Climate engineering reconsidered


Stratospheric injection of sulphate aerosols has been advocated as an emergency geoengineering measure to tackle dangerous climate change, or as a stop-gap until atmospheric carbon dioxide levels are reduced. But it may not prove to be the game-changer that some imagine.

The 1992 Framework Convention on Climate Change, virtually every country agreed to stabilize concentrations of greenhouse gases (GHGs) in the atmosphere at a level that would avoid dangerous climate change. Since then, however, international cooperation in limiting emissions has been ineffectual and concentrations have continued to rise. Recently, there has been more discussion of limiting climate change by geoengineering, a term taken here to be synonymous with solar radiation management, through the injection of sulphate aerosols in the stratosphere. The technique is even mentioned in the Intergovernmental Panel on Climate Change's 2013 Summary for Policymakers.1

Two powerful arguments have been made for using geoengineering: as an emergency measure2 and as a stop-gap.3 We analyse both proposals from two perspectives: (1) effectiveness — would the use of geoengineering achieve the stated goal? (2) political feasibility — is there a reasonable prospect that the international political system would allow geoengineering to be used to achieve the stated goal? Our main conclusion is that, when the use of geoengineering is politically feasible, the intervention may not be effective; and that, when the use of geoengineering might be effective, its deployment may not be politically feasible. On careful reflection, geoengineering may not prove to be the game-changer some people expect it to be.

The effects of geoengineering

Among the many options for ‘global dimming’ aimed at limiting global warming, the simplest involves putting sulphate aerosols in the stratosphere to scatter sunlight.4 This form of geoengineering could reduce temperature in the lower atmosphere quickly. It would also be relatively inexpensive to deploy and could be done unilaterally, without the need for international cooperation. Ironically, however, this is one of geoengineering’s problems: its use might harm some countries (for example, by altering the monsoons) even if it were expected to help others. Geoengineering, particularly the use of stratospheric aerosols, poses a challenge for governance.

Of all the arguments against geoengineering, perhaps the one most frequently advanced is that knowledge of geoengineering’s ability to cool the climate will reduce the incentive to cut emissions.5 However, theory and laboratory experiments suggest that the failure to cut emissions can be explained by free-rider problems, including those associated with uncertainty about the true threshold for dangerous climate change6. Belief that geoengineering could serve as a cheap and quick fix might further dampen the incentive to cut emissions, but it doesn’t seem probable that this belief will, by itself, cause concentrations to exceed dangerous levels. In any event, knowledge of geoengineering cannot be erased.

It is important to understand that geoengineering cannot be used to preserve today’s climate. Sunlight scattering would act on shortwave radiation, and GHGs affect long-wave radiation. In theory, atmospheric
Averting disaster
Would geoengineering be useful as a last resort? The idea seems comforting, but what kind of emergency could be prevented or alleviated by geoengineering? Stratospheric injection of sulphate aerosols would cool surface air temperatures quickly, but if the West Antarctic ice sheet were to disintegrate, the cause would presumably be oceanic, rather than atmospheric warming and it would take centuries for geoengineering to reverse the process leading to this catastrophic collapse. Sunlight scattering would also be ineffective in addressing polar climate emergencies, not least because it cannot directly or quickly affect temperature during the polar winter. Geoengineering could probably help to reduce melting of the Greenland ice sheet and rises in sea level, but these are slow processes that might be better addressed by adaptation, which can also be done unilaterally but without creating significant new risks or arousing geopolitical tensions.

A related problem is the timing of deployment. If countries waited too long before intervening, some geophysical processes might prove impossible to reverse. Early warning signals could help to avert some catastrophes. However, early warnings might be unreliable or come too late to allow geoengineering to avoid catastrophic climate change. A case could be made for using geoengineering prior to any warning signs, to avoid crossing an approaching but uncertain climate tipping point. However, doing so would introduce new dangers and it is not clear that the reduction in climate change hazards would justify the risks associated with geoengineering. It is also not clear that countries would approve the use of geoengineering as a precautionary approach to addressing climate change.

The temptation to use geoengineering to address a regional emergency, such as an altered monsoon, might be harder to resist. However, geoengineering could not be counted on to prevent every regional climate crisis. For example, it probably could not prevent Amazonian forest die-back due to drought conditions. Moreover, countries that expect to be harmed by geoengineering would surely act to prevent it from being used. They might offer assistance to the countries contemplating the use of geoengineering, in exchange for these countries agreeing to refrain from deployment. They might also threaten trade...
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