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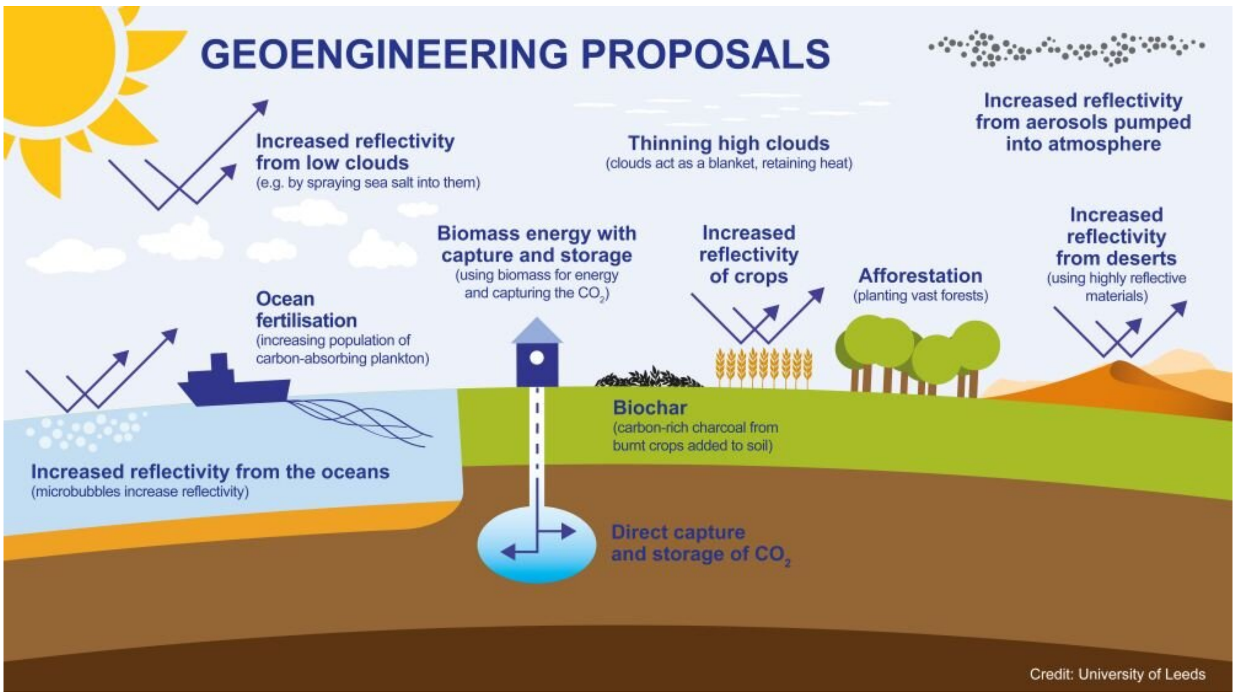
Opinion: Geoengineering is shockingly inexpensive

June 12 2023, by Evan Gough



Geoengineering isn't a quick fix for our climate crisis, and it's also expensive. Credit: University of Leeds

Despite decades of warnings and international climate agreements, global carbon emissions are still rising. Carbon emissions seem like an unstoppable juggernaut as energy-hungry humans keep breeding and pursuing more affluent lifestyles. Reducing emissions won't be enough to confront the climate crisis; we need additional solutions.

Geoengineering, also called climate engineering, could be the solution we seek. But is it financially feasible?

Geoengineering includes two broad categories of methods to deal with climate change. One is carbon dioxide removal, and the other is managing solar radiation. Carbon capture, direct air capture, and accelerated weathering remove carbon dioxide. Cloud brightening, injecting aerosols into the clouds, and solar shades are methods to manage solar radiation.

Geoengineering is a contentious subject. Many people are frightened of messing with nature in these ways. The potential for unpredictable consequences causes concern in many people's minds. They seem extreme to many.

But whether they're potentially extreme or not, there may be no way to avoid them altogether. That's because even if various solutions come along and we significantly lower our carbon emissions, that doesn't change the fact that there are teratons of carbon in the atmosphere that will be there long after we reduce our emissions. The Earth will keep heating up. We need a way to deal with the ongoing heating of Earth even after we lower our emissions.

People in Eastern Canada or the Northeastern United States are confronting the reality of the climate crisis right now. Smoke from an intense and early wildfire season in Canada is blanketing some of America's largest cities in thick, hazardous smoke. Flights have been postponed, sporting events canceled, schools are struggling, and authorities are urging people to stay indoors to safeguard their health. We're living through the forecasts scientists made decades ago.

So what can we do?

Casey Handmer is the founder of Terraform Industries, a company that focuses on using solar power to extract carbon from the atmosphere and use it as fuel. They call it gigascale atmospheric hydrocarbon synthesis.

"Terraform Industries is scaling technology to produce cheap natural gas with sunlight and air," their website says by way of introducing themselves. "We are committed to cutting the net CO_2 flux from crust to atmosphere as quickly as possible. As solar power gets cheaper, there will come a time when it is cheaper to get carbon from the atmosphere than an oil well. That time is now."

Handmer has a Ph.D. in astrophysics from CalTech and has published papers and articles on various topics. On his blog, Handmer writes about space exploration and different aspects of technology. Much of his writing centers on technology that affects carbon emissions in one way or another. Recently, he wrote about climate engineering in a post titled "We should not let the Earth overheat!"

Handmer makes a critical distinction between legacy CO_2 and new emissions in his article. He's optimistic that we can reduce emissions by decarbonizing our energy systems. The technology he's developing at Terraform Industries is one way that we can lower our emissions. His system generates carbon-based fuels from atmospheric CO_2, rather than from fossil fuels in the Earth's crust.

Once we get to a place where our emissions stop rising and begin to drop, we'll be in a much-improved situation. We can pause for a breath, and recognize our collective ability to deal with climate change. But there's still the problem of all that legacy carbon in the atmosphere and all the damage it will cause. Plants can absorb some, and weathering can remove some, but those processes take time and have limitations.

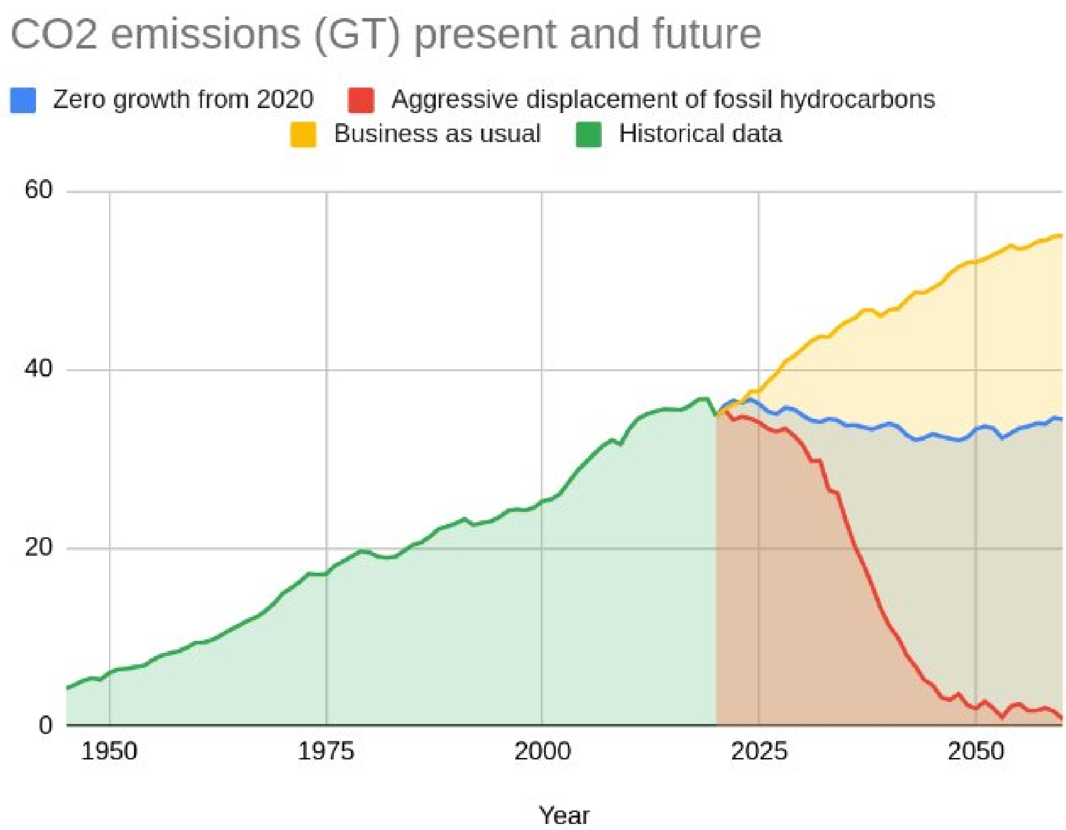
In his blog post, Handmer asks the question we should all be asking:

"How do we keep the world cool for the next few decades while we upgrade our industry to a post-carbon world and scale up CO_2 removal?"

This is where Handmer makes his point about climate engineering. The Earth will continue to heat even after we lower our emissions, and we'll need to do something. Putting aside, for now, the debate over whether or not we should embrace climate engineering, Handmer digs into the expense of climate engineering.

"Synthetic fuel takes care of new CO_2 emission, and two specific kinds of geoengineering can take care of legacy warming in a way that safeguards our planet's well-being for future generations and staunches the bleeding for the next couple of crucial decades while we get the job done," Handmer writes.

The two types he's referring to are enhanced weathering and solar radiation management.



This graph shows CO2 emissions in gigatons and what future scenarios look like. Credit: Terraform Industries

Enhanced weathering is taking something that happens naturally and engineering it to be more effective. It's sometimes called accelerated weathering, but that's confusing because accelerated weathering is a type of testing associated with engineering and industry.

On Earth, carbonate and silicate minerals combine with rainwater and groundwater to form carbonic acid. Carbonic acid is harmless to plants and animals. But it has a deleterious effect on rocks. The acid contacts minerals and forms carbonate ions in the water. Then the minerals, ions, and water recombine. The end result is altered minerals that now contain more atmospheric carbon. This action is a key part of Earth's carbon cycle, taking atmospheric carbon out of circulation and sequestering it into rock, which is eventually buried on the ocean floor and subducted into the mantle.

Enhanced weathering increases the surface area between carbonic acid and rock so that the natural chemistry that removes carbon from the atmosphere has a larger area to work in. Certain minerals are more susceptible to this weathering, so they remove more atmospheric carbon more quickly. In enhanced weathering, these minerals are mined, crushed to increase their surface area, then left exposed. Earth's natural chemical activity takes care of the rest.

The desired rocks are called mafic rocks, which contain significant amounts of magnesium and iron. Basalt is a common and widespread mafic rock.

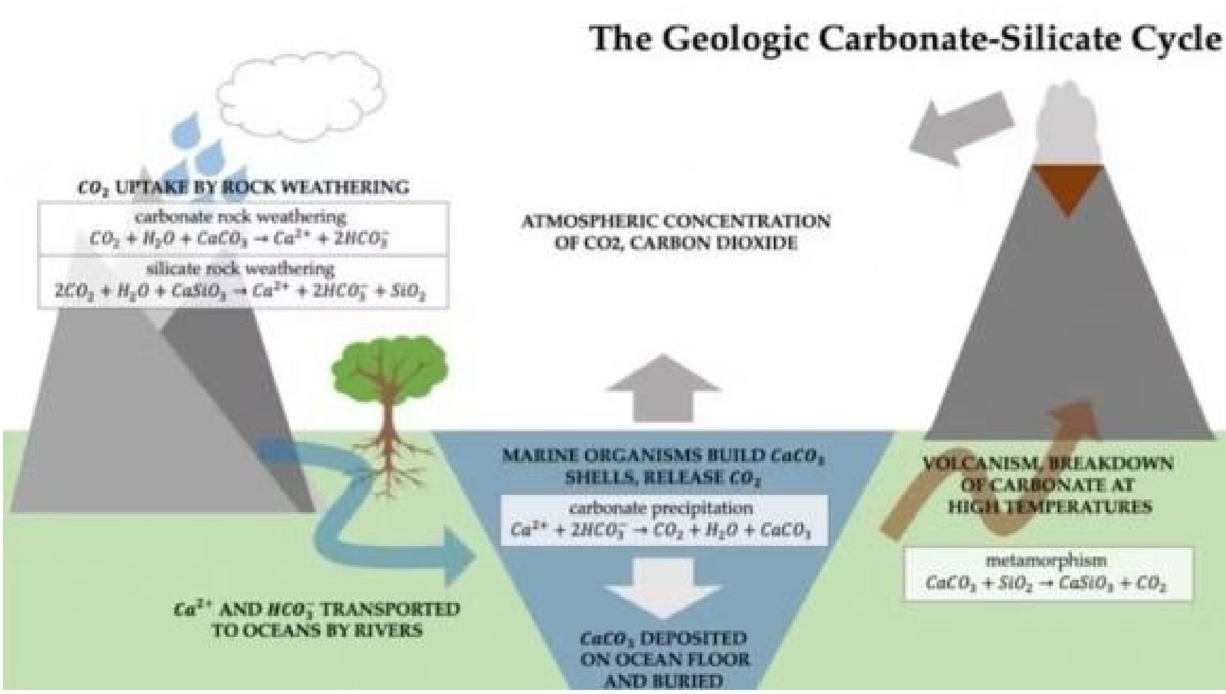
"There are a bunch of ways of doing this, but the easiest and cheapest seems to be to grind up a couple of tropical volcanic mountains and sluice the resulting rock flour into the warm, shallow oceans," Handmer writes. "The rock dust floats around for a few weeks absorbing CO_2 before sinking, permanently sequestering the CO_2."

Other ways include mining, crushing, and spreading it on farm fields. This has the added benefit of improving the soil. We already mine, crush, and spread things like potash and phosphorous on our farm fields, so this is not a huge leap.

In his blog, Handmer refers to work by Campbell Nilsen, an independent researcher in the US. According to Nilsen's calculations, the cost of implementing enhanced weathering is about $20/T-$CO_2$. If there are two teratons of excess CO_2 in our atmosphere, enhanced weathering can remove one teraton for about $400 billion US per year, over the next forty years. The result would be an atmospheric CO_2 level of 350 ppm. (We're currently at 421.)

Of course, the value of this calculation relies on us stabilizing and reducing our new emissions.

Handmer also talks about the other category of geoengineering: managing solar radiation. In the scenario where we lower our emissions and implement enhanced weathering, the Earth will still get hotter. That could lead to a lot of problems, and the worst one might be mass starvation. If we allow Earth to become so hot that crops suffer a widespread inability to grow, then things will get ugly for humanity. We all want to avoid that pandora's box of suffering, with all its unpredictable effects, including warfare.



When carbonic acid dissolves calcium and magnesium silicate minerals, they break down into dissolved compounds, some of which contain carbon. These materials can flow to the ocean, where marine organisms use them to build shells. Later the shells are buried in ocean sediments. Volcanic activity releases some carbon back into the atmosphere, but much of it stays buried in rock for millions of years. Credit: Gretashum/Wikipedia, CC BY-SA

"How do we keep the world cool for the next few decades while we upgrade our industry to a post-carbon world and scale up CO_2 removal?" Handmer asks.

This is where things can get difficult in the civilizational discussion about Earth's climate and what to do about it. Mining, crushing, and spreading rock on fields is something people can easily grasp. But blocking out the sun? That sounds like a supervillain trope.

But it might be necessary, and that's something we all have to contend with if we really want to prevent suffering. If it makes your anger rise, you may have to sort through those emotions. Facts and clarity can help out.

"It does us no good to be stable at 350 ppm by 2060 if we've already lost Greenland, the West Antarctic ice sheet, and 7 m + 4 m of coastline, respectively," Handmer writes. He's correct, of course, and this is where managing solar radiation comes in. "What we need is a short-term tourniquet to take the edge off global heating while we give the long-term fixes time to work."

Managing solar radiation is the short-term tourniquet, a kind of first-aid for the climate. There are multiple proposed methods of managing solar radiation. At the top of the list, and the atmosphere, are clouds. "In aggregate, the most reflective feature of the Earth is its clouds, which reflect some of the sun's light back into space," Handmer writes.

The most well-known method of solar engineering is stratospheric aerosol injection (SAI.) This involves introducing aerosols into the stratosphere, probably with tethered balloons, to make the upper atmosphere more reflective.

It doesn't take a vast quantity of sulfate aerosols to produce the desired effect. A side effect would be more vivid sunsets and sunrises. Instagram would never be the same.

Some people find this idea very upsetting, but usually not because they've looked into it. Often people recoil from the idea of "messing with Nature" like this. You can't really blame them, because some of our other interventions have caused problems.

But this is where we're at. There's no going back. We were warned decades ago, and now we're living through the results of our collective inability to heed those warnings. Sometimes solutions make us uncomfortable, but there's a precedent for this one.

SAI is exactly what volcanoes do. The Mt. Pinatubo eruption in 1991 injected about 17,000,000 t of aerosols into the atmosphere. It lowered the global temperature by 0.5 C for one year.

Handmer lays out some of the facts about SAI that many might not be aware of.

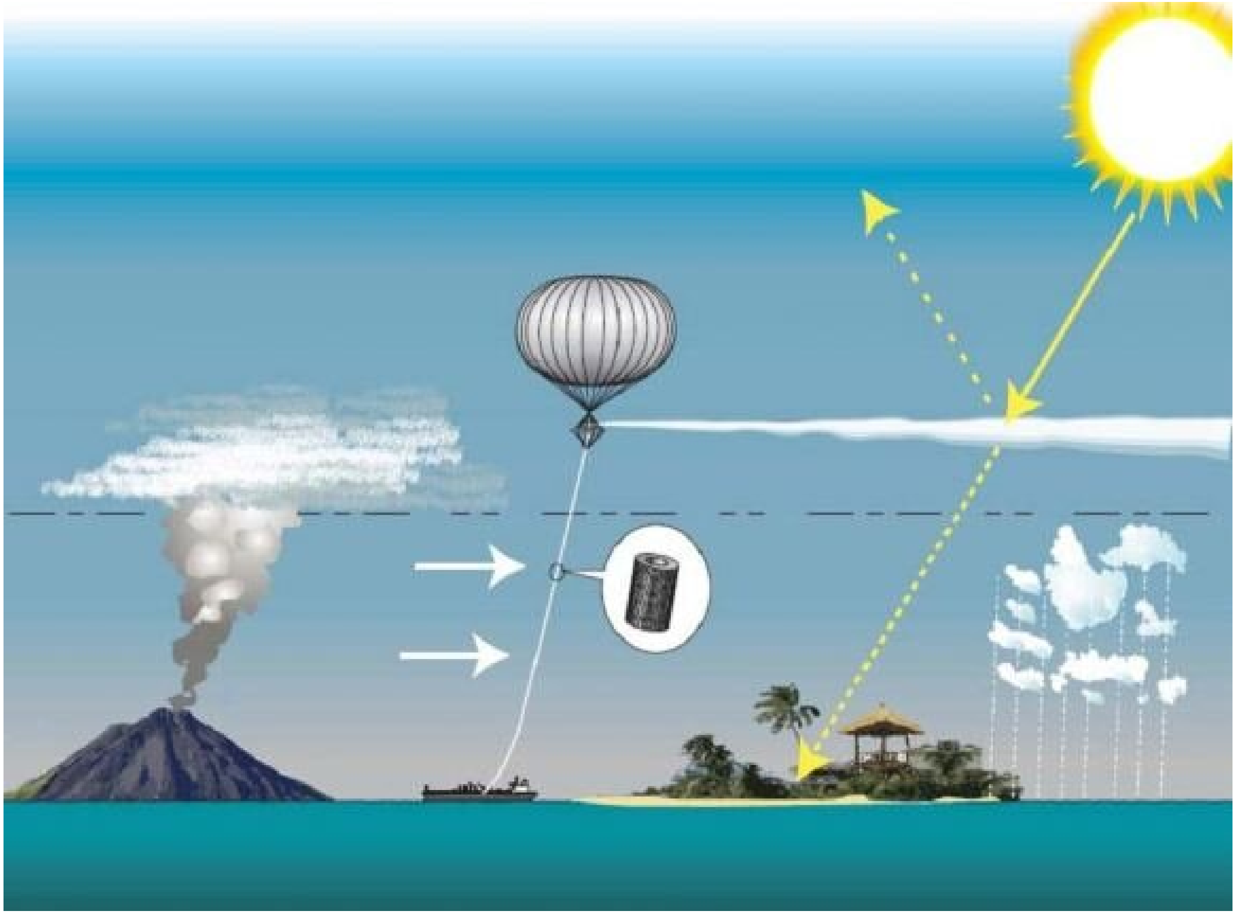
For one thing, sulfate aerosols don't stick around long. After one to three years, they rain out of the atmosphere. So they're easy to implement and monitor. "As a rough rule of thumb, 1 g of stratospheric SO2 offsets the warming of 1 T of CO_2 for 1 year," Handmer explains, which sounds like a good deal.

Handmer mentions the startup Make sunsets, which is already using weather balloons to inject sulfates into the stratosphere, though the amounts are trivial. Anybody can buy in, and the effort shows how feasible it is.

Like enhanced weathering, SAI is not expensive, considering what's at stake. In fact, it's way cheaper.

"1 kg of SO2 offsets 1000 T of CO_2 for 1 year. With enhanced weathering, 1000 T of CO_2 would cost at least $20k to deal with, and existing DAC+sequestration methods currently cost more like $1m. 35c! Now we're talking," writes Handmer. (DAC stands for Direct Air Capture, another method of removing carbon from the atmosphere.)

Handmer does some more calculations showing that if only 10,000 people around the world were willing to spend $2,000 each, SAI with balloons could offset heating by CO_2 until we get emissions and sequestration under control.



This image shows how the SPICE project could use tethered balloons to inject sulphate aerosols into the stratosphere. It would reflect only a few percent of the Sun’s radiation but would do it rapidly. Credit: Hughhunt – Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=16490430

Going deeper, he calculates what it would cost to use SAI to offset one teraton of excess CO_2 in the atmosphere. He says that it would cost $350 million per year. "This costs less than 0.1% on an annual basis of the 40-year program to sequester a trillion tons of CO_2," Handmer writes, and would use only 5% of the US's annual sulfur production.

Keen readers that do some searching will find that sulfate aerosols cause acid rain, which would seem to disqualify it as a solution. "Stupid scientists!" some will think. "How can they be so evil!" As if people trying to come up with solutions to prevent suffering are supervillains.

But the acid rain we're familiar with came from industrial smokestacks, not from stratospheric aerosols. The difference? Altitude, amount, and concentrations.

There are strict regulations on ground-level sulfate emissions because they create acid rain concentrations in one area. Sulfates from smokestacks quickly fall as acid rain and have no cooling effect. But we don't need to put much sulfate in the stratosphere for cooling, plus it stays there longer. "SO2 stays in the stratosphere for much longer," Handmer writes, "so the relatively small quantities needed for cooling don't cause concentrated acidic fallout as they would near, eg, a factory or refinery."

Handmer makes a strong case that climate engineering methods are not necessarily that expensive. Of course, there's lots more detail to it than can be discussed in this article. Some of the people raising objections are very knowledgeable, so there's an ongoing discussion. There are all types of projects being implemented to test and develop potential climate engineering methods, and we'll keep learning more about them.

But we need to take action. In the modern world, we rely on inexpensive, mass agriculture and long supply chains to provide populations with food. Climate change threatens to disrupt all that and cause widespread suffering. It has the potential to create failed states where only the strong and ruthless survive. Who knows what type of apocalyptic hell it can unleash? Students of human history can vividly imagine how people might respond, and what depths some might sink to as the idea of collective humanity is left behind.

The solutions might be controversial in some corners, but as Handmer's analysis shows, they're not necessarily expensive. Eventually, we'll have to embrace and implement some of these methods and put aside our fears, at least the unfounded ones.

Provided by Universe Today

Citation: Opinion: Geoengineering is shockingly inexpensive (2023, June 12) retrieved 2 May 2024 from https://phys.org/news/2023-06-opinion-geoengineering-inexpensive.html