Geoengineering: may provide help but not the cure

Scientists say large-scale engineering projects designed to counteract the effects of greenhouse gases should not be considered as an alternative to strategies which directly reduce carbon emissions. As complementary schemes, however, they may be of some benefit.

Large-scale geoengineering schemes for mitigating climate change have attracted increasing publicity in recent years. But in order to prioritise research in this area, policy makers need to understand the true costs and benefits of such schemes. There is a shortage of clear, comparable data on the potential of different geoengineering schemes, and concerns that some proponents exaggerate the effectiveness of such schemes.

UK researchers made a detailed comparison between a wide variety of different geoengineering schemes. They investigated the potential of each scheme to cool the climate to pre-industrial levels by 2050, calculating the cooling effects achievable in terms of ‘radiative forcing’ – the difference between incoming and outgoing radiation. Geoengineering schemes aim to create negative radiative forcing to counteract the positive radiative forcing caused by higher greenhouse gas concentrations.

According to the researchers, geoengineering schemes with the greatest cooling potential are sunshades in space and injections of aerosols into the stratosphere (the region between 10 and 50 kilometres above the Earth’s surface). Both are designed to reduce the amount of sunlight absorbed by the planet.

However, because atmospheric carbon dioxide is continually increasing, the area of sunshades and amount of aerosol required would also have to continually increase. For example, to offset the warming caused by current levels of carbon dioxide in the atmosphere, the researchers calculate that over 4 million square kilometres of sunshades would have to be launched into space, with an additional 31,000 square kilometres of new sunshades needed every year to keep up with the warming trend. The effects of suddenly losing the shades or stopping the aerosol injections would be extremely rapid warming.

Geoengineering schemes that focus on removing carbon dioxide from the atmosphere are less risky. For example, a large area forest could be planted, and large amounts of charcoal could be produced and added back to soil as ‘biochar’. Both can sequester carbon. Combined with carbon capture and storage from biofuels, such schemes could reduce carbon dioxide levels to preindustrial levels by around 2300, say the researchers.

However, they say that fertilising ocean plankton with iron, currently a popular idea, is not very effective at reducing atmospheric levels of carbon dioxide. Phosphorus fertiliser may be more effective, but both will have negative outcomes for marine life. Another widely publicised but probably ineffective scheme is ocean pipes to enhance the ‘biological pump’. These are designed to pump water, rich in nutrients to the surface of the ocean, where organisms will use them to absorb more carbon. However, this study suggests that the benefits would be negligible.

The researchers therefore conclude that only a combination of some forms of geoengineering could help lower radiative forcing and therefore global temperatures. They are not the solution to avoiding climate change but could be used to complement carbon reduction strategies. Policy makers will also have to take into account the cost of resources, including materials and energy, required to implement such large-scale geoengineering projects, in comparison with alternative mitigation measures.


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Theme(s): Climate change and energy, Environmental technology