

## Supplemental Table A. Timeline of Geoengineering Events

- 1965 Report commissioned by President LB Johnson on "Restoring the Quality of Our Environment" warns of possible climate changes as a result of emissions and mentions SRM as a possible countervailing measure
- 1976 In response to attempts by the U.S. army to use local cloud seeding during the Vietnam war, the UN General Assembly passes a ban on 'weather warfare'
- 1977 Physicist Cesare Marchetti coins the term 'geoengineering' for approaches designed to counteract the warming effect of CO<sub>2</sub>
- 1990 First report of the Intergovernmental Panel on Climate Change (IPCC) declares scientific consensus that anthropogenic carbon emissions contribute to global warming
- 1992 Signing of the Kyoto Protocol, designed to combat climate change via reductions of carbon emissions
- 1992 National Academy of Science report on climate change includes a section on geoengineering that outlines different technological options
- 2004 Tyndall Centre & Cambridge-MIT Institute Symposium: Macro-Engineering Options for Climate Change Management & Mitigation
- 2006 Paul J Crutzen, Nobel Laureate in Chemistry and one of the architects of the Montreal Protocol to fight the depletion of the earth's Ozone layer, publishes as widely noticed essay in the journal *Climate Change* on the possibility of SRM to fight climate change in the face of failure to limit CO<sub>2</sub> emissions through international treaties
- 2007 Geoengineering conference convened by the American Academy of Arts and Sciences at Harvard
- 2008 UN Convention on Biological Diversity adopts a moratorium on ocean fertilization
- 2009 British Royal Society issues a major report on geoengineering (September 1)
- 2009 COP 15 Copenhagen climate negotiations considered failure by most (Dec 18)
- 2009 December - "Oxford Principles" (authored by Steve Rayner and colleagues) are proposed to UK House of Commons Science and Technology Select Committee as a set of initial guiding principles for the governance of geoengineering
- 2010 Environmental advocacy organization ETC Group publishes report calling geoengineering 'geo-piracy'
- 2010 Climate Institute convenes meeting of climate scientists to discuss geoengineering in Washington, DC
- 2011 Protests prompt UK government researchers to cancel high altitude balloon experiment for research on SRM
- 2011 Journalist Jeff Goodell publishes popular press book "How to Cool the Planet: Geo-engineering and the Audacious Quest to Fix Earth's Climate"
- 2012 US entrepreneur Russ George launches ocean fertilization experiment in Canadian waters (subsequently declared illegal)
- 2013 Scientist David Keith publishes popular book "A Case For Climate Engineering" in favor of expanding research into SRM
- 2014 Climate Ethicist David Hulme publishes popular book "Can Science Fix Climate Change?" arguing the infeasibility of governing geoengineering interventions
- 2015 National Academy of Science releases two new reports on geoengineering via CDR and SRM (Feb 2015)
- 2015 Beginning of Paris Climate Conference talks (agreement drafted Dec 2015, signed in Q1 2016)

**Supplemental Table B. Overview of Data Sources**

<b>Medium</b>		<b>Count</b>	<b>Length</b>
Blog Posts		7	31
Books		16	4379
Book Chapter		1	37
Conference Materials		6	30
Congressional Testimony		2	540
Government Testimony		1	196
Interview Transcripts		3	23
Magazine Articles		4	9
News Media Articles Total		2400	4800
	<1992	9	18
	1992-1996	49	98
	1997-2001	105	210
	2002-2006	77	154
	2007-2011	941	1882
	2012-2016	1219	2438
Op Eds		2	7
Position Papers		5	31
Policy Reports		26	2894
Presentation		1	33
Press Releases		3	13
Scientific Articles		32	339
Video - Debate		1	1.5 hrs
Video - Speeches & Interviews		9	4 hrs
Video - Other		14	18.1 hrs
Websites		6	52
<b>Grand Total</b>		<b>2539</b>	<b>12,203 pages &amp; 23.6 hours</b>

**Note:** Length of news media articles estimated as 2 pg/article

**Supplemental Table C: News Media Data Examples for Imaginaries**

Imaginary	Examples from the News Media		
<b>Technofix</b>	<p>A daring proposal to fertilise the world’s oceans to diminish the potentially disastrous effects of global warming has captured the imagination of the international scientific community. In what could be one of the greatest manipulations of nature, the scheme would involve dumping hundreds of thousands of tonnes of iron to accelerate the growth of underwater plants. / Sunday Herald / Scotland / 1990</p>	<p>“If humanity has any hope at all,” said Lovelock, “it lies in the use of radical technologies to deal with the greenhouse gases that are altering our climate.” Lovelock is already renowned for supporting nuclear power as a way of cutting carbon emissions, but he is now proposing something even more radical: a global programme to pollute the stratosphere with sulphur compounds. These, he suggested, would enable it to reflect more sunlight back into space -and so cool the world. “We could fit sulphur dispensers on to the world’s airliners so that they could mitigate the world’s carbon emissions as they go,” he said. / The Sunday Times / London, England / 2007</p>	<p>Thousands of tonnes of iron will be dumped at sea in the biggest trial of a technique that could cut global warming by sucking carbon dioxide from the atmosphere. The iron will seed vast blooms of phytoplankton, which absorb CO2 as they grow. When they die, these microscopic plants sink to the bottom of the ocean, locking away the carbon in their bodies for more than a century. / The Australian / Australia / 2010</p>
<b>Human Hubris</b>	<p>Most scientists and environmentalists frown on such talk. They argue that if people think there may be simple technical solutions for problems like global warming, they’ll be much less likely to tackle the underlying causes -- by drastically cutting back their use of fossil fuels, for instance. In addition, any attempt to control climate could have serious unforeseen side effects, some of which may be irreversible. / San Jose Mercury News / California, USA / 1994</p>	<p>Some environmental groups oppose geoengineering tests because they believe they would suggest that there’s an easy technological fix to carbon emissions. “Research into geoengineering is a distraction from the hard work of reducing carbon emissions,” said Richard Heinberg of the Santa Rosa-based Post Carbon Institute. “If something goes wrong, we may not be able to undo or control the damage,” said Mr. Heinberg, who is particularly opposed to efforts to block sunlight. “The metaphor ‘playing with fire’ hardly begins to communicate the level of risk we are talking about.” / Pittsburgh Post-Gazette / USA / 2015</p>	<p>But SAI [stratospheric aerosol injection] also has the potential for disastrous side effects, crossing national boundaries... Apart from such “known unknowns”, there could also be, to use the catchphrase, the “unknown unknowns”. The global climate system is too complex for current computational techniques to predict all possible consequences of tampering with it. Once the aerosol has been injected into the atmosphere, it cannot be removed. Yet, if for any reason the injection, once begun, is discontinued prematurely, there can be rapid re-warming. That, ironically, could do more damage than the gradual global warming that we are seeking to combat. / The Hindu / India / 2016</p>
<b>Plan B</b>	<p>Worried about a potential planetary crisis, these leaders are calling on governments and scientific groups to study exotic ways to reduce global warming, seeing them as possible fallback positions if the planet eventually needs a dose of emergency cooling. / The New York Times / USA / 2006</p>	<p>Professor John Shepherd, an earth scientist at the National Oceanography Centre in Southampton, who chaired the Royal Society’s working group, said that geo-engineering had to be prepared as a backup in case the “plan A” discussed in Copenhagen fails. “[Geo engineering] is a plan B, but a very real plan B that has to be taken seriously,” Professor Shepherd said. “It is an unpalatable truth that unless we can succeed in greatly reducing carbon dioxide emissions we are headed for a very uncomfortable and challenging climate future, and geo-engineering will be the only option left to limit further temperature increases,” Professor Shepherd said...“Geo-engineering and its consequences are the price we may have to pay for failing to act on climate change.” / The Independent / London, England / 2009</p>	<p>Even supporters of so-called geoengineering are wary of climate interventions because of their poorly understood effects and the risk some may interpret them as a carte blanche to ignore climate change’s root causes. “Geoengineering is, at best, a backup strategy to buy ourselves time, if we don’t move quickly enough and things like the ice melting and methane release are happening in a nonlinear way that we don’t expect,” cautioned Bill Gates, who backs geoengineering research, in an interview with Bloomberg. “But it really is like a fire extinguisher that puts the flames out for decades as opposed to a real solution.” / The Christian Science Monitor / Massachusetts, USA / 2017</p>

<p><b>Governance First</b></p>	<p>According to the Royal Society, technical and scientific issues may not be the ones to impede the promulgation of geo-engineering technology, but rather social, legal, ethical and political issues. If world leaders have been unable to reach consensus on how to reduce carbon emissions, how will they agree on an international legislative framework to ensure the safe usage of this dangerous technology? / Business Daily / South Africa / 2009</p>	<p>There are no international laws to stop them attempting geoengineering, and it is unlikely that governments will be held accountable if something goes wrong. If a nation attempts geoengineering and damages the climate system or the atmosphere, it is doubtful that they could be sued for this damage under international law. International rules need to be developed to govern geoengineering. We need to start talking openly about geoengineering and consider how we want this technology to be used and regulated. This discussion should not be confined to scientists and politicians, or the pages of academic journals. / Washington Post Digital / Australia / 2013</p>	<p>However, any projections of the impacts also foresee secondary effects with unknown political, social and economic outcomes. Albedo modification, McNutt said, “only cools, on average, the planet. There are regional variations which are not controlled.” “As an example,” she said, “It may, on average, cool such that Kansas is happy with the answer, but the Congo may not be happy at all with the answer, because of the changes in rainfall. Australia may not be happy at all with the answer, and it may be actually quite a bit worse for the Arctic -- and it’s not going to address at all ocean acidification. There are all sorts of reasons why one might not view the albedo-modified world as an improvement.” / Daily Camera / Colorado, USA / 2015</p>
<p><b>Conspiracy of Elite Control</b></p>	<p>David is among a growing number of campaigners worldwide who believe that covert experiments are being conducted openly in our skies....David concluded: “I have video footage, found reports, patents, test results and journal articles, all suggesting that the public is being sprayed upon without our consent. If you breathe, this issue affects you. Aside from health impacts, those who control the weather can ultimately control food production, alter biological systems and can use the weather as a weapon. Manipulating our climate is dangerous and can consolidate vast power into the hands of a few. Geoengineering is serious, it’s happening and people need to know about it.” / Blackmore Vale Magazine / England/ 2013</p>	<p>It seems the “neo” environmentalists are running the environmental wing of the global war on terror, scaring us into all sorts of banker, developer, corporation, scientist enriching schemes ala “disaster capitalism.”...Geoengineering is massive pollution of the earth and its inhabitants; nothing less than the corporate scientific takeover of our greatest commons, our sky and atmosphere, natural weather and climate. It needs to be noted that the description of geoengineering matches what many already regularly observe in our skies. / Letter to the Editor: Contra Costa Times (California) / 2013</p>	<p>Ian Thompson from Reigate believes that some of what are commonly thought to be contrails - vapour trails left in the sky by aircraft - are instead “chemtrails”. Mr Thompson, 41, says the longevity and the thickness of the trails is evidence of their chemical composition. He said: “I have never been on a plane and seen anything coming out of the back. These trails are not coming from the engines.” Surrey Mirror/ England/ 2014</p>

**Supplemental Table D: Data Examples for Imaginaries, Dimensions, and Components**

Imaginary	1. Moral Basis	2. Cosmology	3. Present-To-Future Link	4. Stance	Sources
Technofix	<p><u>Evaluation Criteria</u>                      “We need to know more about them because measures of this kind may be crucial if greenhouse warming occurs, especially if climate sensitivity turns out to be at the high end of the range considered in this study.”</p>	<p><u>Privileged Epistemic Domains</u>                      “A few decades may be required before atmospheric scientists produce the answers we seek. Some current limitations on our knowledge could be reduced by better characterization of such ‘subgrid’ processes as precipitation and mechanical heat transfer, better coupling of atmospheric, land surface, and oceanic models, and better models of the role of ecosystems. Access to computers with greater capacity and speed would accelerate these improvements. All of these depend in large measure on progress in the scientific understanding on which the models are based.”</p>	<p><u>Narrative of How to Get There</u>                      “Efforts by societies to restrain their greenhouse gas emissions might be politically infeasible on a global scale, or might fail. In this eventuality, other options may be incapable of countering the effects, and geoengineering strategies might be needed.”</p>	<p><u>Argument About the Role of Geoengineering</u>                      “Geoengineering options appear technically feasible in terms of cooling effects and costs on the basis of currently available preliminary information.”                      &amp;                      “Several geoengineering options appear to have considerable potential for offsetting global warming and are much less expensive than other options being considered.”</p>	<p><i>National Academy of Sciences, 1992: Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base. Panel on Policy Implications of Greenhouse Warming, U.S. National Academy of Sciences, National Academy Press, Washington DC, USA</i></p>
Human Hubris	<p><u>Evaluation Criteria</u>                      Geoengineering “suggests a supreme confidence in human knowledge and ingenuity – a confidence approaching arrogance.” (1)                      &amp;                      “I don’t believe the <i>real</i> climate will behave like the <i>model</i> climate at scales that matter for people and at which the political, legal, and ethical repercussions are felt...I do not believe the human mind has the ability to fathom the intricacies of how the planet functions.” (2)</p>	<p><u>Privileged Epistemic Domains</u>                      “Such conditions are political and ethical before they are scientific and technical.” (1)</p>	<p><u>Narrative of How to Get There</u>                      With geo-engineering: “I argue that it would actually be ungovernable, or at least in any imaginary scenario that we would recognize as being desirable.”                      Without geo-engineering: “We should attend to liberty, justice and human security on the ground and not delude ourselves that utopias can be engineered in the sky.” (1)</p>	<p><u>Argument About the Role of Geoengineering</u>                      “Even if such a technology could be created and governed, the unintended consequences would multiply the humanitarian, political, legal, and security troubles facing the world.” (1)</p>	<p>(1) <i>Can Science Fix Climate Change? A Case Against Climate Engineering by Mike Hulme, 2014</i>                      (2) <i>Mike Hulme Debate with David Keith at the University of Oxford Geoengineering Program, 2013</i></p>

Plan B	<p><u>Corresponding Values</u> Security: “The main issue with the albedo modification method is whether it is environmentally safe, without significant side effects.”</p> <p>Pragmatism: “Progress in the understanding of the complicated earth climate system is generally slow. Therefore it is recommended to intensify research in order to challenge the climate modification idea here presented, starting with model investigations and, dependent on their outcome, followed step by step by small scale atmospheric tests”</p>	<p><u>Privileged Epistemic Domains</u> Science: “The first modelling results and the arguments presented in this paper call for active scientific research of the kind of geo-engineering.”</p> <p>Policy: “The issue has come to the forefront, because of the dilemma facing international policy makers, who are confronted with the task to clean up air pollution, while simultaneously keeping global climate warming under control.”</p>	<p><u>Metaphor</u> Geo-engineering is “an escape route against strongly increasing temperatures”</p>	<p><u>Argument About the Role of Geoengineering</u> “Given the grossly disappointing international political response to the required greenhouse gas emissions, and further considering some drastic results of recent studies (Andreae et al., 2005; Stainforth et al., 2005), research on the feasibility and environmental consequences of climate engineering of the kind presented in this paper, which might need to be deployed in future, should not be tabooed.”</p> <p>&amp;</p> <p>“I repeat: the very best would be if emissions of the greenhouse gases could be reduced so much that the stratospheric sulfur release experiment would not need to take place. Currently, this looks like a pious wish.”</p>	<p><i>Crutzen, Paul J. “Albedo enhancement by stratospheric sulfur injections: a contribution to resolve a policy dilemma?” Climatic Change 77, no. 3 (2006): 211-220.</i></p>
Governance First	<p><u>Corresponding Values</u> “Transparency in decision-making, public participation, and open publication of research results are key elements of such a framework, designed to ensure maximum public engagement with and confidence in the regulation of geoengineering research.” (1)</p> <p>&amp;</p> <p><u>Evaluation Criteria</u> “...it could be possible for a single</p>	<p><u>Privileged Epistemic Domains</u> “Research in many disciplines, including climate science, engineering, law, economics, politics, and ethics, will be necessary to understand and deal with the challenges of developing geoengineering technologies.” (2)</p>	<p><u>Narrative of How to Get There</u> “Geo-engineering will only be implemented if it’s seen to be safe, effective, and affordable. Unless this is the case, I personally don’t believe that any of these technologies are implementable...but ultimately the only way to find out more about climate engineering is to do the research. And I think that</p>	<p><u>Argument About the Role of Geoengineering</u> “It is imperative that governance structures are in place to guide research in the short term and to ensure that any decisions taken ultimately with respect to deployment occur within an appropriate governance framework.” (1)</p>	<p>(1) <i>The Oxford Principles Memorandum to the House of Commons Science and Technology Committee enquiry into The Regulation of Geoengineering</i></p> <p>(2) <i>Rayner, Steve, Clare Heyward, Tim Kruger, Nick Pidgeon, Catherine</i></p>

	country or even an individual frustrated with the pace of climate negotiations to deploy sulphate aerosol injection unilaterally (Victor 2008). Other areas of contention include the extent to which the private sector should be permitted to engage in geoengineering activities and how to redress any harmful side-effects of testing or using the technologies. These considerations suggest that the issue of social control over the technologies is vital in deciding whether to proceed with geoengineering research.” (2)		the imperative at the moment is to set up governance arrangements that allow us to do that research.” (2)		Redgwell, and Julian Savulescu. “The Oxford Principles.” <i>Climatic Change</i> 121, no. 3 (2013): 499-512.
Conspiracy for Elite Control	<p><u>Evaluation Criteria</u></p> <p>“The purpose of our site is to give credible and verifiable data to the public so that we might wake others up as well. It’s our responsibility to wake them up.”</p> <p>“It’s always been about power and control.”</p> <p>“This is not speculation: we have government documents dating back to the 40s that state with no ambiguity the scope and scale of these programs.”</p>	<p><u>Privileged Epistemic Domains</u></p> <p>Lay Expertise:</p> <p>“Climate engineering is shredding the atmosphere, and we know that we’re not being told the actual readings because we’re metering it... We’re seeing UVB levels that are as much as 1000% higher than what we’re being told by all major agencies.”</p> <p>“The degree to which academia has been hijacked and compromised is hard to believe at this point. It’s up to us to put this train back on the tracks.”</p>	<p><u>Narrative of How to Get There</u></p> <p>“It’s up to us again to make people help people to look up, to get past their denial, to understand what’s going on because we’re all part of a grand and lethal experiment.”</p> <p>“We’re going to have nothing left to salvage soon.”</p>	<p><u>Argument About the Role of Geoengineering</u></p> <p>“Geoengineering is climate manipulation on a global scale. It’s the attempt to manipulate Earth’s life support systems.”</p> <p>“That is now reality. Many days our skies look like something from another planet, and there is even more climate engineering going on above the clouds.”</p>	<p><i>Geoengineering, A Clear And Present Danger by Dane Wigington, 2014.</i>  <a href="https://www.youtube.com/watch?v=uv0Ko2OU4Ec">https://www.youtube.com/watch?v=uv0Ko2OU4Ec</a></p>