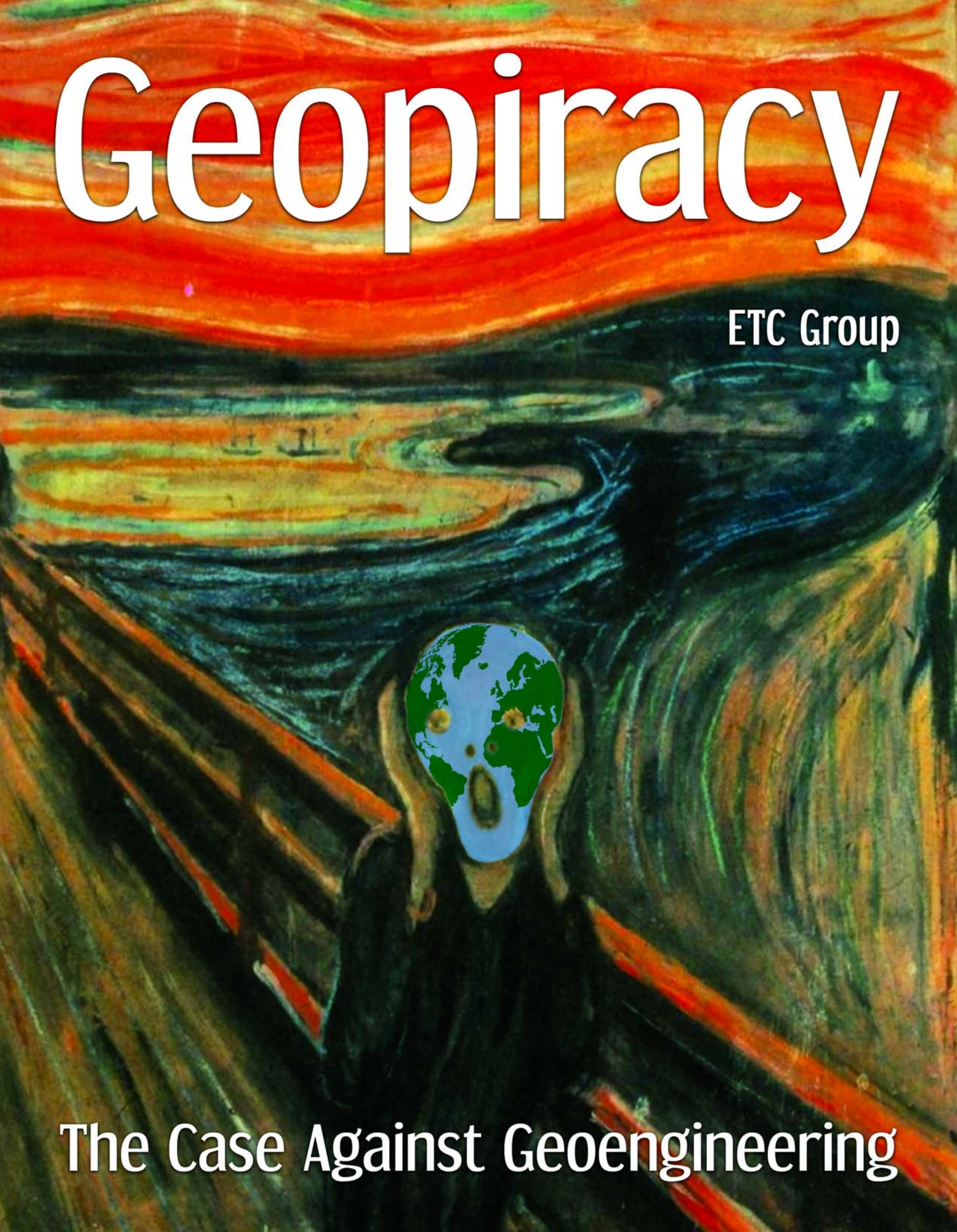
Geopiracy

ETC Group



The Case Against Geoengineering

"We cannot solve our problems with the same thinking we used when we created them."

Albert Einstein

"We already are inadvertently changing the climate. So why not advertently try to counterbalance it?"

Michael MacCracken,
Climate Institute, USA

About the cover

The cover is an adaptation of ***The Scream*** by Edvard Munch, painted in 1893, shown on the right. Munch painted several versions of this image over the years, which reflected his feeling of "a great unending scream piercing through nature." One theory is that the red sky was inspired by the eruption of Krakatoa, a volcano that cooled the Earth by spewing sulphur into the sky, which blocked the sun. Geoengineers seek to artificially reproduce this process.

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Geopiracy:

The Case Against Geoengineering

Contents

Overview: Geopiracy: The Case Against Geoengineering 1

Introduction 3

Defining geoengineering 4

Box: Attempts to define geoengineering 4

Box: Carbon capture and storage 7

Part I: The Context: Technology to the Rescue 8

Technology, the UNFCCC and geoengineering 8

Box: Carbon trade and the squeaky clean development mechanism 9

How we got here: the mainstreaming of geoengineering 10

Media Blitz: Increase in publications while policy makers test the waters 12

The Lomborg manoeuvre: once climate change denier, now geoengineering devotee 14

Geoengineering, climate change and agriculture 15

Part 2: Geoengineering: The Technologies 18

Box: Proof of principle: Is geoengineering feasible? 18

Solar radiation management (SRM) 19

Box: Geoengineering technologies involving solar radiation management 19

Carbon dioxide removal and sequestration 20

Box: Geoengineering technologies involving CO_2 removal and sequestration 20

Weather modification 21

Box: Geoengineering technologies involving weather modification 21

Box: Geoengineering – a brief technical history 22

Case study 1: Ocean fertilization 23

Box: Ocean Fertilization – The Planktos Story 25

Case study 2: Artificial volcanoes – Reflective particles in the stratosphere 25

Case Study 3: Cloud whitening – albedo enhancement below the stratosphere 27

Case Study 4: Burn and bury biochar 28

Geoengineering and Intellectual Property Claims 29

Box: A sampling of Geoengineering Patents 30

Box: Why is Geoengineering unacceptable? 33

Part 3: Governing Geoengineering or Geoengineering Governance? 34

Some key moments 34

The political economy of research 35

Box: ABCDE...Won't you research along with me! 36

UK and US lead geoengineering research 36

Experimenting with Mother Earth: Small-scale Geoengineering is an Oxymoron 37

Military Matters 38

Corporate Connections 38

Macho Mama: Geoengineering's gender bias 39

The case for a Moratorium 39

Govern all technology, not just Geoengineering technologies 40

Appendix 1: A selection of existing International Treaties that could be violated by Geoengineering experiments 41

Appendix 2: An International Convention for the Evaluation of New Technologies (ICENT) 43

Box: Elements of ICENT 43

Endnotes 45

Overview:
Geopiracy: The Case Against Geoengineering

'Bio Wrench' by tanuki

Issue:

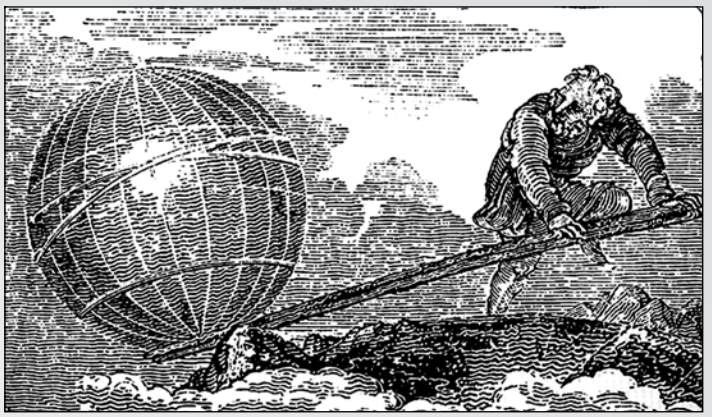
Realpolitik, we are advised, recognizes that the multilateral system can't produce an equitable or effective agreement that will mitigate climate chaos: Recognizing this, concerned governments and scientists have no reasonable choice but to investigate technological strategies that could reduce or delay climate change, at least until social forces make a practical agreement possible. Also according to *Realpolitik*, there is no more hope of achieving a multilateral consensus on re-jigging the thermostat than there is of adopting effective targets for greenhouse gas (GHG) emissions. Therefore, the issue is to create a narrative and construct a governance model that will allow a courageous, far-sighted, science-based "coalition of the willing" to justify their unilateral manipulation of the Earth's systems. They call it geoengineering – we call it geopiracy.

At Stake:

First and foremost is the international control of planetary systems: our water, lands and air. Second, is the commitment to climate change mitigation and adaptation. If some rich governments and industry see geoengineering as a quick, cheap fix for climate change, their money and technologies will be devoted to this "scientific solution" and there will be no resources to help the global South fend off the chaos ahead.

Actors:

Leading the push to advance geoengineering are the UK's Royal Society and the US National Academy of Sciences, joined by counterparts in other countries such as Canada, Germany and Russia. Policymakers, who are looking for a way through the next election even more than a way out of climate change, are listening. Discussions are now taking place in Parliaments and Congresses looking more for a way through the next election than a way out of climate change. Major energy, aerospace and defence enterprises are remaining in the background, for now, allowing scientific hubris and conservative think tanks (the very ones that used to deny climate change) to take the heat. Once others deliver the "shock" – that climate chaos is upon us and GHG emissions won't be reduced in time – industry can deliver the "therapy" of techno-fixes that will alter the stratosphere and/or restructure ocean surfaces to ostensibly buy us more time.



Fora:

Although the main forum for climate change negotiations is the United Nations Framework Convention on Climate Change, the UN Convention on Biological Diversity (CBD) has been quick to defend marine biodiversity by establishing a de facto moratorium against ocean fertilization (one form of geoengineering) at its ninth Conference of the Parties in Bonn, Germany in 2008. The broader issue of geoengineering is now firmly on the CBD's agenda. Given the sorry state of climate change negotiations and catastrophic environmental state of the planet, both climate change and geoengineering will be on the table in the lead up to the UN's Conference on Sustainable Development (Rio+20 Summit) to be held in Brazil in 2012 where international environmental governance is a key thematic focus.

"No matter how great the scientific wizardry, the modern Archimedes still has no place to stand, no acceptable lever or fulcrum, and no way to predict where the Earth will roll if tipped."

James Fleming

Policies:

A moratorium on real-world geoengineering experimentation is urgent. Additionally, the CBD, the UN Environment Programme (UNEP) and / or the UN General Assembly should seek the advice of the International Court of Justice to confirm that geoengineering experimentation would be a violation of the 1978 Environmental Modification Treaty (ENMOD). The Rio+20 Summit should tackle head-on the governance of geoengineering as well as the evaluation of other new and emerging technologies that pose grave threats to the environment and to the hundreds of millions of people who depend upon its health for their livelihoods.

Introduction

The "proof of principle," that cumulative, local interventions in ecosystems can bring about planetary-level effects, is beyond dispute. That's why we have human-induced climate change. However, another notion is quickly gaining ground: that we can use geoengineering to purposefully intervene to correct the unintentional harm we've done to our climate.

Geoengineering is the intentional, large-scale intervention in the Earth's oceans, soils and/or atmosphere, most often discussed in the context of combating climate change. Geoengineering can refer to a wide range of schemes, including: blasting sulphate particles into the stratosphere to reflect the sun's rays; dumping iron particles in the oceans to nurture CO_2 -absorbing plankton; firing silver iodide into clouds to produce rain; genetically-engineering crops so their foliage can better reflect sunlight.

University of Calgary physicist and geoengineering advocate, David Keith, describes geoengineering as "an expedient solution that uses additional technology to counteract unwanted effects without eliminating their root cause."[1] In other words, geoengineering uses new technologies to try to rectify the problems created by the use of old technologies, a classic techno-fix.

Geoengineering is the intentional, large-scale technological manipulation of the Earth's systems, including systems related to climate.

Amidst growing public unease and increasing concentrations of carbon dioxide in the atmosphere, Organisation for Economic Co-operation and Development (OECD) countries are feeling the pressure to "bite the bullet." They either adopt socially-responsible policies to dramatically cut fossil fuel use and consumption, or they can hope for an alternative – a "silver bullet" in the form of an array of techno-fixes that will allow them to maintain the *status quo* and dodge the consequences. No surprise, the silver bullet option – most clearly embodied in the form of geoengineering – is gaining momentum. Also not surprising: the states in the global North, which are responsible for almost all historic greenhouse gas (GHG) emissions and have either denied climate change or prevaricated for decades, are the ones warming most quickly to the geoengineering option. And they will have de facto control over its deployment.

Only the world's richest countries can really muster the hardware and software necessary to attempt rearranging the climate and resetting the thermostat. Equally unsurprising is that once the smog clears, the major private sector players in geoengineering will likely be the same energy, chemical, forestry and agribusiness companies that bear a large responsibility for creating our current climate predicament – in effect, the same folks who geoengineered us into this mess in the first place.

Opting for geoengineering flies in the face of precaution. Even some of those who would like to see large-scale investment in the field are quick to acknowledge that we do not know enough about the Earth's systems to risk intentional geoengineering, or even to risk real-world geoengineering experiments. We do not know if geoengineering is going to be inexpensive, as proponents insist – especially if/when geoengineering doesn't work, forestalls constructive alternatives, or causes adverse effects. We do not know how to recall a planetary-scale technology once it has been released. Techniques that alter the composition of the stratosphere or the chemistry of the oceans are likely to have unintended consequences as well as unequal impacts around the world (sometimes referred to euphemestically as "spatial heterogeneity").[2] As much as the Industrial Revolution's unintended "geoengineering" experiment has disproportionately harmed people living in tropical and subtropical areas of the world, purposeful geoengineering experiments are liable to do the same.

The governments that are quietly contemplating funding geoengineering experimentation are the ones that have failed to pony up even minimal funds for mitigation or adaptation action on climate change. Indeed in some quarters the MAG approach (Mitigation, Adaptation and Geoengineering) is already being proposed for discussions on climate change.[3] These governments will eagerly divert climate change funding away from climate change mitigation and adaptation toward geoengineering if given the opportunity.

After all, they can spend the money on their own scientists and corporations to launch initiatives that are more likely to benefit their part of the world. There is no reason for the governments or peoples of most of Africa, Asia and Latin America to trust that the governments, industries or scientists of the biggest carbon-emitting states will protect their interests. In the absence of demonstrable goodwill by the states likely to conduct geoengineering, the governments of the global South should be more than suspicious. In the absence of public debate and without addressing the inequalities between rich countries and poor countries – in terms of both historical responsibility for climate change and the potential impacts of any techniques deployed to address it – geoengineering is an act of geopiracy.

Defining geoengineering

Defining geoengineering is a political act. As new technological climate fixes are contemplated, definitions become more complex and more contentious. For example, whether or not carbon capture and storage, biochar, or weather modification are geoengineering technologies is hotly disputed. At the same time, as governments and multilateral organizations begin to articulate positions on these developments, they require more precise definitions. Anyone who has participated in international negotiations knows the long and tedious hours spent wrangling over definitions that can have far-reaching consequences when they are incorporated into international law or multilateral agreements.

ETC Group defines geoengineering as the intentional, large-scale technological manipulation of the Earth's systems, including systems related to climate.

Attempts to define geoengineering

From the **US National Academy of Sciences** (1992):

Large-scale engineering of our environment in order to combat or counteract the effects of changes in atmospheric chemistry.[4]

From the **UK Royal Society** (2009):

...the deliberate large-scale intervention in the Earth's climate system, in order to moderate global warming...
Geoengineering can usefully be divided into two basic 'classes':
1. Carbon dioxide removal (CDR) techniques which remove CO_2 from the atmosphere;
2. Solar Radiation Management (SRM) techniques that reflect a small percentage of the sun's light and heat back into space.[5]

From the **American Meteorological Society** (2009):

Geoengineering proposals fall into at least three broad categories: 1) reducing the levels of atmospheric greenhouse gases through large-scale manipulations (e.g., ocean fertilization or afforestation using non-native species); 2) exerting a cooling influence on Earth by reflecting sunlight (e.g., putting reflective particles into the atmosphere, putting mirrors in space, increasing surface reflectivity, or altering the amount or characteristics of clouds); and 3) other large-scale manipulations designed to diminish climate change or its impacts (e.g., constructing vertical pipes in the ocean that would increase downward heat transport).[6]

Continued on next page...

From **University of Calgary** physicist and entrepreneur **David Keith** (2000, 2001):

> ***The intentional large-scale manipulation of the environment. Climatic geoengineering aims to mitigate the effect of fossil-fuel combustion on the climate without abating fossil fuel use; for example, by placing shields in space to reduce the sunlight incident on the Earth. Climatic geoengineering is marked by four characteristics, scale, intent, technology and countervailing action. Two examples serve to demonstrate the roles of scale and intent. First, intent without scale: Ornamental gardening is the intentional manipulation of the environment to suit human desires, yet it is not geoengineering because neither the intended nor realized effect is large-scale. Second, scale without intent: The modification of global climate due to increasing atmospheric CO_2 has global effect, yet it is not geoengineering because it is a side effect resulting from combustion of fossil fuels with the aim of providing energy services. Finally, such proposals are primarily technological rather than social and their mode of action is by counterbalancing some other human impact rather than by minimizing that impact. Put simply, geoengineering is a technological fix on a grand scale.***[7]

The **UK Government** (2009):

> ***The government agrees that technologies which reduce solar insolation or increase carbon sequestration from the atmosphere (excluding carbon capture and storage) should both be considered as forms of geoengineering.***[8]

From the **Intergovernmental Panel on Climate Change** (2010):

> ***The deliberate large-scale manipulation of the planetary environment. Geoengineering methods can be largely classified into two main groups: Solar Radiation Management (SRM) and Carbon Dioxide Removal (CDR).***[9]

From the **New Oxford Dictionary of English** (word added in 2010)

> ***The deliberate large-scale manipulation of an environmental process that affects the earth's climate, in an attempt to counteract the effects of global warming.***

Most definitions include some reference to the stated intent of the technologies: to combat climate change. But the laudable goal of combating climate change has no business in the definition of geoengineering, as it suggests that technologies do, in fact, combat climate change giving the whole suite of planet-altering technologies a veneer of respectability they have not earned. As U.S. meteorologist and historian James Fleming points out, an engineering practice that is defined by its scale (geo) should not be constrained by its stated purpose (environmental improvement) or by its currently proposed techniques (space mirrors) or by one if its perhaps many stated goals (to counteract anthropogenic climate change): "to constrain the essence of something that does not exist by its stated purpose, techniques or goals is misleading at best."[10]

There is also a move, particularly by scientists actively involved in geoengineering research, to get away from the term altogether. They argue that the term is too vague, or that it sends the wrong message and that other terms are better from the point of view of public relations. The scientists who gathered in Asilomar, California, in March 2010 to look at "voluntary guidelines" for research, for example, not only studiously avoided the term geoengineering (the conference was on "climate intervention") but they also sought to rebrand "solar radiation management" as "climate intervention" and carbon dioxide removal as "carbon remediation." Furthermore, the statement by the Scientific Organizing Committee at the conclusion of the controversial meeting does not mention geoengineering (nor for that matter, the voluntary standards the meeting was convened to develop).

The 'team photo' at the Asilomar Conference on "Climate Intervention" California, March 2010

Weather modification is another controversial issue and is often explicitly excluded from discussions of geoengineering. However, as James Fleming has shown, the contemporary fascination with climate manipulation has its historical roots in weather modification[11] and we would be unwise to ignore that history. Some recent reports have excluded weather modification from their understanding of geoengineering, arguing that it is local and short-term and therefore, unlike geoengineering, intended to combat climate change.[12] This ignores the fact that the history, the intention, the technologies themselves, the institutions and the potential impacts have a great deal in common with global climate engineering schemes – there are too many overlaps with climate manipulation and too many potentially dangerous extraterritorial impacts to ignore this whole field of "science."

Different multilateral bodies may end up defining geoengineering differently. However, most, if not all, would agree that the following elements are included in the definition of geoengineering:

Intent: Geoengineering is always deliberate (even if it may have unintended impacts). Unintentional damage of global environment or climate (ie., global warming) is thus excluded.

Scale: Geoengineering technologies are intended for global, or at least large-scale, deployment rather than local application.

Technology: Geoengineering is a technological approach: changing consumption patterns or promoting low-tech organic agriculture, for example, do not qualify although either could have a noticeable impact on the climate.

Earth systems: Contemporary discussions about geoengineering almost always invoke the climate crisis (that is the main rationale for their deployment: desperate measures for desperate times) but it is conceivable that geoengineering schemes could be employed to manage Earth's other systems such as the hydrological or nitrogen cycles in addition to the carbon cycle. While it may be useful to refer to the climate for descriptive purposes, it would be short-sighted to think that climate change mitigation will be the sole purpose of these technologies.

But beyond all these criteria, geoengineering is also a philosophy and a world view that is heavily coloured by a Western, male-dominated, narrowly scientific paradigm that fails to recognize its own epistemic position of privilege. As Simon Terry of the Sustainability Council of New Zealand has pointed out, geoengineering contrasts sharply with the notion of stewardship, seeing our ecosystems as resources to be optimized or "fixed" rather than systems to be protected and restored.[13] The Encyclopedia Britanica defines engineering as "the application of science to the optimum conversion of the resources of nature to the uses of humankind,"[14] while the "geo" of course refers to the Earth. As Indian ecologist Vandana Shiva put it recently: "It's an engineering paradigm that created the fossil fuel age that gave us climate change...Geoengineering is trying to solve the problems in the same old mindset of controlling nature."[15]

"Geoengineering is trying to solve the problems in the same old mindset of controlling nature."

Vandana Shiva

Carbon capture and storage (CCS)

Carbon capture and storage is a technological process that traps carbon dioxide (CO_2) emitted from industrial sources, particularly power plants, by compressing the gas into liquid then pumping it through pipes to a location underground, where it can theoretically be safely and permanently stored. Advocates predict that CCS technologies, sometimes marketed as "clean coal," will one day play a critical role in the reduction of carbon emissions from coal power generation – currently responsible for 40% of total CO_2 emissions. Fossil fuel interests are lobbying for CCS to be recognized under the UNFCCC's Clean Development Mechanism, which would make it eligible for carbon credits.

While CCS is often presented as a partial solution to climate change, in many cases it is actually used to enhance the extraction of fossil fuels. For example, in the U.S., companies have injected 10.8 trillion cubic feet of CO_2 into oil reserves, increasing oil production by 10%. In Norway (which has a carbon tax, making CCS a more attractive business proposition than elsewhere) some CO_2 is used to help extract the remaining reserves of natural gas in the North Sea and the rest is pumped deep below sea.

Safe, permanent storage of the CO_2 is a major hurdle, despite assurances from fossil fuel interests and high-emissions countries.

There are significant technological and economic challenges in both elements of CCS – both capture and storage – that have not been resolved, despite billions of dollars of public investment by coal-addicted countries. While some technologies to capture carbon dioxide, such as amine scrubbing, have been around since the 1930s, they have not been demonstrated on an industrial scale. In fact, some "clean coal" projects have been cancelled because the amount of energy necessary to convert the coal to gas and then capture the CO_2 is as much as the plant would produce in the first place.[16]

Generally, CCS is not considered a geoengineering technology because CCS captures carbon dioxide at source, so, theoretically, it never enters the atmosphere. Most geoengineering technologies that fall in the category of Carbon Dioxide Removal (CDR) are attempts to remove carbon dioxide from the atmosphere after it has been emitted, thereby actively intervening in the climate. This, for example, is what ocean fertilization and so-called synthetic trees aim to do.

However, safe, permanent storage of the CO_2 is a major hurdle, despite assurances from fossil fuel interests and high-emissions countries, which have set up "independent" institutes to promote CCS.[17] Sequestering CO_2 – before or after it is emitted into the atmosphere – involves risks. According to a recent study published in Nature Geoscience that examined five different CCS scenarios, geophysicist Gary Shaffer found: "Most of the investigated scenarios result in a large, delayed warming in the atmosphere as well as oxygen depletion, acidification and elevated CO_2 concentrations in the ocean. Specifically, deep-ocean carbon storage leads to extreme acidification and CO_2 concentrations in the deep ocean, together with a return to the adverse conditions of a business-as-usual projection with no sequestration over several thousand years. Geological storage may be more effective in delaying the return to the conditions of a business-as-usual projection, especially for storage in offshore sediments. However, leakage of 1% or less per thousand years from an underground stored reservoir, or continuous resequestration far into the future, would be required to maintain conditions close to those of a low-emission projection with no sequestration."[18]

Part I: The Context: Technology to the Rescue

Technology, the UNFCCC and Geoengineering

The United Nations Framework Convention on Climate Change (UNFCCC) Conference (COP 15) in Copenhagen December 2009 was billed as the last chance for international negotiators to agree on a post-2012 Framework that can bring about significant reductions in GHG emissions. The first commitment period of the Kyoto Protocol, which entered into force in 2005 and set binding emission-reduction targets for 37 industrialized countries plus the European Community (so-called Annex 1 countries),[19] expires in 2012. A new legally binding climate agreement was supposed to be sealed in the Danish capital, but the meeting ended in disarray, with hundreds of climate justice activists in jail and exhausted delegates being strong-armed into supporting a "Copenhagen Accord" that was by and large a face-saving device for the USA. The chances of a deal being made under the auspices of the UNFCCC in Mexico in 2010 or South Africa in 2011 are remote at best, and the fact that the multilateral forum is unable to deliver a deal is used by geoenegineers to bolster their case to take another course of action.

Annex 1 countries want to abandon the Kyoto Protocol and its notion of "common but differentiated responsibilities" (which puts the onus on those who have historically been the biggest carbon-emitting countries), and get developing countries to accept a deal that makes everyone share the climate debt that wealthy countries have incurred. (It's difficult not to draw a parallel with the financial bailout where governments spent trillions of public dollars to protect banks and businesses while allowing more than a billion people to go hungry, including an additional 150 million people during the current food crisis – sparked itself, in part, by climate change and agrofuels that are supposed to mitigate climate change.[20])

The UNFCCC's Fact Sheet, *Why is Technology so Important?* sums up the Convention's stance: "Environmentally sound technologies are able to provide win-win solutions, allowing global economic growth and climate change mitigation to proceed hand in hand."[21] In other words, technology will allow us to continue on our current trajectory without any reductions in production and consumption – in fact, we are told, technology will enable us to produce and consume more without suffering consequences. Implicit in the faith in technology is a concomitant faith in the private sector: "The role of business as a source of solutions on global climate change is universally recognized," according to the Fact Sheet.

Rich governments are hoping for quick fixes rather than risk inconveniencing their electorate or offending industry. As dangerous as geoengineering may sound (and turn out to be), governments around the world are aware that some action must be taken (or appear to be taken) quickly. They're also aware that carbon-trading schemes won't put a dent in climate change. Geoengineering warrants serious debate and pre-emptive action. The terms "environmentally-sound technologies" (EST) and "innovative technologies" are ubiquitous in climate negotiating texts though there is no explicit definitions of these concepts in the context of climate change mitigation and adaptation, and no specificity about which technologies are involved.

Rich governments are hoping for quick fixes rather than risk inconveniencing their electorate or offending industry.

There are also numerous references to "enabling environment" for technology transfer, covering a wide array of issues, including intellectual property rights (IPRs), incentive mechanisms, and the removal of barriers for technology development and transfer. IPRs are particularly hotly-contested due to wide disagreement about whether they promote or inhibit innovations in climate technologies. (See Geoengineering and Intellectual Property Claims, below.)

The role of the private sector in the different stages of the "technology cycle" and in financing technology development is another contentious issue. Parties have submitted proposals to leverage private investments in the deployment, diffusion and transfer of technologies. Proposals have also been submitted to connect private companies that can provide specific technologies to countries that have already adopted "appropriate measures," which may become prerequisites for technology support. Some developed countries, for example, are proposing the promotion of voluntary technology agreements and partnerships in cooperative research and development and large-scale demonstration projects and technology deployment projects.

In all cases, the "technology cycle" is understood as: research, development, deployment, diffusion and transfer. There is no provision for assessment, and no institution charged with evaluating the impacts of different technological options on climate or people. And there is no attempt to assess which technologies will be most immediately useful, and for whom. In fact, some ideas, like the protection of traditional knowledge of small-scale farmers through seed-saving and crop rotations, which are known to cause no harm to the climate, play second fiddle to approaches such as industrial, high-input technologies like monoculture tree plantations for the production of agrofuels (still considered an environmentally sustainable technology) and biochar, i.e., using buried plant biomass as a carbon sink. It is essential for negotiators at the UNFCCC to keep in mind the full suite of technologies that may come into play, including geoengineering technologies.

While the word *geoengineering* does not (yet) appear in the negotiating text, as long as geoengineering techniques are not explicitly excluded, it can be assumed they are encompassed under the general term technology, and all the provisions on "enhanced action" could therefore apply. Geoengineering techniques that "manage solar radiation" (i.e., prevent a portion of sunlight from hitting the Earth) could also be implied in the temperature reduction targets adopted by states. Already, some geoengineering advocates (notably ocean fertilization and biochar advocates) have tried to use the Convention to get unproven technologies accredited under the Clean Development Mechanism (CDM), which allows countries with emission-reduction commitments to "move" their obligation to an emission-reduction project in a developing country. If a technology as potentially harmful as ocean fertilization or biochar becomes accredited under the CDM, the profits to be made by using the oceans and Earth as ostensible "carbon sinks" will quickly subordinate the other vital functions they serve – notably, but certainly not uniquely, as food sources.

Carbon trade and the squeaky clean development mechanism

The Kyoto Protocol has three "market-based mechanisms" (emissions trading, joint implementation and the Clean Development Mechanism [CDM]), which were introduced in the last hours of the Kyoto negotiations. The CDM mechanism provides flexibility to rich countries unlikely to meet their emission reduction targets domestically by allowing them to buy "offsets" that support "clean" development in the South that would not have occurred without offsets (this is known as "additionality"). That means, theoretically, large polluters in the North will invest in projects in developing countries in order to compensate for the negative impact of their own high emissions. The process is overseen by a CDM executive board, under the authority of the Conference of the Parties of the UNFCCC. The number of CDM projects has exploded recently, growing tenfold, for example, between 2005 and 2007 (from 10 to 100 proposals a month). More than 4000 projects have been supported.

The CDM has been widely criticized at a conceptual level as well as for the way it operates on the ground. Indeed, the CDM itself acknowledges "the renewed urgency in 2009 [of] the task of improving the CDM."[22] One big problem is that it does not actually reduce emissions but rather buys the biggest polluters more time, worsening the climate crisis and allowing more and more GHGs into the atmosphere. In terms of its operations on the ground, common criticisms include: a very small number of countries have received the bulk of the projects;[23] local communities are not properly involved in decision making, resulting in social and environmental hardships; monoculture plantations by agro-forestry companies have replaced traditional and more sustainable land uses; large hydro-electric power stations with negative local impacts have also been certified under the CDM; indigenous peoples have not been able to properly assert their rights in the processes.

While the problems with carbon trading and offsetting are becoming steadily more apparent, influential states within the UNFCCC are working to increase the scope of such mechanisms, notably by the adoption and expansion of REDD programs (Reducing Emissions from Deforestation and Degradation in developing countries) and REDD +, which will expand its activities to include "conservation, sustainable management of forests and enhancement of forest carbon stocks." Although the theory behind REDD sounds sensible (pay people to keep forests standing rather than to cut them down), the consequences in fact could be devastating. Firstly, speculation will be accelerated in a race to control the carbon credits that can be obtained from forests which are newly valuable as carbon sinks. Secondly, more monoculture tree plantations and biochar will place even greater pressures on scarce land. Thirdly, there are indigenous and forest peoples as well as local communities living in and near most of the world's forests. Certifiers and consultants from outside these communities will be the ones who are empowered to "manage" these forests, alienating the rights of indigenous peoples over their own land, effectively constituting a new wave of colonization so that polluting companies can "purchase" the fresh air produced by their conservation.[24] Annex 1 countries are fighting for an ambitious role for the international financial institutions, particularly the World Bank, whereas developing countries are dissatisfied with its undemocratic governance structure (based on financial contributions), conditionalities and prescriptive economic policies that have been so harmful over the past two decades.

CDM is critical in climate negotiations, and there are efforts to expand its scope to include technologies such as Carbon Capture and Storage (CCS), nuclear power and biochar. Critical assessment of the CDM needs to include an understanding of what existing and new technologies are under consideration.

How we got here: the mainstreaming of Geoengineering

In a sense, geoengineering has always been on the table as a possible response to climate change. As early as 1965, the U.S. President's Science Advisory Committee warned, in a report called *Restoring the Quality of Our Environment,* that CO_2 emissions were modifying the Earth's heat balance.[25] That report, regarded as the first high-level acknowledgment of climate change, went on to recommend – not emissions reductions, but a suite of geoengineering options. The authors of the report asserted, "The possibilities of deliberately bringing about countervailing climatic changes...need to be thoroughly explored." They suggested that reflective particles could be dispersed on tropical seas (at an annual cost of around $500 million), which might also inhibit hurricane formation. The Committee also speculated about using clouds to counteract warming. As James Fleming, the leading historian of weather modification, wryly notes: The first ever official report on ways to address climate change "failed to mention the most obvious option: reducing fossil fuel use."[26] In 2005, forty years after the release of the Science Advisory Committee's report, everybody, including – finally – the sitting U.S. president, was talking about global warming: scientists warned that the temperature rise on the Arctic ice cap and Siberian permafrost could "tip" the planet into an environmental tailspin, and the U.S. Congress agreed to study a bill that would establish a national "Weather Modification Operations and Research Board."

"Today's aspiring climate engineers wildly exaggerate what is possible and scarcely consider the political or ethical implications of attempting to manage the world's climate."

James Fleming

The current debate over the possibility of engineering the Earth's climate can be traced to a paper[27] co-authored by the late Dr. Edward Teller – the Nobel laureate responsible for the hydrogen bomb and one of the most politically influential U.S. scientists in the latter half of the 20th century. Teller lent his support to geoengineering when he and two colleagues submitted their paper to the 22nd International Seminar on Planetary Emergencies in Erice, Sicily in 1997. While the authors did not present their views as being endorsed by the U.S. government, their work was conducted at the Lawrence Livermore National Laboratory, under contract with the U.S. Department of Energy.

Teller might have been dismissed as a scientist past his prime (he was 89 years old at the time of the Sicilian seminar, after all) except that another Nobel laureate, Paul J. Crutzen – who won his Prize for pioneering work on the ozone layer – amplified the scientific shockwave in 2002 when he offered grudging support for geoengineering in the journal *Nature*.[28] Since we're living in the "anthropocene" era when humans are increasingly affecting the climate, Crutzen suggested, our future "may well involve internationally accepted, large-scale geoengineering projects." The same year, *Science* published its own article arguing for geoengineering as a legitimate approach to combat climate change.[29]

Also in 2002, Teller, along with colleagues Roderick Hyde and Lowell Wood, submitted an article to the U.S. National Academy of Engineering in which they argued that geoengineering – not reduction of GHG emissions – "is the path mandated by the pertinent provisions of the UN Framework Convention on Climate Change."[30]

In 2005, another high profile climatologist, Yuri Izrael, former vice-chair of the Intergovernmental Panel on Climate Change and head of the Moscow-based Institute of Global Climate and Ecology Studies, wrote to Russian president Vladimir Putin outlining a proposal to release 600,000 tonnes of sulphur aerosol into the atmosphere to take a few degrees off global temperatures. (In 2009, Izrael actually did the first real-world experiment of this kind. According to science reporter Eli Kintisch,[31] a follow-up experiment was done which released "smoke" from helicopters at an altitude of 8000 feet [2438 meters], and further experiments are planned over ten square kilometers in Russia. These experiments are both too small and too low in the atmosphere to provide real data on the climatic effects on stratospheric aerosols but nonetheless illustrate the seriousness of the issue of countries unilaterally undertaking atmospheric experiments to test geoengineering theories.)

Paul Crutzen returned to the debate in August 2006 when he wrote an "editorial essay" in the journal *Climatic Change* calling for active research into the use of "sub-micrometer"-sized sulfate-based aerosols to reflect sunlight into the stratosphere in order to cool the Earth.[32] Crutzen, a professor at the Max-Planck-Institute for Chemistry in Mainz, Germany, opined that high-altitude balloons and artillery cannons could be used to blast sulphur dioxide into the stratosphere, in effect, simulating a volcanic eruption.

The sulphur dioxide would convert to sulfate particles. The cost would run between $25 and $50 billion per year – a figure, he argued, that was well below the trillion dollars spent annually by the world's governments on defense. Crutzen noted that his cost estimates did not include the human cost of premature deaths from particulate pollution. Such tiny reflective particles could be resident in the air for two years. Crutzen willingly acknowledged that his was a risky proposition and insisted that it should be undertaken only if all else fails. He went on to add that the political will to do anything else seemed to have failed already.

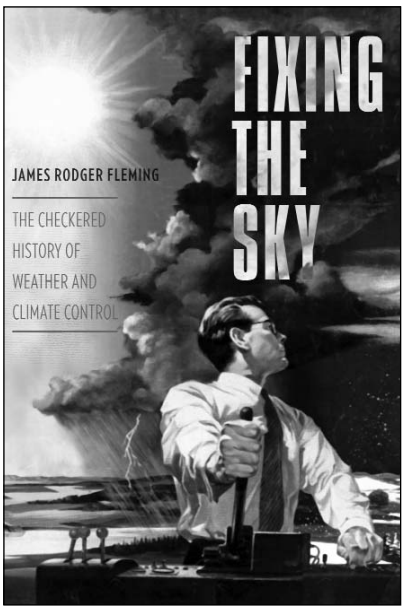
An editorial in the same issue of *Climatic Change* by Ralph J. Cicerone, an atmospheric chemist and president of the U.S. National Academy of Sciences, also supported further research on Crutzen's geoengineering proposals. He told *The New York Times* in mid-2006: "We should treat these ideas like any other research and get into the mind-set of taking them seriously."[33]

By November 2006, NASA's Ames Research Center had convened an elite meeting of geoengineering advocates to explore options with Lowell Wood presiding. "Mitigation is not happening and is not going to happen," the aging physicist reportedly told the group. The time has come, he argued, for "an intelligent elimination of undesired heat from the biosphere by technical ways and means." According to Wood, his engineering approach would provide "instant climatic gratification." From that meeting came the beginnings of a campaign to secure funding for geoengineering techniques – requiring the field to gain respectability – and fast. The crowning achievement in the campaign for legitimacy and funding was the 2009 publication of the UK Royal Society's *Geoengineering the Climate: Science, governance and uncertainty*.

In the months leading up to the Copenhagen Conference, the UK House of Commons Committee on Science and Technology in collaboration with its Congressional counterpart in the United States (House of Representatives Committee on Science and Technology) announced joint hearings on the subject of the regulation of geoengineering. Apparently oblivious to how his statement would sound to the rest of the world, the UK Committee Chair Phil Willis declared: "What better subject than geoengineering – where international collaboration is essential if we are to explore and understand fully its potential – to provide the backdrop to a first-of-its-kind collaboration between UK and US scrutiny committees."[34] The two committees heard from many of the same witnesses – the majority of whom were male scientists actively engaged in geoengineering research.

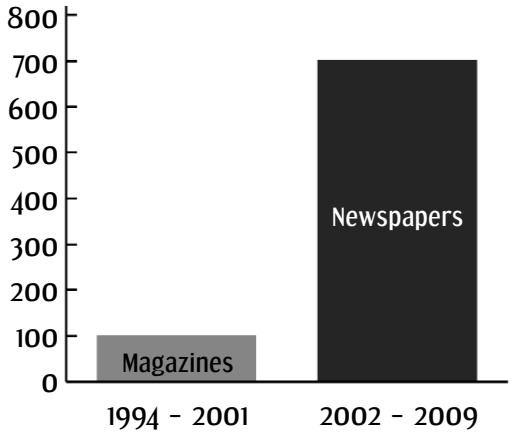
Media Blitz: Increase in publications while policymakers test the waters

To date, current support for geoengineering has come from scientific and political circles, as well as mainstream media. Once a few prominent climate scientists had endorsed geoengineering as a scientifically credible endeavor – in print – publishing in the field exploded both in scholarly journals (almost a fivefold increase) and in the popular press (a twelvefold increase), as seen in the graphs below.[35] It is now politically correct to talk about geoengineering as a legitimate response to climate change: a credibility shift that *The New York Times* called a "major reversal."[36]

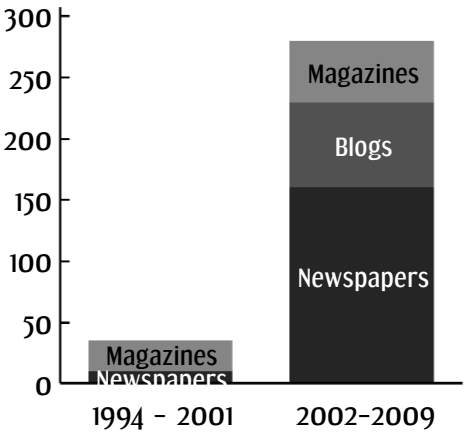


James Fleming,* Fixing the Sky: The Checkered History of Weather and Climate Control, *Columbia University Press, 2010, provides essential historical background as well as a critical commentary on contemporary debates about geoengineering.

Scientific articles on geoengineering before and after 2002



Media coverage of geoengineering before and after 2002



The failure to reach a meaningful multilateral consensus on emissions reduction at COP 15 in Copenhagen – despite the largest mobilization for climate justice in history outside the official conference – offered geoengineers the opportunity they had be waiting for. Indeed, exhausted delegates were just beginning to check out of their hotels when Nathan Myhrvold gave a 30-minute interview on CNN[37] extolling the virtues of putting sulphates into the stratosphere as a solution to global warming, and explaining how a 25-kilometre hose held up by balloons could deliver the particles to the right place to reflect sunlight away from the Earth.

Myhrvold is a former Chief Technology Officer at Microsoft and now runs Intellectual Ventures Management, LLC, which holds patents on geoengineering technologies. Prominent geoengineering scientists Ken Caldeira and John Latham are listed amongst the firm's senior inventors, whom Intellectual Ventures supports with funding and business expertise. The firm files 500-600 patents every year. Ken Caldeira and David Keith jointly manage the "Fund for Innovative Climate and Energy Research" bankrolled by Bill Gates. Since 2007 the Fund has given out $4.6 million in research grants. Some time after major media brought attention to the fund's lack of transparency,[38] a FAQ page was posted on the web site of David Keith's employer, the University of Calgary.[39]

In April 2009, John Holdren, Chief Science Advisor to U.S. President Barack Obama, conceded that the administration is considering geoengineering options to combat climate change.[40] The next month, U.S. Energy Secretary Steven Chu indicated his support for technological solutions to climate change, including "benign" geoengineering schemes that whitened rooftops.[41] In June 2009, the National Academies – the body tasked with advising the U.S. government on scientific issues – hosted a two-day workshop on "Geoengineering Options to Respond to Climate Change: Steps to Establish a Research Agenda."[42] (Geoengineering then figured prominently in "Advancing the Science of Climate Change,"[43] published in 2010.) Steven Koonin, Under Secretary for Science in the U.S. Department of Energy, was instrumental in preparing a report published in July 2009, which considered the technical feasibility of putting aerosol sulfates in the stratosphere to lower global temperatures.[44] Geoengineering is now being studied by the Congressional Research Service and the Government Accountability Office, while new funding is being contemplated by the Department of Energy.[45]

On the other side of the Atlantic, the science policy establishment has also been warming to geoengineering. A high-profile exhibit at London's Science Museum, "Can Algae Save The World?" coincided with reports that a senior UK environment minister was a closet fan of ocean fertilization. In a 2008 letter submitted to a geoengineering blog, the anonymous minister wrote that "ocean fertilization, because of it's [sic] enormous potential simply must (I will emphasize the word must) be explored vigorously...the question is how to do this without engendering public opposition."[46]

"If we could come up with a geoengineering answer to this problem, then Copenhagen wouldn't be necessary. We could carry on flying our planes and driving our cars."

Sir Richard Branson, industrialist and airline owner

The UK Parliamentary Innovation, Science, University and Skills Committee issued a report recommending research into geoengineering based on input from its 2008-2009 session.[47] This was followed by a more detailed set of hearings on the topic, leading to a report on the Regulation of Geoengineering in March 2010.[48] Early in 2009, the German Minister of Research authorized an ocean fertilization geoengineering experiment in the Scotia Sea despite the existence of a moratorium on the practice that his own government had helped broker at the UN Convention on Biological Diversity in 2008.[49]

In April 2009, Portugal's Ministry for Science, Technology and Higher Education convened a Chatham House Rules session on geoengineering.[50] In September, the Royal Society – the UK's national academy of science – followed with the launch of its report, *Geoengineering the Climate: Science, Governance and Uncertainty,*[51] giving geoengineering arguably its biggest credibility boost to date.

The authors of the Royal Society report argued that geoengineering is "an insurance policy" – an unsatisfactory and hopefully distant Plan B, but one that should be considered if we find ourselves in a climate "emergency." The authors acknowledge that there are many ways to geoengineer the planet and admit that little is known about the potential social and environmental impacts. The report recommends that governments fund a dedicated, ten-year internationally coordinated geoengineering research programme (£100 million of which would come from the UK government). The bulk of this research would be in the form of monitoring and computer simulations, but the report also recommends field trials for several technologies.

From some perspectives, the report's insistence that geoengineering be understood as "an insurance policy" may seem prudent, practical and even precautionary. But the report's explicit endorsement of geoengineering research and real-life experimentation – and its unwillingness to reject even the most outlandish schemes[52] – is troubling. The impetus for the report, according to the Royal Society, was the need to equip governments and society with an analysis of the scientific risks and benefits involved. Officials have pointed to the escalating interest in geoengineering over the previous several months and insisted that they felt obliged to take on the task of bringing "rigour" to an increasingly polemical debate.[53]

Unfortunately (or maybe predictably) the occasion of the Royal Society report launch was used by several advocates of the geoengineering approach as an apt moment to amplify their own viewpoints.

Neoconservatives across the Atlantic cooperated to launch a high profile report on why geoengineering is cheaper than climate mitigation (see "The Lomborg Manoeuvre" below), the UK's Institute of Mechanical Engineers pipped the Royal Society to the post by releasing their own favourable analysis of geoengineering one day earlier and one of the Royal Society's own working group members, Dr. Peter Cox (who is developing a cloud-based geoengineering project that targets West Africa) used the release of the report to launch a special geoengineering edition of Physics World under the mantra "Time to lift the geoengineering taboo."[54] The result was that whatever notes of caution appear in the Royal Society's report were lost under an avalanche of simultaneous pro-geoengineering press releases.

Geoengineering has also recently received attention from international agencies such as the World Bank – in its latest World Development Report[55] – and the United Nations Environment Programme (UNEP) in its recent compendium of scientific knowledge published since the last IPCC report.[56] The UNEP suggests that the issue of liability vis-à-vis geoengineering must be discussed but is pessimistic on the prospects for any international governance or regulation: "Considering how difficult it has been to reach agreement on the obvious climate challenge solutions based on common but differentiated responsibilities, the uncertainties involved in geoengineering schemes will likely prohibit any global agreement on deliberately interfering with Earth's Systems."[57] Previous reports of the IPCC have made only cursory and critical mentions of geoengineering, but its next report will cover the field in much more depth, given geoeengineering's recent credibility surge and that a number of prominent geoengineering scientists sit on its panels.

"If we can be made to believe that mega-scale geoengineering can stop climate change, then delay [to reduce emissions] begins to look not like the dangerous folly it actually is, but a sensible prudence."

Alex Steffen,
Executive Editor of
Worldchanging

The Lomborg Manoeuvre: once climate change denier, now geoengineering devotee

An odd effect of geoengineering's mainstreaming has been an alignment of the positions of some interest groups that were previously diametrically opposed. While some long-time climate scientists such as Paul Crutzen and Ken Caldeira claim to have only gradually and reluctantly embraced geoengineering fearing devastating effects from climate change, a new and powerful corporate lobby for geoengineering has emerged in the last two years made up of people whose motivation has never been concern for the environment or the world's poorest people.

In June 2008, Newt Gingrich, former Speaker of the House in the U.S. Congress, sent a letter to hundreds of thousands of Americans urging them to oppose proposed legislation to address global warming. Gingrich argued for geoengineering the atmosphere with sulfates as a better option to fight climate change. "Geoengineering holds forth the promise of addressing global warming concerns for just a few billion dollars a year," wrote Gingrich. "Instead of penalizing ordinary Americans, we would have an option to address global warming by rewarding scientific innovation...Bring on the American Ingenuity. Stop the green pig."[59]

Gingrich is a senior fellow of the American Enterprise Institute (AEI) – a neo-conservative think tank promoting free enterprise and limited government – closely associated with the recent Bush administration. AEI has its own full-time geoengineering project led by Lee Lane, who formerly issued strategic advice to the Bush administration. In 2009, Lane and co-author J. Eric Bickel published *An Analysis of Climate Engineering as a Response to Climate Change,*[60] a report advocating adding geoengineering to existing responses to climate change on the basis of a cost-benefit analysis. Lane and Bickel claimed spraying sea-water into clouds might fix climate change and thereby add $20 trillion to the global economy.

The report was published and widely broadcast by Bjørn Lomborg's Copenhagen Consensus Center. Lomborg is best known as the self-styled and controversial "Skeptical Environmentalist" who has consistently downplayed the existence and importance of climate change much to the anger of climate scientists. Lomborg is now using his "Copenhagen Consensus Center" and media profile to push for geoengineering not as a "Plan B" on climate change, but a "Plan A" – the preferred route to cooling the planet.

The "Lomborg manoeuver" – switching from opposing real-world action on climate change to supporting the most extreme possible action on climate change – is now becoming seemingly de rigueur among industrial apologists, former climate change skeptics and "deniers," especially in the United States. Besides Lane and Gingrich at AEI, political operators at the Cato Institute, the Thomas Jefferson Institute, the Hoover Institution, the Competitive Enterprise Institute, the Hudson Institute, the Heartland Institute, the International Policy Network and elsewhere are now increasingly professing their faith in the geoengineering gospel. While climate scientists and activists have just begun to debate geoengineering, the topic has been a mainstay of discussion for several years now at the Heartland Institute's International Conference on Climate Change, dubbed the annual "climate deniers jamboree" – with several invited talks and presentations by geoengineering advocates.

For those who previously doubted (or still do) the science of anthropogenic global warming, the geoengineering approach shifts the discussion from reducing emissions to an end-of-pipe solution. Once geoengineering is an option, there is no longer a need to bicker about who put the carbon dioxide in the atmosphere (or ask them to stop). If we have the means to suck up greenhouse gases or turn down the thermostat, emitters can continue unabated. At least one commentator has charged that the wholesale embrace of geoengineering by industry-friendly think tanks represents a deliberate tactic of distraction and delay by the same folks who formerly used oil company dollars to discredit the science of climate change. "If we can be made to believe that mega-scale geoengineering can stop climate change, then delay [to reduce emissions] begins to look not like the dangerous folly it actually is, but a sensible prudence," explains Alex Steffen, editor of Worldchanging.com.[61] Indeed, at least one high profile climate skeptic, Julian Morris of the International Policy Network, asserts, "Diverting money into controlling carbon emissions and away from geoengineering is probably morally irresponsible."[62]

Geoengineering, climate change and agriculture

While agriculture is rarely discussed in relation to geoenginering, some forms of agricultural production do indeed constitute geoengineering. This is the case, for example, with biochar, monoculture plantations of genetically-modified trees, or even the engineering of crops to have reflective leaves with an aim to increase the Earth's albedo. These are high-tech, large-scale attempts to modify the Earth's systems.

According to the IPCC, agriculture is the source for 14% of global GHG emissions, with the bulk coming from industrial agricultural production due to the heavy reliance on fossil fuels throughout its supply chain. Furthermore, the global industrial food system when taken as a whole (including transportation, energy for refrigeration, packaging and methane from urban waste) is responsible for an astounding 44-57% of greenhouse gas emissions.[63] Sustainable small-scale agriculture, in addition to feeding the majority of the world's people, has a much lighter footprint and can even absorb excess carbon dioxide from the atmosphere.[64] Nonetheless, the UNFCCC negotiations have largely ignored the role of peasant agriculture and are focusing on how to increase the "productivity" of large-scale, industrial agriculture, and "enhance" its value by exploiting its potential as a carbon sink, especially via fast-growing monoculture crops and biochar.

Commercial breeders of crops and livestock stress yield and uniformity and depend heavily on external inputs. Peasant breeding, on the other hand, depends on diversity and stresses reliability, resistance to pests, disease, and adverse weather conditions. As global agriculture encounters climate change, farmers will not only face radically different temperatures and growing conditions, but also highly erratic weather that will place the premium on diversity and flexibility. In other words, large monocultures of genetically uniform plant varieties will be the most vulnerable to climate change. With the wide diversity of crop and animal resources conserved in the plots of small farmers worldwide, peasant agriculture has to be recognized and supported.

Promotion of small-scale biodiverse and ecological agriculture, especially in the South where the bulk of small-scale farmers are found, is a strategic investment for national governments and multilateral institutions to guarantee global food security and survival of the planet. This does not mean that peasant farmers have found the answer to climate change and we can all relax. Nothing can lessen the grim reality that agriculture in the global South is already experiencing the most damaging impacts of climate change.

But it does mean that peasants must take the lead in developing strategies – including decentralized technological strategies – to meet the food and climate crises and they need a supportive policy environment in order for this to happen. This however does not mean abandoning the potential for conventional laboratory research conducted by formal research institutions as a complement to peasant innovations. The Western model of science and technology has developed micro-techniques that can have macro applications – high-tech advances that have applications throughout much of the world. Peasant research often develops macro-technologies for microenvironments – "wide-tech" – complex, integrated strategies that are location specific. This distinction was clear at the World People's Congress on Climate Change and the Rights of Mother Earth, in Cochabamba Bolivia in April 2010, where a working group on technology rejected top-down approaches. The working group, with strong Southern, indigenous and peasant partipation, challenged the very notion of technology transfer, calling instead for the recognition and recovery of location-specific ancestral knowledge, inter-scientific and inter-cultural exchanges, free sharing of appropriate information, an end to patents for climate-related technologies, and the development of locally adapted and appropriate technologies. The Bolivian government's Submission to the UNFCCC negotiations on long-term cooperative action based on these deliberations, unequivocally rejected "the practices and technologies harmful to humankind and the environment, including agrochemicals, corporate-controlled seeds and intensive water use, genetic engineering, particularly genetic use restriction technology, biofuels, nanotechnology, and geo-engineering."[65]

The implications of industrially produced, genetically engineered climate-ready, synthetic organisms or bioenergy crops in the hands of a small number of powerful multinational companies are serious for both climate change and food security.

Genetic engineering, biofuels and synthetic biology firms and research groups are all racing to develop "climate-ready crops" that will theoretically sequester carbon dioxide, reflect solar rays, or withstand environmental stresses attributable to climate change (i.e., extreme weather conditions such as heat, high humidity, salinity and drought).
Grown over large areas of plains, prairies and pampas, the theory is that agricultural crops with one or more of these traits could play a useful role in protecting the planet from climate change or adapting it to a warming world while continuing to provide food, feed, fuel and fibre.

A 2008 report by the ETC Group[66] identified 532 recent patent applications for crops engineered with "climate-ready traits." The world's largest chemical companies, which also control the global seed market (BASF, Monsanto, Bayer, DuPont, Dow and Syngenta) are actively engaged in developing climate-ready crops, but even more actively stockpiling patents that monopolize key traits found useful to confront the climate crisis.

In 2008, BASF and Monsanto, together with small biotech partners, controlled two-third of all these "climate ready" patents. The same year, they entered the largest agricultural research joint venture to date (US$1.5 billion) to develop climate-ready crops. They added another US$1 billion to this giant venture in 2010. ETC Group's new research on climate ready crops found that there has been a dramatic upsurge in the number of patent applications that relate to "climate-ready," genetically engineered crops. As of July 2010, there exists 258 patent families that include 1633 patent documents related to climate ready crops. Of these, 90 % are held by private companies and just three companies (DuPont, Monsanto and BASF) account for over two-thirds of the total. The breadth of many patent claims is shocking – in a single patent, a company can monopolize dozens of crops.

Furthermore, global agriculture is coming under additional stress as the inevitability of a fossil fuel phase-out becomes apparent. Biofuels are being touted as the "environmental," "renewable" alternative since they are derived from organic sources such as crops and biomass. Already the impacts of first generation biofuels on food security and poor people's access to land have been devastating. Monoculture plantations of oil palm, sugarcane, jatropha and other biofuel crops have displaced local and indigenous communities from their lands in many parts of the world, and have resulted in the destruction of vulnerable forest ecosystems, decimation of biological resources and depletion of water sources.

New threats are emerging under the guise of climate change solutions and these will further imperil the livelihoods of small-scale farmers and indigenous communities. The biochar lobby, for example, proposes that 12% of anthropogenic carbon emissions can be sequestered in the soil,[67] using hundreds of millions of hectares of land, quite explicitly seeking to cash in on the carbon market.
Its industrial development will entail an unprecedented stripping of each last bit of "biomass" on Earth (see Case Study 4) so that its carbon can be stored in soil rather than the atmosphere where it causes warming. Moreover, the emerging field of synthetic biology proposes to create artifical life forms in addition to re-engineering those that already exist (as in classical genetic engineering). To cite but one example, hundreds of new strains of algae are being developed in the hopes that one will provide a new source of fuel that will actually sequester rather than secrete carbon. As with biochar, the large scale development of synthetic algae will have vast implications for land, water, food and livelihoods particularly in the global South.

The implications of industrially produced, genetically engineered climate-ready, synthetic organisms or bioenergy crops in the hands of a small number of powerful multinational companies are serious for both climate change and food security. Certainly, if vast areas of cropland are sown with genetically uniform plant varieties – especially in tropical and subtropical areas of intense sunlight – the strategy could exacerbate genetic erosion and species displacement.

Most significantly, moving crop production onto lands formerly free of industrial agricultural production (such as wetlands, peatlands and forests) will threaten the biodiversity of those ecosystems and the livelihoods of people who live there. If climate-ready traits outcross to wild varieties or via horizontal gene flow in the soil, significant ecosystem changes could follow. If the modified varieties require special chemical applications, the increase in chemical-use could be detrimental to local flora and fauna, farmers and consumers.

Sustainable and small farmers' agriculture is an essential part of the solution to climate crisis and it can´t be ignored anymore. Peasant and indigenous organizations are demanding their rights and the recognition of the role they can play in cooling the planet, but they are the most negatively affected by industrial food systems, biofuel land grabbing and other "climate mitigation measures," as well as by climate change (caused by industrial civilization). Peasants raised their voices in the Bali negotiations, continued in Copenhagen and expressed their proposals clearly at the ground-breaking Summit in Cochabamba, Bolivia. Nevertheless, there is no evidence that wealthy states are listening. The massive introduction of proprietary climate-ready crops over vast areas of land will indeed constitute a form of geoengineering. This is a form of technological adaptation and given the patent rush on climate-ready crops, a handful of agribusiness and chemical firms are poised to grab not only the lands of small-scale farmers in the name of "feeding the world" but some of the billions that will be coughed up by rich countries for "adaptation," and filtered through developing country governments back to the firms that hold the patents on climate ready crops.

Part 2:
Geoengineering: The Technologies

Geoengineering technologies can be divided into three broad areas: solar radiation management (SRM), carbon dioxide removal and sequestration, and weather modification. In this section we first provide an overview of the key technologies currently under development, followed by four case studies, with more in-depth analysis, and a concluding section on the link to intellectual property.

Proof of Principle: Is geoengineering feasible?

Unfortunately, humanity has already proven massive Earth restructuring to be wonderfully operational. Fill enough wetlands and introduce crop monocultures in enough fields and the ecosystem changes. Cut down enough forests and the climate changes. Build up sufficient industrial pollution and the ozone disappears and the smog rolls in. Geoengineering's "proof of principle" is manifest!

Ten old ways to geoengineer the planet:

- Cut down most of the world's forests;
- Convert savannas and marginal land into monoculture cropland;
- Dam watersheds, divert rivers, dry-up wetlands and drain aquifers;
- Pump billions of tonnes of industrial pollutants, car exhaust and other toxic chemicals into the atmosphere and soil every year;
- Wipe out species and genetic diversity in livestock & crops;
- Overuse marginal lands leading to soil erosion and desertification;
- Erode the world's major ecosystems;
- Deplete – possibly beyond recall – most commercial marine species;
- Condemn half of the world's coral reefs to extinction;
- Pollute almost all of the world's fresh water reserve.

Ten new ways to geoengineer the planet:

- Create vast monoculture tree plantations for biochar, biofuels & CO_2 sequestration;
- Contaminate Centres of Genetic Diversity with DNA from genetically engineered crops;
- "Fertilize" the ocean with iron nanoparticles to increase phytoplankton that theoretically sequester CO_2 or nitrogen;
- Build 16 trillion space sunshades to deflect sunlight 1.5 million km from Earth;
- Launch 5,000-30,000 ships with turbines to propel salt spray to whiten clouds to deflect sunlight;
- Drop limestone into the ocean to change its acidity in order to soak up extra CO_2;
- Store compressed CO_2 in abandoned mines and active oil wells;
- Biannually, blast sulphate-based aerosols into the stratosphere to deflect sunlight;
- Cover deserts with white plastic to reflect sunlight;
- Float tiny bubbles over the surface of the oceans.

Solar radiation management (SRM)

Solar radiation management technologies aim to counter the effects of greenhouse gases by increasing the radiation of sunlight back into space. SRM encompasses a variety of techniques: covering deserts with reflective plastic, using reflective "pollution" to modify the atmosphere, or blocking incoming sunlight with "space shades." Common to all these technologies is that they do not influence the concentration of greenhouse gases; they are only intended to counter some of their effects.

Implications:

"Solar radiation management" (blocking or reflecting sunlight) has the potential to cause significant environmental damage, including releasing additional greenhouse gases into the atmosphere, changing weather patterns and reducing rainfall, damaging the ozone layer, diminishing biodiversity, reducing the effectiveness of solar cells, and risking sudden and dramatic climatic changes if the efforts are stopped, either intentionally or unintentionally. SRM will not address the problem of atmospheric GHGs or ocean acidification. Even more critically: Who controls the Earth's thermostat? Who will make the decision to deploy if such drastic measures are considered technically feasible?

Geoengineering technologies involving solar radiation management

Geoengineering technology	Key researchers / advocates	Description
Desert covering	Alvia Gaskill (Environmental Reference Materials, Inc., USA)	Covering large expanses of desert with reflective sheets to deflect sunlight
Space sunshades	Roger Angel and Nick Woolf (University of Arizona, USA), David Miller (Massachusetts Institute of Technology, USA), S. Pete Worden (NASA, USA)	Trillions of small, free-flying spacecrafts would be launched a million miles above the Earth to form a cylindrical "cloud" 60,000 miles long, which should divert about 10% of sunlight away from the planet.
Arctic ice covering	Leslie Field (Stanford University and Ice911 Research Corporation, USA), Jason Box (Ohio State University, USA)	Covering snowpack or glaciers in the Arctic with insulating material or a nano-scale film to reflect sunlight and prevent melting.
White roofs and pavements or mountaintop painting	Hashem Akbari and Surabi Menon (Lawrence Berkeley National Laboratory, USA); Eduardo Gold (Peru/World Bank)	Painting roofs and road surfaces white to reflect sunlight (low-tech geoengineering)
"Climate ready" crops	Andy Ridgwell (University of Bristol, UK); agbiotech firms, including BASF, DuPont, Syngenta, Monsanto, Centro de Tecnologia Canavieira (Brazil)	Includes technologies to increase albedo (reflectivity) as well as large-scale plans to make plants and trees drought, heat or saline resistant
Space mirrors	Dr. Lowell Wood (Lawrence Livermore Laboratory, USA), Stewart Brand, (Long Now Foundation, USA)	Putting a superfine reflective mesh of aluminum between the Earth and sun
Large scale land-use change/rainwater harvesting	Peter Cox (University of Exeter, UK), Ray Taylor (The Global Cooling Project, UK and West Africa)	Engineering large-scale changes in water movements in order to provoke cloud formation to reflect sunlight

Carbon dioxide removal and sequestration

Carbon dioxide removal and sequestration are geoengineering technologies that attempt to remove carbon dioxide from the atmosphere after it has been released. Some of the technologies use mechanical devices to do so; others modify the chemical balance in the oceans to stimulate increased uptake of CO_2, while other technologies manipulate species and ecosystems to create new forms of carbon 'sinks.'

Implications:

Technologies that intervene in complex ecosystems are likely to cause unpredictable side effects. The duration and the safety of sequestration in land or sea (whether through biological or mechanical means) are mostly unknown; and many of these techniques require land/ocean use changes that will negatively affect poor and marginalized people. For the most part, these technologies are also energy-intensive. To date, there is no way to ensure safe and affordable long-term carbon sequestration.

Geoengineering technologies involving CO_2 removal and sequestration

Geoengineering technology	Key Researchers / advocates	Description
Ocean fertilization with iron or nitrogen	Dan Whaley (Climos Inc., USA); Victor Smetacek (Alfred Wegener Institute, Germany); Wajih Naqvi (National Institute of Oceanography, India); Ian S.F. Jones (Ocean Nourishment Corporation, Australia); Russ George (Planktos Science, USA); Michael Markels (GreenSea Ventures Inc., USA)	Adding nutrients to ocean water to stimulate the growth of phytoplankton in an attempt to promote carbon sequestration in deep sea.
Biochar	Johannes Lehmann (Cornell University, USA), Craig Sams (Carbon Gold, UK), Pacific Pyrolysis Ltd (Australia); Biochar Engineering Corporation (US); Carbon War Room (US); ConocoPhillips (Canada); Biochar Fund (Belgium); Alterna Energy Pty Ltd (Canada and South Africa) UK Biochar Research Centre	Burning biomass through pyrolysis (in low oxygen environments so carbon is not released) and burying the concentrated carbon in soil
Carbon-sucking machines or air capture and mineral sequestration or synthetic trees	David Keith (University of Calgary, Canada), Klaus Lackner (Global Research Technology, LLC, Columbia University-Global Research Technologies, USA), Roger Pielke (University of Colorado, USA and Oxford, UK)	Extracting CO_2 from the air by using liquid sodium hydroxide, which is converted to sodium carbonate, then extracting the carbon dioxide in solid form to be buried
Modifying ocean upwelling or downwelling	James Lovelock (UK) and Chris Rapley (London Science Museum, UK), Philip W. Kithil, (Atmocean, Inc., USA)	Using pipes to bring up nutrient-rich seawater to the surface to cool surface waters and enhance ocean sequestration of CO_2
"Enhanced weathering": adding carbonate to the ocean	Ian S.F. Jones (Ocean Nourishment Corporation, Australia);, Tim Kruger (CQuestrate, UK); H.S. Kheshgi (ExxonMobil, USA)	Increasing ocean alkalinity in order to increase carbon uptake
"Enhanced weathering" (terrestrial)	R. D. Schuiling and P. Krijgsman (Institute of Earth Sciences, Utrecht, Netherlands); Olivine Foundation for the Reduction of CO_2 (UK)	Controlling levels of atmospheric CO_2 by spreading fine-powdered olivine (magnesium iron silicate) on farmland or forestland
Crop Residue Ocean Permanent Sequestration (CROPS)	Stuart Strand (University of Washington, USA)	Storing carbon by dumping tree logs or biomass into seawater
Genetically engineered algae and marine microbes	J. Craig Venter (Synthetic Genomics, Inc., USA); Solazyme (USA); Sapphire Energy (USA); BP (UK); Institution of Mechanical Engineers, (UK)	Engineering communities of synthetic microbes and algae to sequester higher levels of carbon dioxide, either for altering ocean communities or for use in closed ponds, or even to cover buildings

Weather modification

The idea that humans might intentionally control the weather has a long history reaching back to indigenous rain dances and the lighting of fires. Since the 1830s, governments and private companies have attempted to apply technological know-how to produce precipitation or restrain storms by altering landforms, burning forests and dropping chemicals into clouds – both for military and agricultural purposes. As climate change ushers in more frequent extreme weather events ranging from drought to tropical storms, attempts to control weather are now witnessing a resurgence. Weather modification is a classic 'end-of-pipe' geoengineering response that addresses neither the causes nor the mechanism of climate change, but seeks only to alter its outcomes. Weather modification has also been advanced as an adaptation technology for climate change (e.g., for protecting water flow for hydropower schemes).

Implications:

Predicting the weather is difficult; proving the efficacy of weather interventions is even more difficult. Since weather is complex and inherently transboundary there may be unwelcome and unpredictable side effects of weather modification interventions. Attempts to produce rainfall in one location have been regarded by residents of another location as rainfall "theft," especially if crops fail in the aftermath of the weather intervention. If interventions such as altering the course of hurricanes become possible, extensive damage at another site may no longer be considered "an Act of God." A series of attempts at weather warfare by the U.S. government during the Vietnam War, under the code name "Operation Popeye," led to an international agreement to ban hostile uses of weather modification techniques. The line between what is a hostile or peaceful use may be difficult to determine.

Geoengineering technologies involving weather modification

Geoengineering technology	Key researchers / advocates	Description
Cloud seeding to increase precipitation	Chinese Meteorological Association; Bruce Boe (Weather Modification, Inc., USA)	Spraying chemicals (usually silver iodide) into clouds to precipitate rain or snow – already practiced on a large scale in the U.S. and China, despite skepticism about effectiveness
Storm modification (eg., redirecting or suppressing hurricanes)	Searete; Nathan Myhrvold and Bill Gates (Intellectual Ventures, USA). See patent table.	Attempting to prevent the formation or affect the pathways of storms.

Geoengineering – a brief technical history

It has taken us some time to realize the influence we can wield over the planet. Back in 1930, Robert Millikan, physicist and Nobel Laureate, insisted there was no danger that human activity could do lasting harm to anything as massive as Earth. Even as he was speaking, chemists were inventing CFCs – chlorofluorocarbons – the chemical cocktail responsible for thinning stratospheric ozone at an alarming rate, whose use eventually led to intergovernmental policy action in the mid-1980s: The Vienna and Montréal Accords phased out the production of CFCs.

Likewise, the notion of a technological fix for global warming isn't new. In the 1940s, Bernard Vonnegut (the novelist Kurt Vonnegut's brother) – a well-respected meteorologist – discovered that silver iodide smoke could cause clouds to give up their rain. His discovery kick-started serious government efforts to manipulate the environment. Until then, cloud-seeding had been the preserve of crackpots and con artists, but by 1951, 10% of the U.S. was said to be under clouds that had been commercially seeded. Governments and industry have a sometimes ignoble history tampering with the weather, including the CIA's top secret "Project Popeye" rainmaking campaign that began in 1966 and ran for seven years, conducting 2300 cloud seeding missions over the Ho Chi Minh Trail during the Vietnam War. The goal was to make the Trail impassable and, as a bonus, to drown out North Vietnam's rice crop. (While rains did increase, the Air Force couldn't establish a clear link between this and the covert campaign.)

As the UN Conference on the Human Environment was convening in Stockholm in 1972, a cloudburst drowned 238 people in Rapid City, South Dakota, USA on a day when seeding experiments were going on nearby.

More recent and convincing experiments have focused on "hygroscopic cloud seeding" – that is, warm-cloud seeding as opposed to cold-cloud seeding (glaciogenic). Results from experiments at the South African National Precipitation and Rainfall Enhancement Programme earned researchers there the United Arab Emirates' 2005 Prize for Excellence in Advancing the Science and Practice of Weather Modification. Other warm-cloud seeding projects have taken place in the USA, Thailand, China, India, Australia, Israel, South Africa, Russia and Mexico. According to the UN's World Meteorological Organization (WMO), at least 26 governments were routinely conducting weather-altering experiments at the turn of this century. By 2003-2004, only 16 World Meteorological Organization member countries reported weather modification activities, although weather modification activities are known to have taken place in many other countries.

Many of the world's military powers remain fascinated with weather control.

Many of the world's military powers remain fascinated with weather control. A U.S. Air Force report entitled "Weather as a Force Multiplier: Owning the Weather in 2025" concluded that the weather "can provide battlespace dominance to a degree never before imagined," including the ability to thwart an enemy's operations by enhancing a storm or by inducing drought and reducing fresh water supplies. In 2004, two Chinese cities in Henan province – Pingdingshan and Zhoukou – came close to fighting when both cities' leaders tried to alter local weather patterns by blasting tiny silver iodide particles into the troposphere (the lowest portion of Earth's atmosphere). The city downwind accused the city upwind of stealing its weather. This didn't deter the Chinese government from using weather modification to fend off rain during the 2008 Beijing Olympics. That effort was dwarfed by the weather intervention at the beginning of October 2009 – involving 260 technicians and 18 aircraft – which tried to secure clear skies for the National Day Parade.

Case Study 1: Ocean Fertilization

"Engaging in experiments with the explicit purpose of assessing iron fertilization for geoengineering is both unnecessary and potentially counterproductive, because it diverts scientific resources and encourages what we see as inappropriate commercial interest in the scheme."

Aaron Strong, et al, *Ocean fertilization: time to move on,* Nature, 2009

Illustration: Liz Snooks

The theory

Oceans play a key role in regulating the world's climate. Phytoplankton (microorganisms that dwell on the surface of the ocean), despite their minute size, collectively account for half of the carbon dioxide absorbed annually from the Earth's atmosphere by plants. Through the process of photosynthesis, plankton capture carbon and sunlight for growth, and release oxygen into the atmosphere. The world's oceans have already absorbed about one-third of all carbon dioxide (CO_2) humans have generated over the last 200 years. According to NASA, about 90% of the world's total carbon content has settled to the bottom of the ocean, mostly in the form of dead biomass.

Proponents of ocean fertilization posit that dumping "nutrients" (generally iron, nitrogen or phosphorous) in waters identified as "high nutrient low chlorophyll" (HNLC) – i.e., where there are low concentrations of phytoplankton due to the absence of one nutrient – will spur the growth of phytoplankton. Since phytoplankton use CO_2 for photosynthesis, the idea is that increasing the population of phytoplankton will increase CO_2-absorption. They argue that when individual phytoplankton die (the lifespan of phytoplankton is short – a few days at most), they will fall to the ocean floor leading to the long-term sequestration of carbon at the deeper levels of the sea.

The goal of commercial enterprises engaged in ocean fertilization is to profit from selling carbon credits or offsets for the sequestered CO_2 through voluntary or regulated carbon markets.

Phytoplankton populations in the world's oceans are declining as a result of climate change and warmer water temperatures. The amount of iron that is naturally deposited from atmospheric dust clouds into the global oceans (providing nutrients for phytoplankton) has also decreased dramatically in recent decades. According to NASA satellite data, as water temperatures increased from 1999 to 2004, the ocean's microscopic plant life dropped significantly. Oceans around the equator in the Pacific saw as much as a 50 percent drop in phytoplankton production. Advocates of iron fertilization schemes believe that iron is the missing nutrient that will restore phytoplankton and sequester two to three billion extra tonnes of carbon dioxide every year – roughly one-third to one-half of global industry and automobile emissions. Some regions of the ocean (especially near the Arctic and Antarctic circles) are nutrient-rich but anemic – they lack sufficient iron to stimulate plankton growth. With the addition of iron in these presumably otherwise healthy zones, scientists hope to increase plankton growth thereby increasing the absorption of CO_2. However, U.S. and Canadian scientists, writing in the journal *Science*, point out that "the oceans' food webs and biogeochemical cycles would be altered in unintended ways." They warn that if carbon trading schemes make it profitable for companies to engage in ocean fertilization, "the cumulative effects of many such implementations would result in large-scale consequences – a classic 'tragedy of the commons.'" Others note that iron may not be the ocean's only nutrient "deficiency" – researchers have identified silicate as a crucial component in carbon export, for example – but each "correction" to ocean water composition could have unintended effects.

Who's involved?

There are both commercial and scientific ventures involved in ocean fertilization and at least 13 experiments have been carried out in the world's oceans over the past 20 years. A 2007 experiment near the Galapagos Islands by U.S. start-up Planktos, Inc. was stopped because of an international civil society campaign. (See box on next page). The company was already selling carbon offsets on-line and the company's CEO acknowledged that its ocean fertilization activities were as much a "business experiment" as a "science experiment." Climos, another U.S. start-up in the field, is still operational. The CEO of Climos has proposed a "code of conduct" for ocean fertilization experiments to "find effective ways for the science, business and carbon market communities to collaborate." The Ocean Nourishment Corporation, an Australian company run by Ian S.F. Jones with ties to the University of Sydney, had plans to dump urea (nitrogen) into the Sulu Sea but was stopped by the Filipino government in 2007, after over 500 civil society organizations campaigned against the plan. The science of ocean fertilization is increasingly discredited, with experimentation receiving negative reviews from everyone from the Royal Society to *New Scientist*, not to mention the Inter-Governmental Panel on Climate Change.

The 191 governments attending the Convention on Biological Diversity adopted a de facto moratorium on ocean fertilization in May 2008 and then commissioned a synthesis of scientific research on the impact of ocean fertilization on biodiversity. This synthesis emphasized the lack of knowledge about the role of oceans in the global carbon cycle and the difficulty in establishing reliable baselines to test efficacy, in addition to warning about the potential impacts of even small-scale experiments and of commercial ocean fertilization as a whole. Elsewhere, prominent ocean scientists have explained in detail that "we know enough about ocean fertilization to say that it should not be considered further as a means to mitigate climate change" although they express interest in further research that may involve the addition of nutrients to the ocean in order to understand better marine ecological and biogeochemical processes.[68] The London Convention and Protocol on ocean dumping have also addressed the issue, and are trying to establish how to define a legitimate scientific experiment and, as we go to press, are establishing protocols for legitimate scientific research and investigating what possible legal recourse available in the event of "illegitimate" activities.

What's wrong with ocean fertilization?

Phytoplankton are the foundation of the marine food chain. Iron may well stimulate the growth of algae blooms but its potential to capture and eliminate any significant amount of carbon is unproven. The list of potential side-effects is long:[69]

- Changes in marine food webs: Artificial plankton production may lead to changes in marine ecosystems at the base of the food chain, of particular concern when ocean ecosystems are already fragile and under stress.
- Reduced productivity in other areas: Iron-induced blooms may consume and deplete other vital nutrients, such that areas down current from the fertilized area could suffer reduced plankton productivity and carbon fixation.
- Low oxygen levels: Some scientists have raised concerns that this could in turn deplete oxygen levels at deeper levels of the ocean.
- Toxic Blooms: Artificially elevated nutrient levels could give rise to harmful algal blooms that produce toxins associated with shellfish poisoning, fatal to humans.
- Production of harmful gases: The production of dimethyl-sulphide (DMS), methane, nitrous oxide and volatile methyl halides can alter weather patterns unpredictably, cause ozone depletion and open a Pandora's box of impacts on atmospheric chemistry and global climate.
- Ocean acidification could be exacerbated.
- Coral reefs can be dramatically affected by tiny increases in nutrient fertilization, especially nitrogen, provoking the growth of toxic dinoflagellates.
- Devastating impacts on the livelihoods of people who depend on healthy marine systems, most notably fisher folk.

Ocean Fertilization – The Planktos Story

Planktos, Inc. was a U.S. start-up company that intended to sow the oceans with iron in order to create plankton blooms that would theoretically sequester CO_2. By early 2007 Planktos was already selling carbon offsets on its web site, claiming its initial ocean fertilization test, conducted off the coast of Hawaii from the private yacht of singer Neil Young, was taking carbon out of the atmosphere. In May 2007, Planktos announced plans to set sail from Florida to dump tens of thousands of pounds of tiny iron particles over 10,000 square kilometres of international waters near the Galapagos Islands, a location chosen, among other reasons, because no government permit or oversight would be required.

In efforts to stop Planktos, civil society groups filed a formal request with the U.S. Environmental Protection Agency to investigate Planktos' activities and to regulate them under the U.S. Ocean Dumping Act. In addition, public interest organizations asked the Securities Exchange Commission to investigate Planktos' misleading statements to potential investors regarding the legality and purported environmental benefits of their actions. Hit with negative publicity, Planktos announced in February 2008 it was indefinitely postponing its plans because of a "highly effective disinformation campaign waged by anti-offset crusaders." In April 2008, Planktos announced bankruptcy, sold its vessel and dismissed all employees. It "decided to abandon any future ocean fertilization efforts" due to "serious difficulty" raising capital as a result of "widespread opposition."

Case Study 2: Artificial Volcanoes – Reflective particles in the stratosphere

The theory

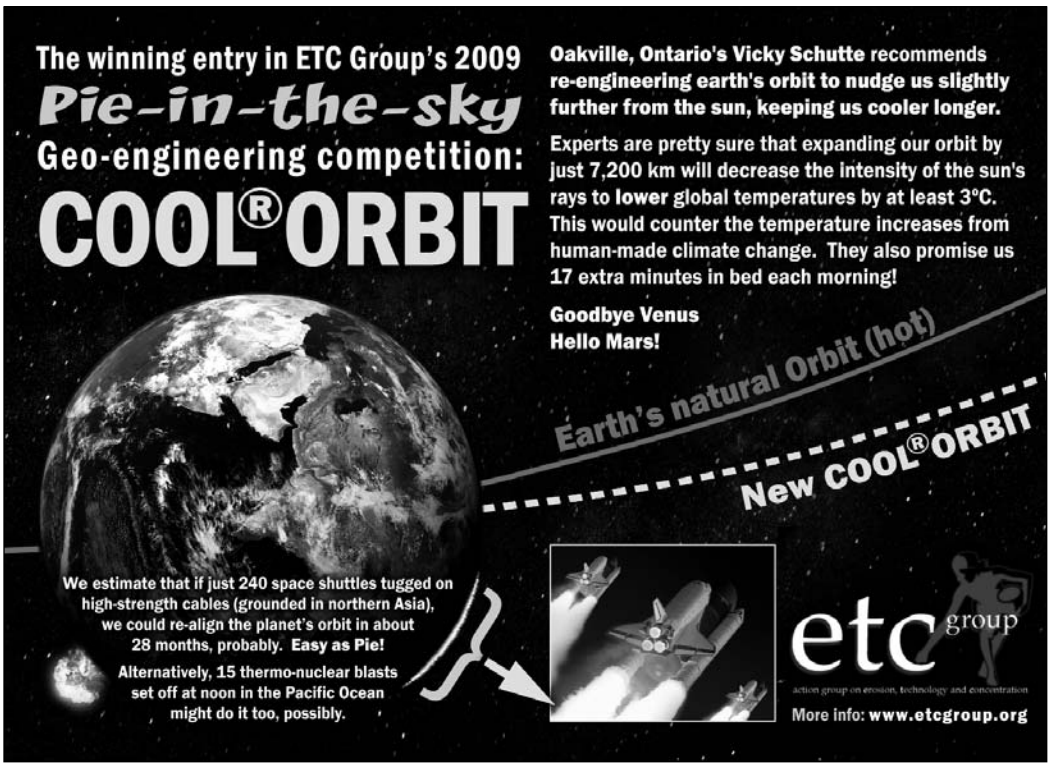
This geoengineering technique falls under the category of solar radiation management (SRM) and aims to reduce the amount of sunlight entering the Earth's atmosphere by putting tiny, reflective particles into the stratosphere. The 1991 eruption of Mount Pinatubo in the Philippines spewed twenty million tonnes of sulphur dioxide into the stratosphere and the entire planet cooled 0.4 to 0.5°C. Although the idea of artificial volcanoes was first proposed in 1977, the concept has undergone refinement in recent years. Scientists estimate that a 2% reduction of sunlight could negate the temperature-rise resulting from of a doubling of atmospheric CO_2. Advocates envisage executing this technique regionally, most likely over the Arctic, in order to stall the disappearance of, or even to replenish, ice. The particles – sulphates are most commonly suggested – could be blasted by jets, fire hoses, rockets or chimneys. More recently, it has been suggested that levitating manufactured nanoparticles could be used to the same end. Ideally, the particles would have a radius of approximately 5μm with 50 nm thickness. The particles would need to be lofted above the stratosphere at a rate of 100,000,000 kg per year, assuming the particles would last ten years.[70]

"Plan B" *par excellence,* artificial volcanic eruptions are promoted as an "emergency" measure that would bring quick and inexpensive results. While some prominent scientists are anxious to move ahead with testing, others, including Rutgers professor Alan Robock, have argued that solar radiation management cannot be tested without full-scale implementation because it is too difficult to distinguish the affects of small-scale experiments on the climate from climatic fluctuations that occur naturally.[71]

Who's involved?

Blasting particles into the atmosphere is getting more attention than any other geoengineering technology. The U.S. Defense Advanced Research Projects Agency (DARPA) has looked at possible methods for distributing the particles and NASA has researched the impacts of aerosols on climate change.

The Novim Group, a California-based outfit with a mission to present "clear scientific options...without advocacy" issued their first report on climate engineering in July 2009, focusing on artificial volcanic eruptions. Steven Koonin, then BP's technology chief, now Under Secretary for Science at the U.S. Department of Energy, was convener of the group and an author of the report. This study proposes an agenda for research, development and deployment. In 2009, the UK Royal Society, along with its partners the Environmental Defense Fund and the TWAS – the academy of sciences for the developing world (Italy) – announced the SRM Governance Initiative which aims to "produce clear recommendation for the governance of geoengineering research." The project is funded by, amongst others, the Carbon War Room, which defines its mission as harnessing "the power of entrepreneurs to implement market-driven solutions to climate change." Bill Gates has also provided funds to the Initiative.[72]



What's wrong with artificial volcanoes?

Slowing down or stopping the rate of warming via solar radiation management does nothing to change the levels of CO_2 in the atmosphere, so symptoms are addressed but not causes. Even advocates admit that injecting particles into the stratosphere has many unknown impacts, and that climate models are not comprehensive or accurate in predicting the future, but already there is research[73] focusing on sulphate injections, that suggests:

- That impacts could be very different regionally and several models show strong risks of increased drought over vast stretches of Africa, Asia and Amazonia.
- There is a fundamental trade-off between average global temperature stability and regional precipitation patterns, with one study showing that, if this technology were adopted, Northern countries and Southern countries would not agree on the amount of sulphate to be pumped into the stratosphere because of the different impacts.
- There will be damage to the ozone as sulfate particles in the stratosphere provide additional surfaces for chlorinated gases such as CFCs and HFCs to react.
- The ability to target particles in the specific areas where sunlight needs to be reduced (i.e., Arctic or Greenland) is highly speculative and it is likely the particles would be diffused elsewhere.
- Preliminary modeling suggests a rapid rise in temperature if the programme were to be started and then stopped. Such a rapid rise would likely be more dangerous to life on Earth than a gradual rise.
- Reduced sunlight could undermine the amount of direct solar energy available and disturb natural processes such as photosynthesis.
- What goes up still (usually) comes down. The tonnes of particles that would be regularly blasted into the stratosphere will find their way back to Earth again. All the issues related to environmental health and safety associated with particulate pollution, including novel manufactured nanoparticles, remain relevant for intentional polluting schemes.
- Geoengineering the stratosphere makes it easier for industry to continue its own atmospheric pollution.
- Our skies would no longer be blue and astronomy would be impeded.

Case Study 3:
Cloud whitening – albedo enhancement below the stratosphere

The theory

The theory behind cloud whitening is deceptively simple: modify the composition of clouds by injecting them with seawater in order to make them whiter. Injection of salt water theoretically increases the clouds' "condensation nuclei," making them smaller and more reflective. Up to 25% of the world's oceans are covered with thin low-lying stratocumulus clouds (below 2400 metres). Cloud whitening is another solar radiation management technique and, like simulating volcanic eruptions, it could reduce the temperature of the atmosphere and the oceans, but would not reduce levels of greenhouse gases. It is imagined that fleets of unmanned vessels would spray mist created from drawn seawater into the clouds above.

Who's involved?

The most prominent scientists advocating for cloud whitening are John Latham from the National Center for Atmospheric Research at the University of Colorado (USA) and Stephen Salter from the University of Edinburgh (UK). Based on "very artificial" modeling techniques that assume "perfect cloud condensation nuclei," Phil Rasch of the Pacific Northwest National Laboratory argues that seeding the clouds above one quarter to one half of the world's oceans (!) could offset warming by 3 watts per square metre. Or, as Latham and others hypothesize, "subject to resolution of specific problems," cloud whitening "could hold the Earth's temperature constant as the atmospheric CO_2 concentration continues to rise to at least twice the current value."[74]

There are also private sector players involved. Bill Gates has funded research on cloud whitening schemes, accounting for a small amount of the $4.6 million he has given to geoengineering research through the Fund for Innovative Climate and Energy Research. Kelly Wanser, an entrepreneur who runs the Silver Lining Project in San Francisco, had announced that a large-scale (10,000 square kilometer) cloud whitening experiment was being planned in the next couple of years. However, when the experiment was reported in the Times of London in May 2010, and the involvement of Bill Gates in funding one of the key scientists (Armand Neukermans) came to light, all of the project's information and list of scientific collaborators were soon after deleted from the website of the Silver Lining Project.[75]

What's wrong with cloud whitening?

As noted by the American Meteorological Society in its statement on geoengineering, proposals that reduce the sunlight reaching the Earth would not only cool the temperature, but "could also change global circulation with potentially serious consequences such as changing storm tracks and precipitation patterns." The statement continues: "As with inadvertent human-induced climate change, the consequences of reflecting sunlight would almost certainly not be the same for all nations and peoples, thus raising legal, ethical, diplomatic, and national security concerns."[76] Altering the composition of the clouds over one quarter to one half of the Earth's surface will affect weather patterns and could disrupt marine ecosystems, including bird and plant life. The technique is inherently transboundary and should require international agreement. For example, models suggest that one of the most effective areas to target is off the coast of California and South America, but this may adversely effect coastal rainfall and hence agriculture. Although there have been well-founded rumours regarding plans to experiment with this technology in the Faroe Islands, located between the Norwegian Sea and the North Atlantic, these have not been confirmed and public queries from ETC Group have not produced clarification.

The political and ethical dimensions of climate modification are tremendous. In a 2005 interview in *The Boston Globe*, Harvard's Director of the Laboratory for Geochemical Oceanography, Daniel Schrag, asked, "Suppose we could control hurricanes, but stopping one requires an incredibly hot day in Africa that would burn up all the crops." Schrag went on, "Let's say you have a mirror in space. Think of two summers ago when we were having this awful cold summer and Europe was having this awful heat wave. Who gets to adjust the mirror?"

Case study 4: Burn and bury biochar

The theory

Plants are classed as "carbon neutral:" they both absorb CO_2 from the atmosphere through photosynthesis and then release carbon back into the air or soils when they decompose. Biochar is a technology that claims to be "carbon-negative:" unused agricultural or forestry "waste," crops or trees grown for this purpose are burnt under low-oxygen conditions in a process known as pyrolysis and then added to the soil where they remain stored indefinitely. In addition to safely sequestering carbon, the process delivers bioenergy as a byproduct that can replace some fossil fuel uses. Proponents also claim it improves soil fertility and water and food security. When biochar is envisioned on a large scale, as it would need to be to have a noticeable impact on the climate (i.e., millions of hectares of land), it is a geoengineering technology.

Who's involved?

The main lobby group, the International Biochar Initiative (IBI), brings together industrial interests and academics to advocate for biochar subsidies and carbon credits, holding a bi-annual conference and developing "sustainability criteria." The IBI has a number of regional spin-off groups, and is actively promoting "supportive policy and regulatory environments at international and national levels to help foster investments in and commercialization of the nascent industry." While most agree that research on biochar is far from conclusive in terms of long-term carbon storage, and its impacts on soil health, some high profile climate change commentators, such as scientists Tim Flannery and James Lovelock, have endorsed biochar as a means of combating climate change.

According to one promotional web site (http://terrapreta.bioenergylists.org/), more than 40 companies are actively engaged in producing biochar or biochar technologies. Many of the private sector actors are start-ups, but there are also oil and carbon trading interests actively promoting biochar's commercial deployment. ConocoPhillips Canada, with important interests in the Alberta Tar Sands, for example, has contributed to the development of a biochar protocol to make biochar eligible for carbon offsets on the Alberta Offset System and the Voluntary Carbon Standard – and eventually on global carbon markets.

Other players include Cargill, Embrapa and palm oil interests in Malaysia, Indonesia and Colombia. Hype about biochar's efficacy abounds in the mainstream press, ranging from exaggerated and unsubstantiated claims to outright fraud. (The U.S. Securities and Exchange Commission sued executives of Pennsylvania-based Mantria Corporation for running a $30 million "Ponzi" scheme. The company claimed to be making 25 tonnes of biochar per day, but the company never sold biochar and had just one facility supposedly working on future production).[77] Despite the scientific uncertainty about biochar's efficacy and the potential for unintended effects, some NGOs and international agencies (notably the United Nations Convention to Combat Desertification) have jumped on the biochar bandwagon. Africa is being heavily targeted by biochar marketers, raising hopes among some governments that biochar will not only render soils more fertile, but also deliver badly needed funds through the carbon markets via the Clean Development Mechanism. A November 2009 survey by NGOs identified 19 different biochar field trials underway in Africa.[78]

What's wrong with biochar?

Even if biochar turns out to sequester carbon long-term, hundreds of millions of hectares of land would be required to produce the amount of biomass that would need to be burned in order to sequester a significant amount of carbon.[79] Biochar will be unsustainable for the same reason agrofuels are unsustainable: there simply is no spare land upon which "biochar crops" can be grown without causing harm. In a recent article published in Nature Communications, the authors, who include the Chair and Vice-Chair of the IBI, suggest that 12% of global greenhouse gas emissions could be 'offset' with biochar, requiring not just vast quantities of "residues" but also the conversion of 526 million hectares of land to dedicated crops and trees for biochar.[80] In addition, biochar processing (transportation, burning, ploughing into land) would all require significant energy inputs. Depleting soils and forests and converting vast areas of land to biochar crop plantations will worsen climate change.

Despite the grandiose claims for biochar, there are significant unknowns. A 2008 study by CSIRO (Australia), for example, identified a number of research gaps including: how different feedstocks affect biochar's chemical and physical properties; its long-term stability in the soil; the presence of toxins from the feedstock itself or the combustion process; and social and economic constraints and impacts.[81]

Geoengineering and Intellectual Property Claims

As if restructuring the climate isn't controversial enough, a handful of geoengineers are privatizing the means to do so by claiming patent rights over geoengineering techniques. The politics of patents has always been a divisive issue when it surfaces in different international fora. Climate negotiations are no exception.

In the UNFCCC, governments from the global South generally advocate enhanced mechanisms for transfer of useful technologies, including significant financing from developed countries, arguing that existing intellectual property regimes are a barrier to accessing the technologies necessary to mitigate and adapt to climate change. The North advocates – and gets – strong protection of intellectual property, arguing that high profits derived from IP drives invention and, eventually, transfer of technologies. The North has also more recently insisted on "enabling environments," a euphemism for corporate-friendly policies at the national level (e.g., liberalized foreign investment and strong domestic IP regimes) as well as easy government access for foreign corporations.

With regard to climate-related technologies, restricting the diffusion of technologies by way of a twenty-year monopoly is clearly counterproductive to enabling urgent action. What IP in this sphere therefore enables is for patent holders to levy lucrative licensing and transfer fees or to press for a more favourable 'enabling environment.' As with other high-tech industries, the profits to be made from licensing patented geoengineering technologies becomes a driver for governments to support geoengineering development, research and diffusion – regardless of ethics, safety or efficacy.

If geoengineering techniques move toward actual deployment, the existence of patents held by individuals and private companies could mean that decisions over the climate-commons will be effectively handed over to the private sector.

If geoengineering techniques move toward actual deployment, the existence of patents held by individuals and private companies could mean that decisions over the climate-commons will be effectively handed over to the private sector. Indeed geoengineers are already claiming that their patents give them extended commercial rights over the commons in which they operate. In one of several geoengineering patents granted to Professor Ian S.F. Jones, founder and CEO of Ocean Nourishment Corporation, the claim that his "ocean nourishment" method of dumping urea into seawater will attract fish is accompanied by a claim of legal ownership over any fish subsequently harvested from a urea-fertilized patch of ocean! Jones has reiterated this legal claim in correspondence with ETC Group.

Some geoengineering patents also attempt to appropriate and privatize indigenous and traditional knowledge, most clearly demonstrable in the area of "biochar." The technique of burying charcoal in soil was widely practiced by communities throughout the Amazonian Basin before the turn of the first millennium, where it was known as Terra Preta. This technology is now the subject of several patents. (See table below.)

As with other technology innovators (in software, biotechnology, robotics), some geoengineers are considering forgoing their intellectual property claims in order to speed up development of the technology. CQuestrate, a geoengineering firm in the UK with investments from Shell Research, is developing a technique to add lime to oceans. The company is a self-described "open source geoengineering company" and declares it will not seek any patents on the technology that results. The table on the next page provides a sampling of geoengineering patent applications and issued patents.

A Sampling of Geoengineering Patents

Patent number	Title / explanation	Inventor / assignee	Publication date
US20020009338A1	Influencing weather patterns by way of altering surface or subsurface ocean water temperatures / Refers to an ocean "upwelling" system capable of bringing up deeper waters to surface waters.	Blum, Ronald D.; Duston, Dwight P.; Loeb, Jack	January 24, 2002
US6056919	Method of sequestering carbon dioxide / Refers to increasing phytoplankton by applying nutrients to the ocean, specifically, fertilizers "in pulses".	Michael Markels	May 2, 2002
US6200530	Sequestering carbon dioxide in open oceans to counter global warm-ing / Refers to increasing phytoplankton by applying nutrients to the ocean, specifically, fertilizers "in pulses" and in a spiral pattern.	Michael Markels	March 13, 2001
US20090173386A1	Water alteration structure applications and methods / Refers to using an ocean vessel for wave induced downwelling – pushing warm surface waters to lower depths for hurricane suppression, biological enhancement, "recreational area creation," etc.	Bowers, Jeffrey A.; Caldeira, Kenneth G.; Chan, Alistair K.; Gates, III, William H. (yes, a.k.a. Bill Gates); Hyde, Roderick A.; Ishikawa, Muriel Y.; Kare, Jordin T.; Latham, John; Myhrvold, Nathan P.; Medina, Salter, Stephen H.; Tegreene, Clarence T.; Wattenburg, Williard H.; Wood, JR., Lowell L. Searete LLC	July 9, 2009
WO2009062097A1	Ocean Fertilization Project Identification and Inventorying / Refers to methods to "identify units of carbon sequestered for storage with additional information associated with [ocean fertilization] projects".	Whaley, Dan; Leinen, Margaret; Whilden, Kevin; Climos	May 14, 2009
WO2009062093A1	Quantification and Quality Grading for Carbon Sequestered via Ocean Fertilization / Systems and methods for accurately quantifying amounts of carbon sequestered and the minimum periods of time before which the sequestered carbon returned to the atmosphere as CO_2.	Whaley, Dan; Leinen, Margaret; Whilden, Kevin; Climos	May 14, 2009
WO2008131485A1	Method For Attracting and Concentrating Fish /Increasing the number of phytoplankton in the ocean by providing a source of nitrogen.	Jones, Ian S.F. Ocean Nourishment Foundation Limited, Australia	Nov 6, 2008

Continued...

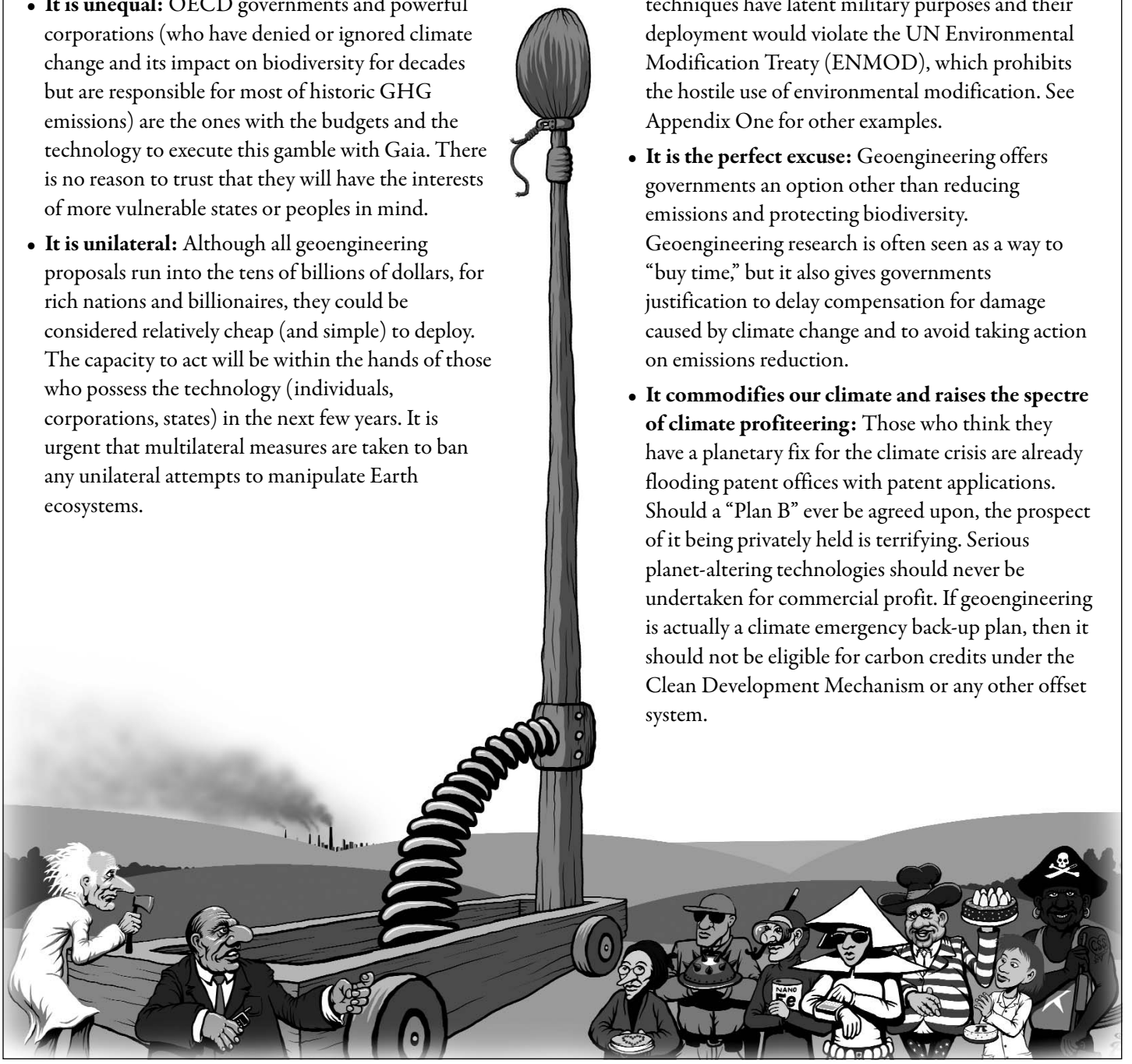
Patent number	Title / explanation	Inventor / assignee	Publication date
WO2008131472A1	Carbon Sequestration Using a Floating Vessel/ Refers to fertilizing the ocean with urea to increase the number of phytoplankton.	Jones, Ian S. F.; Rodgers, William; Wheen, Robert, John; Judd, Bruce, Joseph Ocean Nourishment Corporation Pty Limited, Australia	Nov 6, 2008
WO2008124883A1	Method of Determining the Amount of Carbon Dioxide Sequestered into the Ocean as a Result of Ocean Nourishment / Provides a formula for calculating the amount of sequestered CO_2 for the purposes of "producing tradable carbon credit."	Jones, Ian, Stanley, Ferguson Ocean Nourishment Corporation Pty Limited, Australia	Oct 23, 2008
EP1608721A1	Method and Device for the Pyrolysis of Biomass /Describes a process for "biochar" – heating biomass and compressing it under pressure.	Meier, Dietrich Klaubert, Hannes	Dec 28, 2005
WO2009061836A1	Removal of Carbon Dioxide from Air / Removing CO_2 from a gas stream by contacting the stream with a substrate having cations on its surface, where CO_2 from the stream becomes attached to the substrate by reacting with anions, and releasing CO_2.	Lackner, Klaus, S.; Wright, Allen, B. Global Research Technology, LLC	May 14, 2009
WO0065902A1	Sequestering carbon dioxide in open oceans to counter global warming.	Michael Markels	Nov 9, 2000
US6440367	Method of sequestering carbon dioxide with a fertilizer comprising chelated iron.	Michael Markels/GreenSea Ventures, Inc.	Aug 27, 2002
US5965117	Water-buoyant particulate materials containing micronutrients for phytoplankton / Ocean fertilization with iron.	DuPont	Oct 12, 1999
US5992089	Process for sequestering into the ocean the atmospheric greenhouse gas carbon dioxide by means of supplementing the ocean with ammonia or salts thereof.	Ian Jones, William Rodgers, Michael Gunaratnam, Helen Young, Elizabeth Woollahra	Nov 30, 1999
JP2004148176A2	Method for Suppressing the Amount of Carbon Dioxide Discharged / Refers to the production of biochar "to be embedded in a concrete molded body or the ground."	Maywa Co. Ltd. (Japan)	May 27, 2004
US20040111968A1	Production and use of a soil amendment made by the combined production of hydrogen, sequestered carbon and utilizing off gases containing carbon dioxide / Describes a method for producing biochar.	D. M. Day, James Weifu Lee	June 17, 2004

Continued...

Patent number	Title / explanation	Inventor / assignee	Publication date
GB2448591A8	Method for affecting atmospheric change, involves supporting high-altitude conduit by lifting forces, then flowing material e.g. sulphur oxide, through conduit, and expelling material into atmosphere at high altitude	Alister Chan K; Roderick Hyde A; Nathan Myhrvold P; Clarence Tegreene T; Lowell Wood L Jr; Searete	Nov 26, 2008
WO2009155539A2	Carbon dioxide capture method for generating carbon credits, involves separating anhydrous sodium carbonate from aqueous solution	Keith, David; Mahmoudkhani, Maryam 1446881 ALBERTA LTD Non-standard company	Dec 23, 2009
US20100064890A1	Carbon dioxide capture facility e.g. gas-liquid contactor, has pump that is operated constantly at the average flow rate to increase the capture rate of carbon dioxide	Keith, David; Mahmoudkhani, Maryam; Biglioli, Alessandro; Hart, Brandon; Heidel, Kenton; Foniok, Mike;	Mar 18, 2010
JP2006254903A2	Apparatus for lowering the water temperature of a sea surface, to reduce the evaporation of water thus preventing the generation of low atmospheric pressure	Kitamura Koichi; Ise Kogyo:KK	Sept 28, 2006
US20090294366A1	Removal of carbon dioxide from air involves contacting air with carbon dioxide sorbent, contacting sorbent with ion exchange resin, contacting ion exchange resin with carbon dioxide sorbent and recovering sorbent	Wright, Allen B.; Lackner, Klaus S.; Wright, Burton; Wallen, Matt; Ginster, Ursula; Tucson, AZ, United States of America Peters, Eddy J.;	Dec 3, 2009
GB0815498A0	Sea going hardware for the cloud albedo method of reversing global warming	Salter, Steven H.	Oct 1, 2008
GB0513933A0	Means for the reduction of global warming by control of cloud albedo	Salter, Steven; Latham, John	Aug 17, 2005
US6890497	Extracting and sequestering of carbon dioxide from a gas stream, utilizes water and carbonate to form a bicarbonate solution	Rau, Gregory H.; Caldeira, Kenneth G	May 10, 2005
US20090227161A1	Inorganic particles to float as reflective surface on the ocean	US Department of Energy	Sept 10, 2009
US20100199734A1	Preparing a soil substitute, comprises mixing pyrogenic carbon with organic biomass, inoculating the mixture by addition of a starter culture made of microorganisms and incubating the mixture under air exclusion	Lambert, Kal K Böttcher, Joachim; Pieplow, Haiko; Krieger, Alfons-Eduard	Aug 12, 2010

Why is Geoengineering unacceptable?

- **It can't be tested:** No experimental phase is possible – in order to have a noticeable impact on the climate, geoengineering must be deployed on a massive scale. "Experiments" or "field trials" are actually equivalent to deployment in the real world because small-scale tests do not deliver the data on climate effects. For people and biodiversity, impacts would likely be massive as well, and immediate and possibly irreversible.
- **It is unequal:** OECD governments and powerful corporations (who have denied or ignored climate change and its impact on biodiversity for decades but are responsible for most of historic GHG emissions) are the ones with the budgets and the technology to execute this gamble with Gaia. There is no reason to trust that they will have the interests of more vulnerable states or peoples in mind.
- **It is unilateral:** Although all geoengineering proposals run into the tens of billions of dollars, for rich nations and billionaires, they could be considered relatively cheap (and simple) to deploy. The capacity to act will be within the hands of those who possess the technology (individuals, corporations, states) in the next few years. It is urgent that multilateral measures are taken to ban any unilateral attempts to manipulate Earth ecosystems.
- **It is risky and unpredictable:** The side effects of geoengineered interventions are unknown. Geoengineering could easily have unintended consequences due to any number of factors: mechanical failure, human error, inadequate understanding of ecosystems and biodiversity and the Earth's climate, unforeseen natural phenomena, irreversibility, or funding interruptions.
- **It violates treaties:** Many geoengineering techniques have latent military purposes and their deployment would violate the UN Environmental Modification Treaty (ENMOD), which prohibits the hostile use of environmental modification. See Appendix One for other examples.
- **It is the perfect excuse:** Geoengineering offers governments an option other than reducing emissions and protecting biodiversity. Geoengineering research is often seen as a way to "buy time," but it also gives governments justification to delay compensation for damage caused by climate change and to avoid taking action on emissions reduction.
- **It commodifies our climate and raises the spectre of climate profiteering:** Those who think they have a planetary fix for the climate crisis are already flooding patent offices with patent applications. Should a "Plan B" ever be agreed upon, the prospect of it being privately held is terrifying. Serious planet-altering technologies should never be undertaken for commercial profit. If geoengineering is actually a climate emergency back-up plan, then it should not be eligible for carbon credits under the Clean Development Mechanism or any other offset system.



'Pie-in-the-sky competition' by Shtig

Part 3: Governing Geoengineering or Geoengineering Governance?

More than a set of technologies, geoengineering is a political strategy. Rather than nurturing and protecting biodiversity, the objective of geoengineering is to sustain the very excesses that are at the origin of the ecological and social crises in which we find ourselves. Simultaneously, OECD states see geoengineering as "plausible denial" allowing them to shift funding to their own industries to develop geoengineering technologies and sidestep funding to compensate the global South for the damages already incurred due to Climate Change.

Geoengineering offers a technological "fix" to the governments and industries that created the climate crisis in the first place, and then failed to adopt the policies that would mitigate its damage. The consequences of high-risk geoengineering activities, including real world experimentation, are global. The world's peoples and governments must debate these consequences and determine limits now, before any action outside the laboratory can be countenanced. No unilateral initiative to experiment with these technologies can be considered legally, practically or morally acceptable.

The year 2010 was critical for the discussion of geoengineering in general, and of governance in particular. The breakdown of global climate negotiations in Copenhagen at the end of 2009 offered the "Geoclique"[83] a rare political opportunity to advance their agenda, though most realized that progress on governance was vital to their success.[84] Building on the credibility boost obtained through the UK Royal Society's 2009 report, they undertook to debate the question of governance publicly.

"The issue of large-scale geoengineering experimentation and its impact is not about technical peer-review. It is about no less than rights, responsibilities and the future of the planet. This public debate must include the peoples and countries that are most vulnerable and likely to be affected by geoengineering, not only those who stand to gain from its exploitation."

Civil Society letter to organizers of the Asilomar Conference on Climate Intervention.[82]

Some key moments:

Asilomar Conference on Climate Intervention, organized by two US organizations (the Climate Response Fund and the Climate Institute), was held in **March 2010** at the California resort. The event was inspired by the 1975 Asilomar meeting on recombinant DNA, which established voluntary guidelines on genetic engineering that "not only allowed genetic research to resume but also helped to persuade Congress that legislative restrictions were not needed. In other words, that scientists could govern themselves."[85] The so-called International Conference on Climate Intervention brought together 172 scientists and a scattering of other experts. Their job was to configure voluntary guidelines that the "scientific community" could use for "governing" research and experimentation. All but 4 participants at this "international" meeting were from institutions in the industrialized world. Most participants received funding in order to attend.[86] The event was bankrolled by the Climate Response Fund, publicly criticized for its conflict of interest due to its choice of sponsors and links with commercial ocean fertilization activities,[87] and by the Guttman Initiatives, who specialize in increasing "return of investment for a business by introducing new products, generating new revenue, and by increasing public support of the industry through positive, proactive, arms length public relations and cause marketing campaigns."[88]

Joint Congressional and Parliamentary hearings on the Regulation of Geoengineering in the US and UK

These hearings offered an unprecedented forum to geoengineering proponents. However, women, the global South, and critical voices were all severely under-represented, leaving the politicians and researchers with a one-sided view of how necessary geoengineering is, how more research dollars are required, and how it would be unwise to bring this matter to the UN "prematurely." Quoting self-styled "geoengineering governance expert" John Virgoe, the Committee said the UK must become a "policy entrepreneur pressing for serious consideration of, or research into, geoengineering."[89] The UK Committee's final report: "The UN is the route by which eventually we envisage the regulatory framework operating, but first the UK and other governments need to prime the UN pump. As Mr. Virgoe pointed out, such 'an approach would encourage enhanced awareness of the options and help ensure that, if and when a crisis arrives, there is a reasonable chance of getting multilateral agreement to a geoengineering deployment through the UN."[90]

US Government Accountability Office (GAO)

The GAO has been working on the issue for many months and as we go to press, two reports are expected: one that will review US involvement in geoengineering and that will deal with the issue of governance; and another that is known as a "technology assessment" which will look globally at the leading developments in science and technology in the field, their limitations and possible social responses. Some preliminary observations were offered by Frank Rusco, GAO Director for Natural Resources and Environment, in March 2010 when he appeared before the House of Representatives Science and Technology Committee.[91]

Chatham House Chats

In addition to these very public events, there were many smaller off-the-record, invitation-only encounters where the Geoclique put into practice their preferred "bottom-up" approach. Foreign policy movers and shakers from OECD countries were wooed and wowed by leading geoengineering scientists. Chatham House Rule meetings took place under the auspices of the International Risk Governance Council and the Centre for International Governance Innovation, for example.[92]

One of the ideas floated as a trial balloon was the notion of an "allowed zone" for SRM experiments, which would only need to be "informally vetted" with the "international research community," allowing scientists "to proceed with studies that fall inside this zone without formal international approval, subject only to the requirement that their studies are publicly announced and all results are made public."[93]

The UK Royal Society, in partnership with the TWAS (the Academy of Sciences for the Developing World) and the Environmental Defense Fund, has also announced its "Solar Radiation Management Governance Initiative." While claiming to welcome "a diversity of views," they have invited only those organizations and individuals who were firmly onside and could be trusted to look favourably upon this governance entrepreneurship. While using one hand to claim that geoengineering is not a substitute for mitigation, they warn with the other that "it may be the only option," recognizing that "broad legitimacy and support" will be required if research is to proceed. In the project's description, there is no reference to the possibility that the world could decide to NOT go down this path. As with the Asilomar conference, it is a marketing exercise wrapped up as a policy discussion.

The political economy of research

The Geoclique prefers to publicly discuss research about geoengineering rather than discuss geoengineering itself. Leading spokespersons for the scientific community go to great lengths to insist that advocating for more research is an entirely separate matter from advocating for development and deployment of the technologies. This view is at best naive and at worst deliberately misleading. Scientists have their careers and often financial interests at stake, and they want more funding, more institutional support and a more permissive regulatory environment. Also at play are carbon markets, corporate interests, patents, profits, policies, institutional reputations, egos and scientific hubris. All this perverts research and ensures that some directions are followed and others are left behind. The dollars that are spent on geoengineering research will necessarily be diverted from elsewhere, including from badly needed funds for adaptation, already hopelessly inadequate.[94]

ABCDE. . . Won't you research along with me!

Advocating more money for geoengineering research has been the common chorus of the five main groups described below. Geoengineering is often spoken of as Plan B, but in fact, there is also Plan A, C, D, and E. While there are many links between these groups, getting more money for research is what really unites them:

Plan A (Action):

Geoengineering is faster and cheaper than carbon taxes and emission reductions. Let's get on with it! (Copenhagen Consensus Center's Bjorn Lomborg, Virgin Airline's CEO Richard Branson, and the American Enterprise Institute).

Plan B (Backup):

We must prepare an emergency Plan B because we are headed towards certain climate catastrophe (UK Royal Society, Carnegie Institution / Stanford University scientist Ken Caldeira, University of Calgary physicist David Keith).

Plan C (Commerce):

There is good money (and carbon credits) to be made from geoengineering (ocean fertilisation company Climos, the network and lobby group International Biochar Initiative).

Plan D (Defense):

Control of the climate, especially regional control, gives military advantage (Star Wars architect Lowell Wood, U.S. Defense Advanced Research Projects Agency-DARPA).

Plan E (Environmentalists):

Ecological emergency means we need to look seriously at deployment (Frozen Isthmuses Protection Campaign, Environmental Defense Fund).

UK and US lead in Geoengineering research

Public research money has started to flow but is expected to haemorrhage in the coming years unless there is a global ban on testing. A three-year European program of $1.5 million was announced in 2008: "Implications and Risks of Engineering Solar Radiation to Limit Climate Change (IMPLICC)."[95] It is sponsored by French, Norwegian and German institutions. The UK's research councils timed their own announcement of funding directly to the Royal Society's geoengineering report launch on September 1, 2009, and have reportedly contributed $4.5 million.[96] Those with resources include the National Engineering Research Council's public dialogue on geoengineering,[97] while the Engineering and Physical Sciences Research Council has announced US$2.6 million to the University of Leeds for its program entitled "Integrated Assessment of Geoengineering Proposals."[98] The UK national weather authority, known as the Met Office, is now covering geoengineering on its website and calling for more research. Further, several UK government departments (Department of Energy and Climate Change and the Department of Environment, Food and Rural Affairs) are actively following geoengineering developments (despite an overall downsizing of government). Many other institutions are also implicated: the Oxford Geoengineering Institute, the University of East Anglia's Tyndall Centre, the Geoengineering Assessment and Research Centre, the Institution of Mechanical Engineers, and the Kavli Centre for Theoretical Physics.

Even though the US Department of Energy had a $64 million plan for geoengineering research back in 2001, it has not yet initiated a coordinated research program (at least as we go to press). Indeed, key figures at the Department were astonished to learn in the press that Bill Gates was funding geoengineering.[99] The US National Science Foundation, the Department of Energy and the US Department of Agriculture have had small research initiatives,[100] but a much grander program is anticipated in the short term, with Congressman Bart Gordon announcing that he hopes a bill will be introduced to authorize a federal geoengineering research program in late 2012.[101] Certainly, the expectations are high. Geoengineering scientist David Keith, in Canada, wants to see a hundred-fold increase in the amount of public money devoted to the topic – from approximately $10 million today to $1 billion within a decade.[102]

He even argues that an immediate investment in SRM is a wise decision because, "the value of reducing this uncertainty can readily exceed several trillion US dollars over the next 100 years."[103] (Needless to say, a legally binding global ban on testing would considerably reduce uncertainty about SRM deployment and would not cost anything).

Those who would have the technical, scientific and financial resources to carry out geoengineering schemes that would pretend to manage Earth's systems in a predictable manner (be it the carbon cycle, ocean currents, atmospheric dynamics, etc.) operate from the North (geographically, culturally, economically, politically). These well-capitalized governments and corporations are not only responsible for the climate crisis, they prevaricated and denied its existence, slowed down and sabotaged the best available multilateral responses (emissions reduction under the principle of common but differentiated responsibility), and put forward deeply unequal and false "solutions," such as carbon trading and offsets, carbon capture and storage, expansion of biofuels, REDD, and proprietary GMO–driven agriculture. All this while increasing emissions.

Can we then expect, from OECD governments, a Damascene conversion that will result in a thoughtful and consequential consideration of the rights, interests and livelihoods of poor countries and peoples? Quite the contrary. Geoengineering schemes will entrench and exacerbate existing inequalities. The global South suffers more severe climate change impacts than the industrialized North. Peoples of the South should be in control of climate response decisions instead of being cast as helpless victims waiting to be saved by the technologies of the North, with lip service to their interests the only acknowledgement of their dilemma.

The HOME campaign* (www.handsoffmotherearth.org) *was launched in April 2010 at The World People's Conference on Climate Change and the Rights of Mother Earth in Cochabamba Bolivia by a coalition of international civil society groups, indigenous peoples organizations and social movements.

Experimenting with Mother Earth: Small-scale Geoengineering is an Oxymoron

Some small-scale experimentation has taken place with some geoengineering technologies (for example, biochar, ocean fertilization). Such experiments may yield some knowledge about biochemical reactions in the milieu in which substances (charcoal, iron) are introduced. But small-scale experiments cannot yield the critical information that large-scale geoengineering requires to become a reliable technology. For example, how many gigatonnes of carbon could be sequestered over the long term if these technologies were executed on a massive scale? And what are the potential consequences should it go wrong? Even though a geographically small-scale experiment may be designed to have "acceptably" limited impact on ecosystems, the experiment will not be considered to be conclusive – especially by commercially interested advocates, who will in turn press for larger tests.

A clear example of this 'slippery slope' is in the debate over ocean fertilization. More than a dozen small-scale experiments have shown the technique to be ineffective in terms of carbon sequestration, not to mention potentially dangerous to marine ecosystems. That should signal the end of the dream. However, advocates of ocean fertilization argue instead that those failures point to the need for larger-scale tests in order to understand how real deployment would work.[104]

The debate over experimentation vs. deployment is particularly lively in the case of stratospheric aerosols.[105] University of Calgary physicist David Keith has argued, "Field tests will be needed, such as generating and tracking stratospheric aerosols to block sunlight, and dispersing sea-salt aerosols to brighten marine clouds. Such tests can be small: releasing tonnes, not megatonnes, of material."[106] But Rutgers environmental scientist Alan Robock disputes the wisdom of moving tests outside, stating: "Geoengineering cannot be tested without full-scale implementation. The initial prediction of aerosol droplets can be tested on a small scale but how they will grow in size (which determines the injection needed to produce a particular cooling) can only be tested by injection into an existing aerosol cloud, which cannot be confined to one location. Furthermore, weather and climate variability preclude observation of the climate response without a large, decade-long forcing. Such full-scale implementation could disrupt food production on a large scale."[107]

Military Matters

The military implications of geoengineering and weather modification are often forgotten, or at least hidden from view. Journalist Jeff Goodell, who is sympathetic to the geoengineering enterprise, calls it the elephant in the room: "It's not easy to see how a serious geoengineering program could move forward without some degree of military involvement both here in the United States and in countries such as China and Russia."[108] Weather control has long been a consideration of military strategists and the geoengineering-military connections will be strengthened as increased attention is devoted to the "security" implications of climate change. As science historian James Fleming has shown, the military distorts science and engineering by imposing secrecy on new discoveries, seeking to weaponize every technique, even those designed for peaceful purposes. In exchange, they offer scientists access to political power, an unlimited stream of resources, and the ability to deliver on the promise of controlling nature/weather/climate.[109] Key military strategists are involved in geoengineering development discussions. 'Father of the atom bomb' Edward Teller, in his day, was involved, as was his protégé, Star Wars architect Lowell Wood, who continues to publish on the topic. Key US institutions with military mandates, budgets and contracts, such as the Lawrence Livermore National Laboratory, NASA and DARPA (the Defense Advanced Projects Research Agency) are also involved. Some geoengineering scientists, such as Gregory Benford, have argued that the military must be involved as they "can muster resources and they don't have to sit in Congress and answer questions about every dime of their money."[110]

Corporate Connections

Geoengineering is still too contested a field for most big corporate investors, and for many an open association with geoengineering would be a public relations liability. At this stage, the fossil fuel and automobile industries are much more likely to fund market-friendly solutions and organizations than they are to openly advocate for geoengineering solutions.

However, there is a complex web of connections between big capital and the global technofixers, comprised of researchers, multinational corporations and small start-ups, the military establishment and respected think tanks, policy makers and politicians. The non-profit institutions that promote geoengineering are well connected with the private sector. In an event called the "Virgin Earth Challenge," Richard Branson, CEO Virgin Airlines, offered $25 million for a climate technofix.[111] He has also devoted considerable resources to the Carbon War Room, a "geoengineering battlefield" that is actively engaged in obtaining offsets for biochar and cloud whitening. Bill Gates has provided US$4.6 million to scientists David Keith and Ken Caldeira for geoengineering and climate related research, and Microsoft's former technology chief, Nathan Myhrvold, is busy patenting geoengineering technologies through his firm Intellectual Ventures, which counts prominent geoengineers amongst its senior scientists.[112] Both Gates and Branson have provided funding to the so-called Solar Radiation Management Governance Initiative, headed up by the UK Royal Society.[113] In his former role as BP's Chief Scientist, Steve Koonin convened a group of scientists under the auspices of NOVIM to look at the research, experimentation and deployment of stratospheric aerosols.[114] He then went on to become Under-secretary of State for Energy in the Obama administration. A year later, the lead author of that report, Jason Blackstock, convened a Chatham House Rule meeting at the Centre for International Governance Innovation in Canada for senior business executives and policy makers and a select group of individuals to explore bottom up governance innovations and "prepare for emerging geoengineering possibilities."[115] Blackstock argues that geoengineering technologies are more likely to be deployed by a small island state than by the United States of America![116] CIGI, along with the Royal Society, also ran three geoengineering side events during the Copenhagen Climate summit in December 2009. Shell Research has been involved in the International Biochar initiative and funds CQuestrate, an open source start-up looking into liming the oceans that is headed by Tim Kruger, who also runs the Oxford Geoengineering Institute.[117] ExxonMobil has funded similar research into altering the ocean's alkalinity in order to increase carbon dioxide absorption.[118] Boeing's Integrated Defense Systems Chief Scientist and Vice President David Whelan (formerly of DARPA) is also active in geoengineering debates. He claims there is a small team at Boeing studying the issue and has publicly mused about the technical feasibility of getting megatonnes of aerosol sulphates up to different levels via aircraft or large cannons.[119] Whelan also sits on the National Centre on Energy Policy's task force on geoengineering. ConocoPhillips Canada, which invests in the Athabaska tar sands, is also working to obtain an "industry-led" protocol for biochar on the Alberta Offsets System.[120]

Macho Mama: Geoengineering's gender bias

The astute reader will notice that these actors (with few exceptions) are men from northern industrialized countries. This demographic homogeneity for a subject so universal in its implications is dismaying. In one recent content analysis examining English language print and online media coverage, it was found that men provided 97% of the media commentary on geoengineering.[121] Overwhelmingly, it is men who do the science, write about the field, and who are called upon to comment and testify in policy debates. Some of the few female scientists working in geoengineering have remarked that their invitations to participate in discussions were predicated only on the fact that the men were embarrassed to find themselves in exclusively male company.[122]

While it is not clear what impact, if any, this has on the research, it has certainly led to a proliferation of male sexual metaphors. The authors of SuperFreakonomics, when speaking about stratospheric aerosols, stated, "What distinguishes a big-ass volcano is not just how much ejaculate it has but where the ejaculate goes."[123] Elsewhere, a scientist and a journalist giggle over comparisons between "getting hard" (and not knowing what to do with it) and "developing technologies" (and not knowing what use they will be put to).[124] For all the talk about risks and benefits associated with these technologies, virtually no attention has been paid to the fact that women and men tend to assess risk differently.[125]

The case for a Moratorium

Governance determines who has power, who makes decisions, how other players make their voice heard, and how account is rendered.[126] Often, it is the scientists and institutions engaged in the geoengineering projects who are among the most anxious to put in place some structure of governance, since the absence of any governance regime is seen as delaying funding, experimentation opportunities, public acceptance, and the ability to take techno-fixes to market.

The dominant frame in which experts talk about geoengineering governance is voluntary: "codes of practice," "voluntary standards," "norm entrepreneurship," and "bottom-up approaches" are offered, whereas words like "legally binding," "prohibition," and "treaty" are rarely mentioned. In fact, several prominent experts argue explicitly against such "outmoded" and "ineffective" multilateral processes.[127] In the case of the 2010 Asilomar conference on climate engineering, sponsored by the Climate Response Fund, organizers tried (unsuccessfully) to restrict the debate on governance to voluntary standards.[128] Indeed, the only topic up for discussion was voluntary guidelines – not the a priori question of whether or not any research and experimentation is even desirable. This point was made by a coalition of non-governmental organizations who declined to participate in a debate that was so limited in scope.[129] In the end, the output of the meeting was rather meager – and predictable: a call for more research.[130]

One of the reasons the geoengineering debate has focused on research governance is that the technology itself is largely theoretical (there is no actual deployment to govern). Another reason is that the real world consequences of research experiments are potentially devastating. This stage should not be exempted from international monitoring and regulation. Since it is "only research," the argument goes, voluntary approaches are more acceptable than if actual deployment were being discussed. More research, advocated by the vast majority of scientists, may even seem precautionary. Yes, if we lived in a perfect world, where all nations and all peoples were equal, where technologies were carefully assessed before they were deployed and where science was guided uniquely by serving the long-term interests of humanity, more research might not be such a bad idea. This, however, is not the case.

So far, the most promising multilateral avenue for governance of geoengineering is the Convention on Biological Diversity. Already in 2008, the CBD was ahead of the curve when it adopted a moratorium on ocean fertilization. The CBD has almost universal membership (193 member states) – the most notable exception being the United States – and a clear mandate to look not only at biodiversity, but also to involve local communities and indigenous peoples in its procedures. Geoengineering is now firmly on its agenda. If the protection of biodiversity as defined by the CBD means the careful stewardship of diverse genetic resources that make up the planet's microorganisms, plants and animals, ensuring their sustainable use and fair and equitable benefits, then surely geoengineering, with its top-down, quick-fix, "boys' club" dimensions is diametrically opposed.

Many international treaties are potentially violated by geoengineering (see Appendix 1). The geoengineering suite of technologies affects outer space, the atmosphere, the land, the oceans and fresh water bodies, the weather, the production of food, the protection of health and livelihoods, and national sovereignty. It entails risks that we know about and many more that we cannot yet predict. Until there has been a full debate on the course all countries wish to go, there must be a moratorium on all geoengineering activities outside the laboratory. Anything else is folly, putting the planet and its peoples at tremendous and unjustifiable risk.

The geoengineering establishment rails against any restrictions on testing of these technologies, while Southern governments, scientists and activists who oppose real-world testing are attacked as "sticking their heads in the sand." Very shortly, the world will be faced with a decision: whether geoengineering governance is to be established by a set a voluntary norms scripted by a small group of enthusiasts in closed-door meetings with no accountability to the international community, or whether the world's governments will collectively call for a halt on all real world experimentation to ensure that the Earth's systems are not hijacked in the name of fixing global warming or anything else.

A moratorium on geoengineering is the only possibility when the international community lacks the capacity to monitor, assess or regulate new technologies that have broad social or environmental impacts. It is incumbent upon the United Nations to establish something like an International Convention for the Evaluation of New Technologies (ICENT), which would allow governments to properly track emerging technological developments from the lab all the way through to commercialization. As such, regulatory mechanisms could evolve, as appropriate, in an orderly and predictable manner and reliable information on their benefits and risks would be available to the public.

A real governance discussion on geoengineering would have to be:

International, transparent and accountable, where all governments can freely participate in a democratic manner, open to public scrutiny and the full participation of civil society organizations, Indigenous peoples and social movements (especially those most directly affected by climate change), and that is accountable to the UN in its outcomes.

Free from corporate influence so that private interests cannot use their power to determine favourable outcomes or to promote schemes that serve their interests.

Respectful of existing international laws including those protecting peace and security, human rights, biodiversity, national sovereignty, and those prohibiting hostile acts of weather modification.

Mindful of concomitant crises, especially hunger, poverty, loss of biological diversity, ecosystem destruction and ocean acidification.

Guided by the principle of precaution and cognizant that neither the seriousness of the climate crisis nor a lack of scientific knowledge can be used to justify experimentation.

Govern all technology, not just Geoengineering technologies

A wider global mechanism for technology assessment is long overdue. Geoengineering is not the only technology that markets itself as a solution while creating a more serious set of problems. History is replete with examples of technologies that have been sold as panaceas and then released into the environment without proper evaluation of their risks and benefits beforehand.[131] At the UNFCCC, for example, despite years of a stated commitment to diffuse "environmentally sound technologies," assessment is a radical and rare notion, as is consideration of the socio-economic impacts of technologies.

In the weeks before Copenhagen, more than 200 organizations signed on to a joint declaration, "Let's Look Before We Leap." The declaration called on states to put in place a process for the assessment or evaluation of new technologies before they are deployed. "Precaution demands the careful assessment of technologies before, not after, governments and inter-governmental bodies start funding their development and aiding their deployment around the globe... National and international programs of public consultation, with the participation of the people who are directly affected, are critical. People must have the ability to decide which technologies they want, and to reject technologies that are neither environmentally sound nor socially equitable."[132]

Appendix 1:

A selection of existing International Treaties that could be violated by Geoengineering experiments

Treaty Bodies	Signatory Parties	Relevance
Vienna Convention on Protection of the Ozone Layer, and Montreal Protocol	**196**	Injection of sulphate or aluminum aerosols into the stratosphere is expected to harm the ozone layer.
Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (or ENMOD, Environmental Modification Convention)	**73**	Prohibits intentional use of environmental modification of one party against another for hostile purposes. It outright bans weather warfare.
Convention on Biological Diversity	**193**	Has established de facto moratorium on ocean fertilization. Discussions underway on impact of geoengineering on biodiversity.
London Convention and Protocol	**86/35**	Has been establishing rules for "legitimate scientific experiments" in ocean fertilization, and contemplating action on other ocean-based geoengineering technologies.
Convention on Long Range Transboundary Air Pollution (Europe)	**53**	Long-range transboundary air pollution is defined as the human introduction of substances or energy into the air which has deleterious effects on human health, the environment, or material property in another country, and for which the contribution of individual emission sources or groups of sources cannot be distinguished.
International Convention on Economic, Social and Cultural Rights	**160**	Protects the right to food, health and an adequate standard of living under the general principle of "progressive realization."
International Declaration on the Rights of Indigenous Peoples	**Not applicable**[133]	Recognizes the right of free prior and informed consent to measures that affect Indigenous peoples
United Nations Framework Convention on Climate Change and Kyoto Protocol	**192**	The main treaty dealing with climate change. It establishes principles such as common but differentiated responsibilities. It also establishes carbon credits through the CDM and flexibility mechanisms whose rules affect the profitability of geoengineering.

Continued on next page...

Treaty Bodies	Signatory Parties	Relevance
UN Convention on the Law of the Sea (UNCLOS)	**160**	Widely seen as constitution of the ocean. It is mandated to control ocean pollution from any source. ARTICLE 195 states that "Parties shall not transfer directly or indirectly damage or hazards from one area to another or transform one type of pollution into another."
Outer Space Treaty	**99**	This treaty defines celestial resources as common heritage of mankind to be used for peaceful purposes. It gives all Parties rights of consultation with a state planning experiments in outer space.
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	**194**	The UNCCD has already been involved in the biochar debate. Certain geoengineering technologies will have direct impacts on deserts.
Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Europe)	**44**	This treaty links the environment to human rights. It acknowledges our debt to future generations with its emphasis on public accountability.
Antarctic Treaty System	**28**	This treaty establishes Antarctica as an area reserved for peaceful purposes, including scientific research.

Appendix 2:

An International Convention for the Evaluation of New Technologies (ICENT)

The challenge of addressing climate change highlights the critical need for the sound and timely evaluation of new technologies. What is required is an international participatory and transparent process that supports societal understanding, encourages scientific discovery and diversity, facilitates equitable benefit-sharing from new technologies, and results in a legally binding treaty: an International Convention for the Evaluation of New Technologies. Such an instrument could also ensure the conservation of useful, conventional or culturally distinct technologies and promote technological diversification and decentralization.

UN treaties and organizations that deal with geoengineering should work with states to draft and adopt a multilateral treaty that provides a framework for the assessment (including an early warning system), monitoring and regulation of new and emerging technologies based on the following principles:

- Strict application of precautionary principle
- No unilateralism
- Ensuring environmental integrity
- Full consideration of potential negative social, cultural or environmental impacts
- Open and transparent process with full civil society participation, including social movements and indigenous peoples
- Fair, full and equitable representation and participation of developing countries
- Respect for international human rights and environmental law

Southern governments will welcome the early warning procedures, open and participatory assessment, and facilitated access elements of the initiative. Some risk assessment and regulatory expenses could be secured at the international level. The North – including scientific organizations, industry, and governments – will welcome an end to unpredictability and societal distrust. The establishment of a generalized, non-crisis approach to technology diffusion will also be a relief. A transparent and participatory process with both early listening and technology conservation/diversification potential will encourage civil society. Everyone stands to gain by such an instrument, and the absence of one is a threat to us all.

Elements of ICENT

The following is a possible structure for such a convention:

The member states would form a Conference of the Parties to the Convention (COP). The COP would be supported by a modest Secretariat and enabled by a Bureau comprised of regionally determined representative states. The COP would meet biennially while the Bureau would meet semi-annually. Two expert permanent committees, consisting of all members, would convene annually and report to COP through the Bureau.

This new treaty body would have a Committee on Technology Assessment (COTA) to identify significant new technologies, establish appropriate evaluation processes for each identified technology, review progress, and recommend each technology's dismissal, delay or diffusion to COP.

COTDAC, the Committee on Technological Diffusion and Conservation, would promote the conservation and enhancement of conventional/cultural technologies, encourage technological diversification, promote public participation and understanding, and support the diffusion of appropriate new technologies. COTDAC would have the financial resources to support national capacity building in science and technology, and to encourage broad and equitable dissemination.

Although it would function financially and politically as an independent nongovernmental agency, ACSENT (Advisory Committee for the Socio-Economic and Ecological Evaluation of New Technologies) would be a centre of scientific excellence dedicated to the independent monitoring of science and technology and would have the necessary resources to offer the international community an alternative or additional perspective on technologies and their dissemination.

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109 James Fleming, Fixing the Sky, New York: Columbia University Press, 2010, pp. 167-8.

110 Jeff Goodell, How to Cool the Planet, Boston: Houghton Mifflin Harcourt, 2010. p. 211.

111 See Virgin Earth Challenge at http://www.virgin.com/subsites/virginearth. No prize winner had been announced ten months after the deadline (8 January 20100.

112 Ken Caldeira and John Latham are both listed as senior inventors on the Company's website. See http://www.intellectualventures.com/WhoWeAre/Inventors.aspx.

113 See Fund for Innovative Climate and Energy Research, available at http://people.ucalgary.ca/~keith/FICER.html and Royal Society, TWAS, EDF, The Solar Radiation Management Governance Initiative. Not available online.

114 J. J. Blackstock, D. S. Battisti, K. Caldeira, D. M. Eardley, J. I. Katz, D. W. Keith, A. A. N. Patrinos, D. P. Schrag, R. H. Socolow and S. E. Koonin, "Climate Engineering Responses to Climate Emergencies," Novim (2009). Available online at: http://arxiv.org/pdf/0907.5140

115 Media Advisory, CIGI Hosts Conference on Climate Change, 17 September 2010.

116 Matthew O. Berger, "Geoengineering May Represent Earth's Best Plan B," IPS, 30 September, 2010. Available online at: http://ipsnews.net/news.asp?idnews=53021

117 Information on Cquestrate can be found online at: www.cquestrate.com. Information on the Oxford Geoengineering Institute, also run by Tim Kruger, can be found online at: http://www.oxfordgeoengineering.org. Kruger was one of the authors promoting a set of principles for governance that have been influential amongst the geoclique, including the astonishing notion that geoengineering is a public good.

118 Exxon Mobil discloses that it funded papers, for example by H.S. Kheshgi on disposing of CO_2 in the ocean by increasing its alkalinity. Kheshgi is cited as an expert in the Royal Society report. See ExxonMobil contributed papers on climate science, available online at: http://www.exxonmobil.com/Corporate/investor_issues_contributedpapers.aspx

119 "Geoengineering: Global Salvation or Ruin," a round table at the Commonwealth Club, broadcast by Fora.tv. Available for viewing at: http://fora.tv/2010/02/23/Geoengineering_Global_Salvation_or_Ruin

120 Keith Driver and John Gaunt, "Bringing Biochar Projects into the Carbon Market Place," Carbon Consulting LLC, Blue Source, Carbon War Room, ConocoPhillips Canada, May 2010.

121 Holly Buck, "Framing Geoengineering in the media: Spectacle, Solution, Tragedy?" unpublished manuscript, Lund University, p. 9.

122 MIT scientist Sallie Chisholm: "They invited me at the last minute and I think it was because they suddenly realized the whole meeting was made up of white men," in Jeff Goodell, op.cit. p. 191.

123 Steven D. Levitt, Stephen J. Dubner, Superfreakanomics: Global Cooling, Patriotic Prostitutes and Why Suicide Bombers Should Buy Insurance (New York: Harper Collins), 2009. NEED REFERENCE PAGE NUMBER

124 Jeff Goodell, op.cit, pp. 213-214.

125 Karen L. Henwood, Karen Anne Parkhill and Nick F. Pidgeon, "Science, technology and risk perception: From gender differences to the effects made by gender," Equal Opportunities International, Vol 27, no 8, 2008, p. 663.

126 See Institute on Governance, Governance definition at http://iog.ca/en/about-us/governance/governance-definition.

127 David Keith and John Virgoe, for example, both make this argument before the UK Parliamentary Committee studying the regulation of geoengineering. See UK House of Commons, "The Regulation of Geoengineering: Fifth Report of Session 2009-2010," 10 March 2010. Also available online at: http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/221/221.pdf.

128 The initial announcement of the conference stated, "This Conference is being convened to discuss and develop a set of voluntary guidelines, or best practices, for the least harmful and lowest risk conduct of research and testing of proposed climate intervention and geoengineering technologies." Letter from Michael MacCracken, chair of the Scientific Organizing Committee, November 14, 2009.

129 "Open Letter Opposing Asilomar Geoengineering Conference," 4 March 2010. Available online at: http://www.etcgroup.org/en/node/5080

130 See final statement by the Scientific Organizing Committee, issued 26 March 2010, which does not even mention the voluntary standards the meeting had been convened to discuss. Available online at: http://www.climateresponsefund.org/index.php?option=com_content&view=article&id=152&Itemid=89

131 See for examples, Claire Parkinson, Coming Climate Crisis: Consider the past, Beware of the Big Fix, Lanham, Rowman & Littlefield, 2010, Chapter 6.

132 See "Let's look before we leap: Civil society calls for technology assessment in any Copenhagen deal," 10 December 2009, online at http://www.etcgroup.org/en/node/4956

133 The declaration (like the Universal Declaration of Human Rights) is not a treaty and therefore does not have states as parties. It does however have the force of international law.

Notes:

ETC Group

Action Group on Erosion, Technology & Concentration

ETC Group is an international civil society organization. We address the global socioeconomic and ecological issues surrounding new technologies with special concern for their impact on indigenous peoples, rural communities and bio-diversity. We investigate ecological erosion (including the erosion of cultures and human rights), the development of new technologies and we monitor global governance issues including corporate concentration and trade in technologies. We operate at the global political level and have consultative status with several UN agencies and treaties. We work closely with other civil society organizations and social movements, especially in Africa, Asia and Latin America. We have offices in Canada, USA, Mexico and Philippines.

Other ETC Group publications on geoengineering are at:

http://www.etcgroup.org/en/issues/geoengineering

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BANG!

In 2008, ETC Group and its partners convened an international meeting of civil society activists in Montpellier France under the title, BANG – signifying the convergence of technologies at the nano-scale – specifically, Bits, Atoms, Neurons and Genes. At the meeting, ETC Group agreed to prepare a series of background documents on major new technologies that could assist our partners and governments in the global South in understanding these developments and responding to them. This report is one of the studies.

The full set is:

Communiqué # 103 – Geopiracy : The Case Against Geoengineering

Communiqué # 104 – The New Biomassters: Synthetic Biology and the Next Assault on Biodiversity and Livelihoods.

Communiqué # 105 – The Big Downturn? Nanogeopolitics 2010

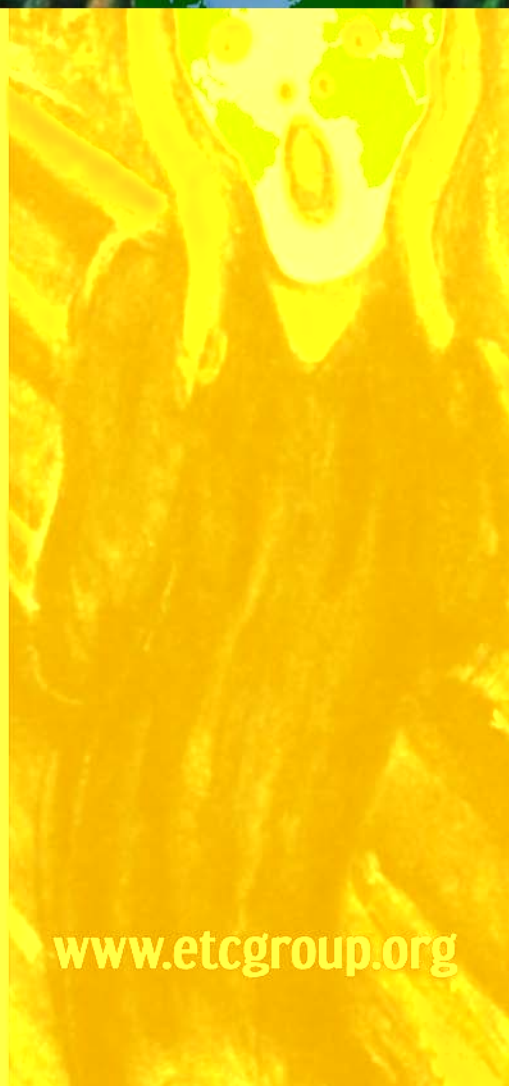
ETC Group has also completed a book, BANG, describing the impact of technological convergence over the next 25 years. While the book is not science fiction, it uses fiction to describe four different scenarios for the next quarter-century. “BANG” has been published in German by Oekom with the title “Next BANG”.

ETC Group aims to publish all these reports in English, French and Spanish.

Geopiracy

The Case Against Geoengineering

This report exposes the new climate 'Plan B' for what it is: a political strategy aimed at letting industrialized countries off the hook for their climate debt. From adjusting the global thermostat to changing the chemistry of our oceans, these technofixes are a threat to people and the planet. The report contains an overview of the history, the science, the interests behind their rapid development and the international governance issues at stake.



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