Geoengineering ... because we must [1]

As climate change denial fades as an argument, geoengineering techniques will become the focus in delaying adequate CO2 controls. Suggested geoengineering solutions are blocking the sun's rays, manipulating Earth's biology to absorb more CO2, and scrubbing CO2 from the atmosphere. These techniques are expensive, dangerous or both. Nevertheless we must probably use some form of geoengineering but not as a replacement for carbon controls but as a necessary adjunct.

Climate change is becoming increasingly obvious, even to the deniers. As the changes affect individuals—in New Orleans from Hurricane Katrina, in Vermont from Hurricane Irene, in California from forest fires, or in the Southwest from severe drought—climate change denial will fade as a defense against limiting carbon dioxide (CO_2) emissions. The next step in the strategy of delay by the fossil fuel industry and its allies is to advance “geoengineering” (the implementation of technology to affect planetary processes) as an
alternative
to reducing fossil fuel consumption.

We don’t need to endanger economic growth by drastically

cutting fossil fuel use, their reasoning goes, if we can use geoengineering to

- block some of the sun's rays from warming the earth or
- manipulate the biology of the planet to absorb more CO_2
- develop technology to scrub CO_2 from the atmosphere and sequester it somewhere.

Human ingenuity and technological mastery, the fossil fuel lobby will point out, have always come to the rescue before; why should climate change be an exception? Technological mitigation, they will argue, will be cheap compared to the economic risks of limiting CO_2 emissions.

Environmentalists opposing geoengineering often counter such a economic argument by asserting that "green growth" can replace fossil fuels and maintain the economy without harm. But that's a losing argument. It's not only inaccurate but it also allows the opposition to set the terms of the debate. Restricting the question to economic impact concedes to the fossil fuel industry the first round of the debate. Curbing CO_2 emissions will not be economically painless; it

will
decrease the American material standard of living.
[2]

We who are trying to ring the environmental alarm bell might as well face reality. The fact that climate change will ultimately have far worse economic consequences than does emissions abatement will not much affect the emotional response to the argument that a cap on fossil fuel use will harm the gross national product.

The most important issue is limiting carbon emissions, not geoengineering. The fossil fuel industry will try to distract us from that basic reality: the positive aspects of geoengineering will be emphasized and exaggerated, the projected costs will be minimized, and the risks will be ignored, denied or ridiculed. Unfortunately, American society seems desperate for a painless way out and will latch onto the possibility of technological cures. Geoengineering will be an easy sell.

Besides, what's the harm in trying?

WHAT'S THE HARM IN TRYING?

Well, the harm will be considerable.

There are three broad categories of harm:

- prolonging the implementation of effective carbon regulation,
- further distorting the equilibrium of the planet, and
- deepening international tensions.

Any delay in implementing carbon caps means more damage from climate change. Even the positive effects of any geoengineering techniques will be overwhelmed by ongoing discharge of CO_2 into the atmosphere. But in the industry's campaign that concern will be disregarded. A prolonged debate over geoengineering's pros and cons added to the time for the chosen technique's implementation, however, will force unacceptable delays in reducing carbon emissions. Anxious to avoid the implications of fossil fuels caps, corporations, government and the public will eagerly take on the (false) sense of security that geoengineering offers. The urgency of limiting emissions will be blunted, voters will put less pressure on government and government will be only too happy to accommodate.

The second broad category of harm is the near certainty that

any human-induced planetary changes will create foreseeable (and, worse, unforeseeable) side-effects. Our society does not yet appreciate that the Earth is not a machine whose parts we can tinker with. The Earth is more like a living organism in which minute changes in one place can result in unpredictable and disastrous changes elsewhere. [3]

More fundamentally, each of these geoengineering techniques is based on the assumption that—if we can just change this or modify that—we will solve the problem and accommodate to any side-effects. Technological fixes, however, rely on the same outmoded assumptions that got us into the problem in the first place. Earth processes are too complex. It's not just that the human mind doesn't fully comprehend Nature ; it's that the human mind is incapable of comprehending it fully. The vast majority of us don't want to believe this, but that doesn't make it any less true. The truth is that beyond the known side-effects lie the unknown, and we haven't a clue what they will be.

Any mitigation technique places a fallible humanity at the controls of the Earth's homeostasis. Someone has likened this to fish fiddling with the dials of the aquarium. Suddenly a complex system beyond human understanding is being "managed" by humans. Climate control is the delicate service—comprising intricate feedback loops—that the Earth

has been providing *gratis* for millennia. To use another analogy, it is as if I had to consciously control all my bodily functions: breathing, heart rate, digestion, trillions of inter- and intracellular processes, and so on. The assumption that humanity can safely fiddle with planetary processes is hubris of the most dangerous sort.

The third issue is that reliance on any geoengineering solution ignores the vast political problems that would hamper any implementation. International relationships would have to be far more integrated, cooperative and continuous than we can currently imagine. Even if we actually discovered how to control the climate satisfactorily, who would make the decisions on how to use that control? Russian politicians would like Siberia warmer; Bangladeshis, not so much. In the case of the very expensive methods, who should bear what portion of the costs? Is there anyone familiar with the past 5000 years of human history who believes that international relationships are stable enough to reach agreement on such difficult issues and then maintain them continuously over centuries?

MITIGATION TECHNIQUES

There are three broad types of geoengineering that have been proposed:

- blocking the sun’s rays from warming the planet,
- manipulating the earth’s chemical and biologic processes to reduce atmospheric CO_2, and
- technologically scrubbing the earth’s atmosphere of CO_2.

These proposals have not only their own variations of the above problems but also their own unique issues.

1) **Blocking the sun’s rays**

Proposals to maintain the desired average temperature by blocking some of the sun’s rays have ranged from spraying sulfate particles into the upper atmosphere, to changing the Earth’s cloud cover and composition, and to positioning various kinds of sunshades in space.

Byspewing **sulfate particles high into the atmosphere**, some major volcanic eruptions have been natural experiments in cooling the climate. Dianne Dumanoski reports in *The End of the Long Summer* that the sulfate particles blasted into the stratosphere by the 1991 eruption of the volcano Pinatubo cooled the Earth 1.3º Fahrenheit at their maximum—enough to temporarily counter all global warming since the beginning of the industrial age—and lasted about three years before the particles ultimately fell to the ground. Artificial spraying of such sulfates would be relatively cheap but would have to be maintained—at ever greater intensity as the density of the greenhouse gasses increased—indefinitely. Unfortunately sulfate particles seem to harm the ozone layer, too. Further, volcano-generated sulfate particles in the atmosphere have previously disrupted the climate, leading to widespread drought. Further, sulfur is a critical element in most of life's biological processes, and we know little about the other possible impacts on the Earth's own chemical/biologic balance from the continuous rain of sulfate particles.

Proposals have been advanced to spray massive amounts of seawater into the atmosphere to **stimulate cloud formation**. Unfortunately, the impact of clouds on surface temperature is complicated because they not only cool the planet by reflecting the sun's rays back into space but also warm the Earth because

water vapor is itself a greenhouse gas. Whether more clouds would be effective in decreasing global temperatures or would even further increase average temperature is just not known.

Sunshades in space would be inordinately expensive with estimates in the trillions of dollars. If we can't get international agreement on modest limitations of greenhouse gas emissions, what makes us believe that countries could agree on the financing of such a project?

Each of these sun-blocking methods has the potential to lower the Earth's average temperature, but, perhaps most significant, each would do nothing about the continuing accumulation of atmospheric CO_2. As the CO_2 rose, any interruption in blockading the sun would be devastating because the now much denser greenhouse gas layer would warm the earth drastically within a short time. Technical failures, political disagreements, unstable international relationships, indeed, anything that interrupted the technological fix would be catastrophic. Any rogue nation or terrorist group with basic technological competence could hold the world hostage by threatening to undo the process.

Increased CO_2 in the atmosphere also creates other known

environmental problems. As CO_2 increases, for instance, the oceans absorb more of it and become more acidic. This interrupts shell formation in tiny marine animals at the bottom of the food chain, leading to destruction of marine life that is a major source of the world's protein. Increased atmospheric CO_2 also increases plant growth which leads, paradoxically, to less release of moisture into the air, further increasing the risk of drought. And these are just a few of the side-effects that we know about. Given the complexity of the Earth organism, there would undoubtedly be others.

2) Manipulating the Earth's biologic processes

If we can't block the sun's rays with any safety, can't we augment the natural, biologic absorption of CO_2 from the atmosphere, thus solving the problem? Theoretically, yes, practicably and safely, no.

Ocean plankton are plants that use large amounts of CO_2 for photosynthesis. Proposals (and some actual pilot projects) suggest that

seeding the ocean

with iron or nitrogen increases plankton metabolism and causes huge plankton blooms that would absorb more CO-

2

. Research on the long-term impact—both effectiveness and side effects—however, is scarce. To be effective the method must

permanently

sequester the CO-

2

deep in the ocean or else it recycles into the atmosphere as it moves through the food chain. Only a small percentage of the plankton, however, sinks to the bottom of the sea, and it appears that only a small fraction of that actually stays there. There's no evidence of a large scale permanent sequestering of the CO-

2

. And, like spewing sulfates into the stratosphere, we have no idea of how increased iron, nitrogen, or plankton would impact other of Earth's delicate balances in the ocean or elsewhere.

A similar problem plagues proposals to **increase forest land** in order to absorb the CO-

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. (This is the main source of the "carbon offsets" that people buy to "neutralize" their carbon footprint.) Unfortunately, forested land is shrinking under human pressure for farmland. Increasing temperatures and climate change have also been causing forest loss, not only from drought-induced stunting of

the forests but also from increases in forest fires, which release the CO-
2
back into the air. It's possible that forests will become a major *source*
of atmospheric CO-
2
rather than a storage depot. Indonesia was the third largest carbon emitter in the world as it burned its forests to plant palm trees.

3) Technologically Scrubbing the Earth's Atmosphere of CO_2

Probably the least dangerous of the proposed methods for altering the composition of the atmosphere would be a technology to remove CO_2 directly from the air and sequester it permanently. This is similar to already available technology that can scrub CO_2 from industrial emissions (in coal-fired electric plants, for example) before they reach the smoke stacks although, because of its cost, this technology is being used in only a handful of places around the world). Research is already proceeding to create technology to scrub the atmosphere. One the one hand, this technique would have the potential to balance some CO-
2
emissions; on the other hand it is not yet available and cannot

be developed or implemented soon enough or on a large enough scale to prevent further catastrophic change.

The cost of mechanical atmosphere scrubbers would also be prohibitive. Until the technology is developed, of course, the cost cannot be known with any precision, but estimates run into the trillions of dollars. If the world cannot begin to agree on limiting CO_2 emissions because of the economic consequences, how will we agree on apportioning the costs of such technology?

There is also the practical problem of where to permanently store the stuff. One possibility is the now-empty subterranean oil and gas reservoirs. It might also be possible to transport the liquid CO_2 onto the deep ocean floor or even under the mud of the ocean. (At ocean depths of two miles or more, CO_2 is transformed into a semi-solid that is heavier than water.) It would also be possible to dissolve the CO_2 into underground saltwater seas. Unfortunately, however, none of these methods has yet been tested on large scale operations or for long enough a time to test their practical applicability. In the underground saltwater seas, for instance, the dissolved CO_2 creates increasing acidity that can dissolve the rock keeping it

bound. None of these methods can guarantee that the CO_2 won't leak out or even escape in massive "burps" that that can suffocate everyone in the surrounding area … as has already happened during CO_2 release by active volcanoes and earthquakes.

It is also theoretically possible to sequester CO_2 permanently by chemical reactions with available minerals to create highly stable stone. The amount of energy needed, the dollar cost and the huge amounts of minerals necessary, however, make this unfeasible.

WELL, SHOULDN'T WE TRY THEM ANYWAY?

Despite the very real dangers of the mitigation strategies above, it is hard to deny the argument that, since humanity has already changed the environment so much and the results will be so dire, we have to try something. Yes, many of these methods probably won't work. Yes, some will be extraordinarily expensive! Yes, any might cause unknowable side-effects that could make things worse. But, given the near certainty that unchecked global climate change will devastate our civilization, we have to try something.

But we are between a rock and a hard place. Any acknowledgment by committed environmentalists that we must use mitigation techniques will provide powerful fodder for those seeking to delay the necessary regulations on carbon emissions.

Most environmentalists have refused to acknowledge the necessity of using mitigation techniques for just this reason: it creates the moral hazard of encouraging continued CO_2 emissions. This tactic is certainly understandable. It is hard to cede that part of the argument to the opposition. Nevertheless, as the threat of climate change becomes undeniable, such environmentalist absolutism will be characterized as Luddite and effectively marginalized from the political discussion.

A more coherent strategy, it seems to me, is to co-opt the corporate approach in advance by acknowledging the need for mitigation but insisting that fossil fuel reduction must be an inherent part of any geoengineering. If the hidden intent of the corporate pro-engineering argument is to delay carbon caps, we may be able to blunt the force of their argument by unmasking it in advance and persistently associating geoengineering with fossil fuel reduction. We are in favor of geoengineering, our argument can go, but it will be swamped by atmospheric CO_2 without limits on CO_2 emissions.

A second advantage to publicly acknowledging the need for geoengineering is to give us entry into the very important debate about which mitigation technique to use. The cheapest techniques (for instance, spraying the upper atmosphere with sulfate particles or inducing plankton growth with the addition of nitrogen or iron into the ocean) are likely to have the greatest danger of catastrophic side-effects. Mechanically extracting CO_2 from the air has probably the lowest risk of such side-effects but is also likely to be extraordinarily expensive. To put our muscle into the latter option would create the largest chance of success with the smallest chance of devastating side-effects.

The particulars of our argument may change with continued development of technology, but our insistence on using the technique with the least chance of side-effects regardless of cost can be important in the debate.

This geoengineering debate is not an either/or. As environmentalists, still our most valuable contribution will be to remind people that Nature always has the last word, to encourage them to see the environment's delicate balances, and to introduce them to our concept of the Earth as a living organism. If our civilization is to survive, that "deep ecology"

must permeate our thinking and our strategizing about the best next steps for humanity. Humanity is Earth's experiment, and the danger to that experiment has not been greater since the dawn of civilization. Rather than attempt to control Nature we must seek to think and act with her.

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