Engineering the climate: Ridiculous movie Geostorm has some important questions for us

Imagine a future where we are able to control the climate by using some very sophisticated technology involving an array of satellites orbiting Earth. With these satellites we can control the weather, overcoming detrimental climate change. Storms, hurricanes, and harsh winters are all but a distant memory of the "bad old days of not knowing any better". Such is the premise of the recent 2017 Hollywood movie Geostorm.

The 2017 Hollywood movie Geostorm is ridiculous but raises interesting questions especially relevant today: the role, risks, and effectiveness of geoengineering in climate change mitigation.

But sadly, instead of science, what we get from Geostorm is an apocalypse porn. The movie over-indulgences style over substance, obsessing on the pandemonium

special effects rather than on the science. This is a shame and missed opportunity because Geostorm addresses some very pertinent issues today: climate change and the role of *geoengineering*.

Geoengineering is the large scale and deliberate modification of Earth's climate, primarily to mitigate climate change. But geoengineering is controversial because it is dangerous. And it is dangerous because we cannot predict its outcome or fully control it. Climate science is complex. Climate is the net outcome of many factors that interact with one another in a nonlinear manner. Alter one or more climate factors, and the whole climate system goes out of sync in a manner that can be difficult to predict. Moreover, the effects of geoengineering may not be reversible and may even exacerbate the problem.

No wonder then that in 2010, 193 countries during the UN Convention on Biodiversity in Japan signed to outlaw geoengineering projects, permitting only small scale scientific research studies.

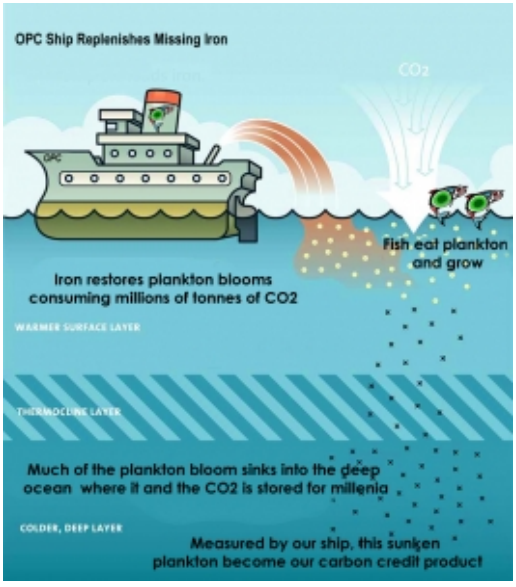
The world is slow to respond to climate change mitigation. Our collective efforts are still far short of what is needed to correct the imbalance in Earth's energy budget. The world appears to be warming unrelentingly and could even surpass the 2 degrees Celsius in warming, the tipping point where a warmer world becomes a permanent, irreparable state.

"Climate change is happening faster than our ability to respond," observed astrophysicist Neil deGrasse Tyson. Global greenhouse gas (GHG) emissions, in particular for methane (CH4) and nitrous oxide (N2O), have increased steadily every year, with an overall increase of 91% from 1970 to 2012. Only carbon dioxide (CO2) emissions have surprisingly stalled for three years in the row in 2016. This could be due to efforts of Russia, China, Japan, the US and the EU in reducing or stabilizing their CO2 emissions.

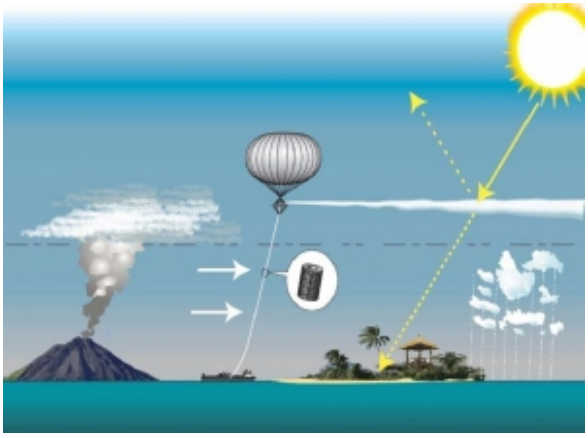
The effectiveness of geoengineering strategies have so far not been promising. A recent study in Nature Scientific Report estimated that one popular geoengineering strategy, the ocean fertilization method, if deployed, could alter global rainfall patterns and affect water resources. The idea of ocean fertilization is simple: pump iron into the ocean and because iron stimulates the growth of plankton, the plankton would in turn absorb greater amounts of CO2; thus; "sucking out" more CO2 from the atmosphere.

But twelve ocean fertilization studies by the European Iron Fertilization Experiment (EIFEX) in 2004 have shown mixed results. Some trials showed that sequestration of CO2 was indeed increased by ocean fertilization but others none. In some cases, adding iron into the ocean failed to stimulate plankton growth. Iron, as it turns out, is only one of the many factors that stimulates plankton growth in the oceans. But even if ocean fertilization was to work perfectly, Prof. Victor Smetacek of The Alfred-Wegener-Institute, predicted that ocean fertilization would take up only one quarter of the extra CO2 deposited by human activities.

Solar geoengineering strategies suffer the same fate. Releasing sulfur-based aerosols into the stratosphere would scatter and reflect incoming solar radiation; thus, reducing the amount of solar radiation reaching the ground, even by as much as 20%. Likewise is the use of a giant space mirror (or many small space mirrors) and parking these mirrors in the sky or in space to reflect a portion of the incoming solar radiation. Both these strategies work by reducing the amount of solar radiation reaching the ground; thus, resulting in cooler air temperatures.

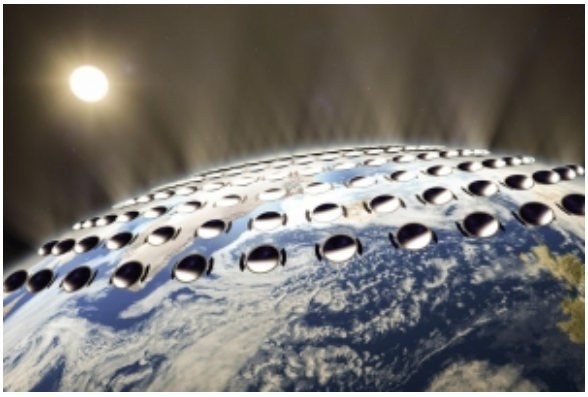


Ocean fertilization: Introducing iron into the ocean encourages plankton growth, and in turn, the plankton absorb CO2; thus, removing CO2 from the atmosphere and storing the carbon in the ocean (photo: www.oceanpastures.com).



Injection of aerosol into the stratosphere helps to reflect solar radiation (much like volcanic ash); thus, cooling Earth (photo: large.stanford.edu).

But the major problem with these aerosols in the stratosphere is they form sulfuric acid which eats ozone, and the use of space mirrors is prohibitively expensive and requires very advanced technology that we do not have today. Moreover, these mirrors could cause uneven distribution of solar radiation and unintended cooling on Earth. A country could get lesser solar radiation, upsetting the energy balance, and altering rainfall patterns. The net outcome may be a negative to the country's agriculture crop yields. The consequences could be far reaching: causing economic crisis or political unrest in countries whose climate have been unpredictably affected by these space reflectors.



Installing space mirrors over Earth to reflect solar radiation (photo from www.scmp.com).

Another concern of geoengineering is it addresses only the symptoms but not the

root causes of climate change. Solar geoengineering, for instance, reduces the amount of solar radiation reaching the ground but it does nothing to reduce the amount of CO2 released by human activities. Geoengineering risks being used as a “band-aid” solution to climate change and an excuse to continue with our business-as-usual polluting practices.

At the end, we need to realize that there is no all-in-one solution, no magic bullet in mitigating climate change. Geoengineering is only one option. But even then, Prof. Frank Keutsch of Harvard University, Cambridge, MA realistically puts geoengineering in its place: “Geoengineering is like taking painkillers. When things are really bad, painkillers can help but they don’t address the cause of a disease and they may cause more harm than good. We really don’t know the effects of geoengineering, but that is why we’re doing this research.”

Research on geoengineering methods needs to continue and expand to determine if they can be safely and reliably deployed. David Keith of Harvard University, Cambridge, MA and his associates, for instance, have developed aerosols that are made of calcite that are effective to reflect solar radiation but without the side effect of sulfuric acid formation which would destroy the ozone. This is a step in the right direction, but ultimately, the most important strategy against climate change is not in geoengineering but in reducing GHG emissions from human activities.