04-18
30. *The Guardian*. The climate engineers 2009-04-29
31. *ZDNet*. Geo-engineering can save this planet 2009-06-12
32. *Washington Post*. Irreversible Change? 2009-06-13
33. *Washington Post*. Climate Engineering: Thinking the Unthinkable on Global Warming 2009-06-14
34. *Popular Science*. Geoengineering: Are Weather Machines Really the Answer? 2009-06-18
35. *The Guardian*. Manchester Report: Plans for renewable energy bonds among 20 climate ideas to save the world. 2009-07-03
36. *New Scientist*. Climate engineering research gets green light 2009-07-20
37. *Times Online*. Cloud ships on course to beat climate change 2009-08-07
38. *The New York Times*. Engineer the Climate? 2009-08-11
39. *Globe Investor*. A radically different greenhouse gas strategy 2009-08-19
40. *Daily Commercial News*. Kyoto has had no impact on CO₂ output. Let's try something else 2009-08-28

41. *Morningstar.com*. UK's Top Science Body Warns Against Relying On Geoengineering 2009-09-01
42. *The Telegraph*. Geoengineering should be developed as insurance against dangerous climate change. 2009-09-01
43. *The Guardian*. Investment in geo-engineering needed immediately, says Royal Society. 2009-09-01
44. *Times Online*. Climate engineering "could cause disaster" 2009-09-01
45. *Times Online*. Royal Society warns climate engineering ... 2009-09-02
46. *The Independent*. Man-made eruptions – "Plan B" in the battle for the planet 2009-09-02
47. *Scotsman*. Climate change plans are out of this world 2009-09-02
48. *Canada.com*. Risky "geoengineering" measures may be needed to save climate: Report. 2009-09-02
49. *Scientific American*. Is geoengineering humanity's last hope to avoid catastrophic global. 2009-09-02
50. *Independent Online*. Risky schemes may be only way for Earth 2009-09-02
51. *New Scientist*. Do mention the "G" word 2009-09-03
52. *The New York Times*. A Skeptic Finds Faith in Geoengineering 2009-09-03
53. *National Geographic*. 5 Last-Ditch Schemes to Avert Warming Disaster 2009-09-04
54. *Engineering News*. SA wants technology diffusion to developing countries at centre of Copenhagen deal 2009-09-04
55. *Scientific American*. Engineering better than tax on climate: economists *Scientific American* 2009-09-04
56. *BBC*. Harrabin's Notes: Spending \$250bn 2009-09-05
57. *New Statesman*. Closed because of geoengineering works 2009-10-15
58. *Forbes*. Climate Change: A Perilous Path 2009-09-21
59. *The New York Times*. Scrubbing the Atmosphere 2009-09-25
60. *CNN*. Climate change: Can we even do it? Should we even try? 2009-10-29
61. *CNN*. Saving the Earth through science 2009-10-29
62. *CNN*. The hot debate on "climate engineering" 2009-10-29
63. *The New York Times*. Scientists Seek "Plan B" for Fighting Climate Change 2009-11-02
64. *New Statesman*. Cloud control 2009-11-18
65. *The Engineer*. Particle injection could abate climate change 2010-07-16
66. *The Guardian*. Stewart Brand: My plan B for climate change 2010-10-03
67. *Washington Post*. Threat of global warming sparks U.S. interest in geoengineering 2010-10-04
68. *WaterWorld*. Climate change adaptation report released by Task Force WaterWorld 2010-10-15
69. *The Guardian*. Geo-engineering: just a sticking plaster for the planet? 2009-10-21
70. *Scientific American*. "Albedo Yachts" and Marine Clouds: A Cure for Climate Change? 2009-10-21
71. *Time*. A Ban on Geoengineering Research: Bad Idea 2010-11-03
72. *The Age*. Don't lose heart, technology can still save the day 2009-12-03
73. *AFP via Yahoo!*. Climate change 'Plan B' awaits if diplomacy fails 2009-12-10
74. *Inter Press Service*. CLIMATE CHANGE: Willingly or Not, We Must Prepare for geoengineering. 2009-12-10
75. *Mother Jones*. Copenhagen: Geoengineering's Big Break? 2009-12-14
76. *Scientific American*. Owning the climate: Will geoengineering help combat climate change? 2009-12-18

77. *The Independent*. Letters: Climate after Copenhagen 2009-12-21
78. *The New York Times*. Principles for Managing Climate "Management" 2010-11-08
79. *Fox News*. As climate talks drag on, more ponder techno-fixes 2010-12-04
80. *USA TODAY*. Can geoengineering put the freeze on global warming? 2011-02-25
81. *USA TODAY*. Geoengineering: global warming antidote? 2011-02-25
82. *ABC News*. Tweaking the Climate to Save It: Who Decides? 2011-04-03
83. *The Ecologist*. The link between BP, geoengineering and GM 2011-05-14
84. *Business Green*. Scientists to deploy giant balloon 20km above earth in climate cooling 2011-09-01
85. *New Scientist*. Give geo- and genetic engineering a fair trial 2011-09-07
86. *Time*. Geoengineering: Why We Need to Test It, and Soon 2011-09-07
87. *LiveScience.com*. Climate-Cooling Balloon Put to First Test 2011-09-15
88. *Guardian Professional Networks*. Scientists criticise handling of pilot project to "geoengineer" climate 2011-11-17
89. *Scientific American*. Canceled: "Artificial Volcano" Test for Geoengineering Climate 2012-05-16
90. *BBC*. Climate fix test grounded again 2012-05-16
91. *Reuters UK*. UK climate experiment cancelled on patent concerns 2012-05-16
92. *Science Daily*. Geoengineering could disrupt rainfall patterns 2012-06-06
93. *LiveScience.com*. Global Warming Fight Could Turn Skies Brighter, Whiter 2012-06-06
94. *Mail Online*. Climate engineering to "cure" global warming could turn sunny blue Skies 2012-06-06
95. *United Press International*. Geoengineering climate solution said risky 2012-06-07
96. *Popular Science*. Strategies for a Changing Planet: If All Else Fails ... 2012-07-12
97. *The Guardian*. US geoengineers to spray sun-reflecting chemicals from balloon 2012-07-17
98. *LiveScience.com*. Could Pumping Aerosols into the Atmosphere Stop Global Warming? 2012-08-09
99. *Morgenbladet*. Den skremmende løsningen 2012-09-28
100. *The Sydney Morning Herald*. True science or fiction? 2012-11-10
101. *Harvard University Gazette*. A notion to cool the skies 2012-12-12
102. *PhysOrg.com*. Benefits, risks of using geoengineering to counter climate change 2012-12-13
103. *Earth Island Journal*. We need some symptomatic relief. 2013-03-01
104. *Scientific Blogging*. Engineering Global Warming Using Natural Chemical Weathering. 2007-11-07