

# Stratospheric Aerosol Injection

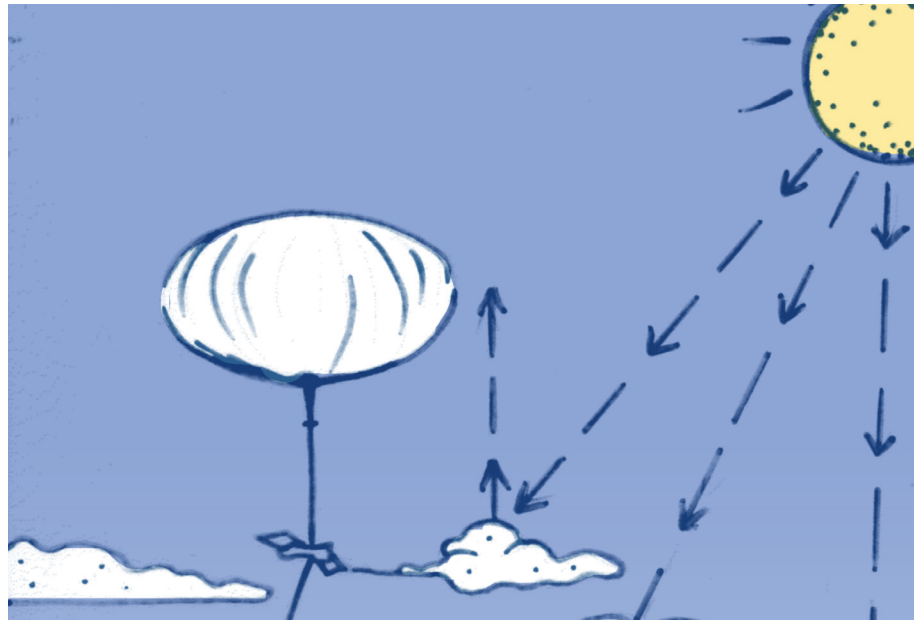
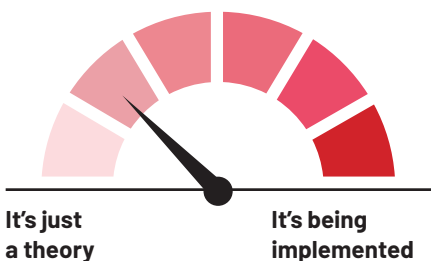
## POINT OF INTERVENTION



### OVERVIEW

This is a Solar Radiation Management (SRM) proposal to spray large quantities of inorganic particles (e.g. sulphur dioxide) into the stratosphere (the upper layer of the atmosphere) to act as a reflective barrier against incoming sunlight. Proposals range from shooting particles from artillery guns, using large hoses to reach the sky, or emptying particles from the back of aircrafts. SAI using sulphates is the most-studied option; this technique would likely cause droughts in Africa and Asia and endanger the source of food and water for two billion people. Because of the unequal global impacts and its potential to be weaponized, SRM carries unsurmountable challenges

## REALITY CHECK



SAI proposes spraying particles into the upper atmosphere to block sunlight.

for governance and should be banned.

### IMPACTS OF THE TECHNOLOGY

As with all SRM technologies that only address global surface temperatures, dramatic perturbations in the climate system can be expected if SAI is deployed. Early research into SAI from the UK's Met Office Hadley Centre found that SAI could lead to severe drought in the Sahel region of Africa. While researchers found that this could possibly be countered by injecting particles into the southern hemisphere stratosphere instead, this would likely cause a failure of the rains in northeast Brazil.<sup>viii</sup>

A recent modeling study simulating the climate effects of SAI found similar potential negative consequences. Injection in the northern hemisphere would lead to fewer hurricanes in the North Atlantic, which might be good news for the Caribbean, but it would likely create drought in Sub-Saharan Africa and parts of India. Injecting aerosol in the southern hemisphere wouldn't create drought, but it would create more hurricanes in the North Atlantic.<sup>ix</sup>

Regional warming is also likely, based on the results of the 2014-2015 Geoengineering Model Intercomparison Project. It predicted

**KEY PLAYER: DAVID KEITH AND SCOPEX**

David Keith, based at Harvard, is the foremost engineer advancing SRM. He is an investor in the technology, has lobbied governments, and manages (along with Ken Caldeira) a multimillion geoengineering fund provided by Bill Gates to the Harvard University (FICER). He has also commissioned a study by a US aerospace company that argued for the feasibility of large-scale deployment of solar geoengineering technologies. In early 2017, he launched Harvard's Solar Geoengineering Research Program, which aims to raise \$20 million in funding from several billionaires and private foundations to execute this project.<sup>i</sup>

Alongside other engineers and researchers, Keith has proposed a number of field experiments,<sup>ii</sup> including the "stratospheric controlled perturbation experiment" (SCoPEX). This experiment aims to improve estimates SRM's impact by understanding the optical properties of different aerosols and the microphysics properties of introducing particles into the stratosphere. The plan is to spray water molecules into the stratosphere from a balloon 20 km above the Earth, creating a plume, and then inject different kinds of aerosols into the plume to observe its reflective properties.

However, more than a limited scientific experiment, the geoengineers appear to have a different agenda for this outdoor SRM experiment: to slowly build mainstream legitimacy for large-scale experiments that ultimately lead to deployment of solar geoengineering.

that temperatures in the tropics would cool, but higher latitudes would warm, with ice sheets and Arctic sea ice still declining, and extreme temperature anomalies also still increasing. A researcher noted that: "If geoengineering were halted all at once, there would be rapid temperature and precipitation increases at 5–10 times the rates from gradual global warming."<sup>x</sup> This means that stopping SAI once it had started could be more dangerous than starting it in the first place. Ozone depletion is another important side effect of SAI.<sup>xi</sup>

Studies on the impacts of SAI on public health are limited, but a recent analysis suggests that adverse public health impacts may reasonably be expected. Little is known about the toxicity of some aerosols that have been suggested, and there is no consensus on what acceptable levels for public exposure to these aerosols are. There are also very few means of evaluating potential public health impacts should SAI be deployed.<sup>xii</sup>

**GLOBAL POWER IMBALANCES**

The prospect of controlling global temperatures raises serious

questions of power and justice: Who gets to control the Earth's thermostat and adjust the climate for their own interests? Who will make the decision to deploy if such drastic measures are considered technically feasible, and whose interests will be left out?

The risk for weaponization is considerable. The premise of controlling the weather originated with military strategies and even led to the signing of the international Environmental Modification Convention (ENMOD). Military leaders in the United States and other countries have pondered the possibilities of weaponized weather manipulation for decades. If the explicit aim of a technology is to "combat climate change," it doesn't guarantee its use will be limited only to that application. If anybody can control the Earth's thermostat, this can and will be used for military purposes, as historian James Fleming explains.<sup>xiii</sup> Even before hostile use, any state or actor claiming to be able to alter global weather patterns will hold a powerful geopolitical bargaining chip with which to threaten and bully.

**A PERFECT EXCUSE FOR  
INACTION ON CLIMATE CHANGE**

SRM, and geoengineering more broadly, is a "perfect excuse" for climate deniers and governments seeking to avoid the political costs of carbon reductions. For those

looking to stall meaningful climate action, the active development of geoengineering tools and experiments will be presented as a preferred pathway to address climate change and be used as an argument to ease restrictions on high carbon emitting industries. This line of argument was already put forward by conservative think tanks in the United States such as the American Enterprise Institute.<sup>xiv</sup>

Furthermore, once SRM is deployed, sudden interruption would cause a termination effect, raising temperatures rapidly, creating a situation worse than it was before its deployment. Therefore, SRM will create dependency and captive markets.

### **GOVERNANCE OF SRM COULD BE IMPOSSIBLE**

There is a moratorium on geoengineering under the Convention on Biological Diversity that clearly articulates the need for a global transparent regulatory mechanism for governance before experimentation is considered. 193 countries agreed to require a global mechanism because they recognized that the potential impacts and side effects of geoengineering will be unfairly distributed.

Since SRM could be a tool to control the Earth's thermostat for those who have legal, economic and technological resources, any step

### **KEY PLAYERS: EXXONMOBIL AND SHELL**

There are large companies for whom 'saving the world' – exclusively through some sort of techno-fix – is increasingly becoming a structural prerequisite for continuing their business, particularly when those companies depend heavily on fossil fuels. They try to shift policy norms so that previously unthinkable notions and activities – like solar radiation management – start to become more mainstream and acceptable.

Among them, ExxonMobil's Senior Scientific Advisor Dr. Haroon Kheshgi is the point person on geoengineering, recruited from the Lawrence Livermore National Laboratory.<sup>iii</sup> Through his efforts, ExxonMobil has influenced "independent" reports on geoengineering and has funded a report that advocates for Carbon Dioxide Removal and Solar Radiation Management. ExxonMobil's former CEO and former US Secretary of State Rex Tillerson has described climate change as an "engineering problem" with "engineering solutions."<sup>iv</sup>

Shell's chief lobbyist, David Hone, is evangelical about "negative emissions" and increasingly openly supports SRM.<sup>v</sup> When Steve Koonin was chief scientist at BP, he led a project to determine hardware feasibility for SRM experiments.<sup>vi</sup> Boeing's Integrated Defense Systems Chief Scientist and Vice-President David Whelan (formerly of DARPA) is also active in geoengineering debates, claiming there is a small team at Boeing studying the issue. He has publicly mused about the technical feasibility of getting mega-tonnes of aerosol sulphates up to different stratospheric levels via aircraft or large cannons.<sup>vii</sup>

towards realizing those capabilities must be agreed through consensus by all members of the UN.

The problem is that if all governments could effectively agree on such a complex issue with so many social, economic, environmental and intergenerational aspects at play, including how and who will carry the cost and burden of the negative impacts,

and if countries had the capacity to implement the necessary agreed climate measures that demand persistence and coherence over several decades, we wouldn't have climate change in the first place, because they could have agreed on stopping emissions. Even the Paris Agreement, which seems a miraculous convergence of political will, only lasted a few months after entering into force before the largest

historical GHG emitter country declared it won't respect it.

The failure to manage fair and effective international climate governance is a clear argument against moving ahead with geoengineering and particularly Solar Radiation Management, which is more deeply unfair and complex and for which there are poor prospects for establishing the fully democratic, multilateral, legally binding and century-long agreement needed for minimally fair governance. Without such a mechanism, once the tools are developed it will be extremely difficult – or impossible – to stop powerful governments from using it. Therefore, the most appropriate governance for Solar Radiation Management is a ban.

**REALITY CHECK**

SAI is seen as a quick and cheap way of geoengineering the climate. Although outdoor experiments have been successfully opposed so far, limiting research to modeling (one aerosol injection field experiment in the troposphere has taken place in Russia<sup>xv</sup>), there is a new push to normalize this kind of research which could see the technology being developed very quickly. SCoPEX is the most high-profile experiment that has been put forward on SRM.

**FURTHER READING**

For more information on SCoPEX and other SRM experiments see:

- <http://www.geoengineeringmonitor.org/2017/11/scopex/>
- <http://www.geoengineeringmonitor.org/2018/04/marine-cloud-brightening-project-geoengineering-experiment-briefing/>
- <http://www.geoengineeringmonitor.org/2018/04/ice-911-geoengineering-experiment-briefing/>

The Big Bad Fix: <http://www.geoengineeringmonitor.org/2017/12/3087/>

**SOURCES**

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- iii. ETC Group, "Trump Administration – A Geoengineering Administration?" Briefing, 28 March 2017, <http://www.etcgroup.org/content/trump-administration-geoengineering-administration>
- iv. Associated Press, "Climate change fears overblown, says ExxonMobil boss," *The Guardian*, 28 June 2012, [www.guardian.co.uk/environment/2012/jun/28/exxonmobil-climate-change-rex-tillerson](http://www.guardian.co.uk/environment/2012/jun/28/exxonmobil-climate-change-rex-tillerson)
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ix. Jones et al, "Impacts of hemispheric solar geoengineering on tropical cyclone frequency," *Nature Communications*, Vol. 8, No. 1382, 2017.

x. Alan Robock, "Stratospheric Aerosol Geoengineering," *Issues in Environmental Science and Technology*, Vol. 38, 2014. <http://climate.envsci.rutgers.edu/pdf/RobockStratAerosolGeo.pdf>

xi. Heckendorn et al, "The impact of geoengineering aerosols on stratospheric temperature and ozone," *Environmental Research Letters*, Vol. 4, No. 4, 2009.

xii. Utibe Effiong and Richard L. Neitzel, "Assessing the direct occupational and public health impacts of solar radiation management with stratospheric aerosols," *Environmental Health*, Vol. 15, No. 7, 2016.

xiii. James Rodger Fleming, *Fixing the Sky: The Checkered History of Weather and Climate Control*, New York: Columbia University Press, 2010.

xiv. ETC Group, *Geopiracy: The Case Against Geoengineering*, ETC Group Communiqué, Issue 103, 18 October 2010, <http://www.etcgroup.org/content/geopiracy-case-against-geoengineering>

xv. ETC Group and Heinrich Boll Foundation, "Field Experiment in Russia," *Geoengineering Map of Experiments*, 2017, <https://map.geoengineeringmonitor.org/Solar-Radiation-Management/field-experiment-in-russia/>