



# BRIEF ANALYSIS

## Geoengineering: A Global Warming Fix?

by Pete Geddes

Carbon dioxide (CO<sub>2</sub>), a potent greenhouse gas, helps warm the climate. Absent water vapor, CO<sub>2</sub> and other natural greenhouse gases that trap a portion of the sun's radiation, the Earth would be about 60°F colder than it is now — an icebox.

Recently, the burning of fossil fuels has pushed atmospheric levels of CO<sub>2</sub> from approximately 280 parts per million (ppm) at the start of the Industrial Revolution to approximately 380 ppm today. Over the next few decades CO<sub>2</sub> levels will continue to increase. This worries scientists who argue that increasing CO<sub>2</sub> emissions are raising global temperatures substantially and later in the century could result in a variety of problems, including rising sea levels and the spread of tropical diseases. Worse still, there is a small possibility of abrupt and catastrophic change over one or two decades, including the sudden disintegration of the Greenland or West Antarctic ice sheets, causing a rapid, many-meter rise in sea levels. This would happen over too short a time to reduce the damage through CO<sub>2</sub> emissions reductions.

This is the rationale for the serious exploration of geoengineering solutions.

**CO<sub>2</sub> Increases Are Likely for the Next 50 Years.** If combating potentially harmful global warming requires substantially reducing CO<sub>2</sub> emissions, then we will likely lose the fight. Why? Because, over the next 50 years, developing nations will seek to emulate the West's material success. Improving their quality of life requires more, not less, energy consumption. Coal will be their fuel of choice because it is abundant, cheap and reliable. China and India alone (already among the top CO<sub>2</sub> emitters worldwide) propose building 750 to 1,000 low-tech, coal-fired power plants in the next 10 years.

**Geoengineering: A Hedge Against Uncertain Risks?** Geoengineering is the deliberate modification of the Earth's climate. It is a stopgap measure that ameliorates the problem of global warming without addressing the underlying cause.

In 1992 the National Academy of Sciences issued a report, *Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base*. It suggested three geoengineering options might be worth exploring: reforestation,

directly screening out some sunlight and increasing ocean absorption of CO<sub>2</sub>.

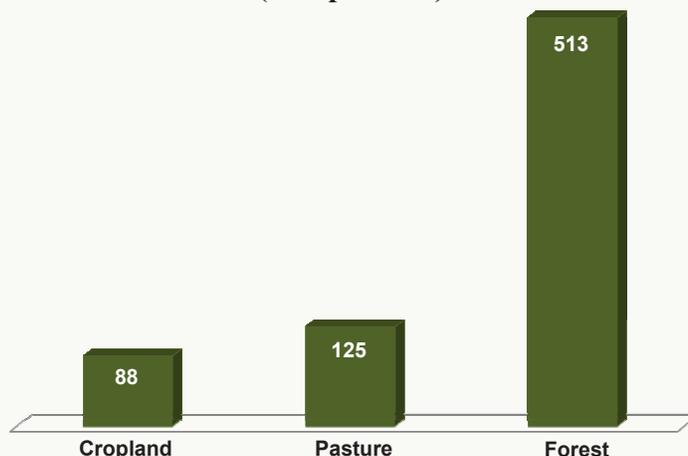
**Reforestation.** Through photosynthesis, trees remove CO<sub>2</sub> from the atmosphere. Reforestation in the United States already removes as much as 40 percent of U.S. CO<sub>2</sub> emissions from the atmosphere, primarily through the regrowth of eastern forests.

Thus reforestation (and reduced deforestation) can play an important role in offsetting carbon emissions. This is especially true in the tropics, where trees grow three times faster than in temperate zones. Each tropical tree removes about 50 pounds of CO<sub>2</sub> from the atmosphere each year. In 2001 the United Nations' Intergovernmental Panel on Climate Change estimated reforestation could remove carbon equivalent to about 10 percent to 20 percent of projected fossil fuel emissions by 2050. In addition to forests, other types of vegetation, and the soil beneath them, have carbon storage potential, according to a recent Congressional Budget Office study. [See Figure I.]

Reforestation, including clearing dead and dying timber, has the added environmental benefit of providing species habitat and improving water filtration, which reduces run-off while removing pollutants and silt.

**Atmospheric Sun Screens.** Another geoengineering idea is to mimic the natural cooling effects of volcanic

FIGURE I  
Potential CO<sub>2</sub> Absorption  
(tons per acre)



Source: Congressional Budget Office, *Potential for Carbon Sequestration in the United States*, September 2007.

eruptions that release massive amounts of sulfur dioxide (SO<sub>2</sub>) into the atmosphere. SO<sub>2</sub> eventually turns into highly reflective solid particles that bounce solar radiation back into space.

There is evidence that adding SO<sub>2</sub> to the atmosphere cools the climate. [See Figure II.] The eruption of Mount Tambora in 1815 caused 1816 to be labeled the “year without summer.” In 1991, the Philippines’ Mount Pinatubo spewed such huge amounts of SO<sub>2</sub> into the atmosphere that the average global temperature dropped 0.5°C for almost two years. This decrease is the same amount of climate warming experienced over the last 100 years.

Gregory Benford has proposed a variation on this idea, *Science* magazine reports. He suggests increasing the planet’s reflectivity by putting tiny particles of silicon dioxide (basically, kitty litter) into the stratosphere. “[S]ilicon dioxide...is chemically inert, cheap...and readily crushable to the size we want,” says Benford. He suggests testing the idea over the Arctic, where atmospheric circulation patterns would confine the particles to the polar region.

Other proposals to reduce the solar radiation reaching the Earth include putting a large mirror or shade into orbit between the Sun and the Earth, or placing trillions of small transparent sheets in orbit to reduce the sunlight reaching the Earth’s surface by 2 percent (sufficient to offset warming even with a doubling of CO<sub>2</sub>), or laying a reflective film over much of the planet’s deserts.

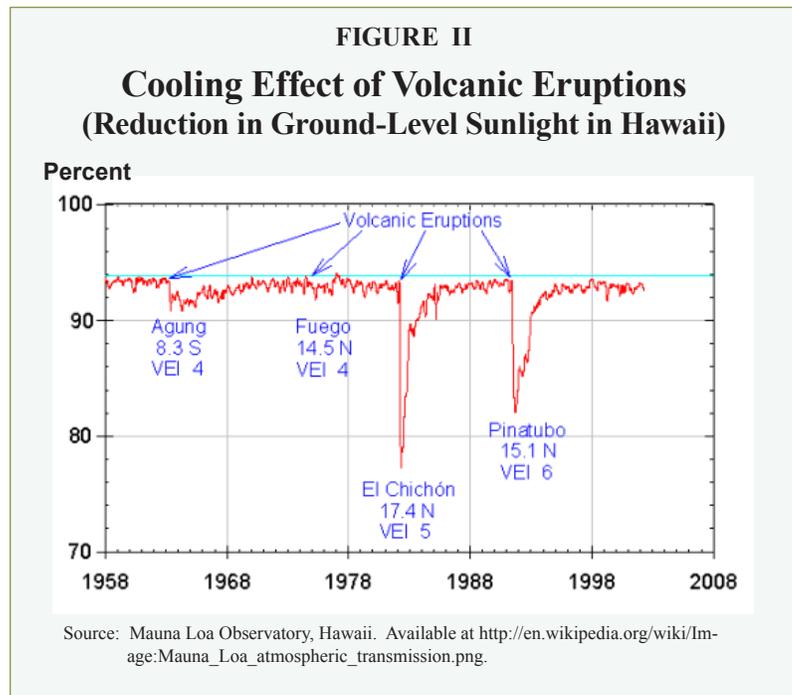
**Ocean Absorption.** A third idea is to add iron to the upper layers of the ocean. Iron acts as a fertilizer, increasing the growth of phytoplankton which, like all plants, create carbon compounds by removing CO<sub>2</sub> from the atmosphere. The resulting “algal blooms,” when they sink, would take carbon to the sea floor, essentially storing it away. While questions remain, *Science* reports that 10 international research teams have conducted small-scale ocean trials since 1993.

Vast areas of the ocean are considered dead zones because temperatures and currents combined with the lack of mineral cycling leaves them largely unable to support life. Adding iron filings to these areas would have the added benefit of helping the ocean fisheries recover by starting the ocean food chain in new areas.

**Time and Cost Advantages to Geoengineering.**

Alan Carlin, a senior economist with the U.S. Environmental Protection Agency, has argued that geoengineering is “our best hope of coping with a changing world,” because it can work, it can be implemented relatively quickly and (perhaps most importantly) it is affordable.

While the cost of reducing greenhouse gases enough to stave off serious harm has been estimated at 2 per-



cent to 5 percent of gross domestic product, Stanford University climate scientist Ken Caldeira projects the cost of putting reflective aerosols into the atmosphere at one-thousandth of the low estimate of 2 percent. Johns Hopkins University Professor Scott Barrett has argued that geoengineering solutions would cost 0.5 percent to 0.05 percent as much as mandatory stringent emission reductions, while preventing more damage.

**Will Greens Object?** Until recently, geoengineering has been largely taboo. Many environmental activists fear using geoengineering to reduce climate change will provide policymakers with an excuse not to cut carbon emissions. For example, in *Earth in the Balance* Al Gore describes policies promoting adaptation as “...a kind of laziness, an arrogant faith in our ability to react in time to save our skins.”

However, it is becoming clear that a single-minded focus on reducing CO<sub>2</sub> emissions will fail. It is simply too inflexible, expensive, risky and politically unrealistic. Dealing responsibly with climate change requires a portfolio of strategies, probably including geoengineering. Greens who dismiss this out-of-hand will find their credibility and sincerity questioned by critics claiming their real motives are to force us into austerity to atone for our environmental sins.

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