We can and must govern climate engineering

Use the Montreal Protocol to manage controversial work intended to limit global warming, urges **Stephen O. Andersen**.

Last month, the World Meteorological Organization announced a tragic milestone. Average atmospheric carbon dioxide concentrations surpassed 400 parts per million in 2016. That level last occurred 3 million years ago, when temperatures were 2–3 °C warmer and sea levels 10–20 metres higher.

Unless strategies of reduced emissions, cleaner energy and the increased use of carbon capture, utilization and sequestration are taken up immediately, the last-ditch strategy will be climate engineering: ambitious attempts to brighten clouds to reflect more heat back into space or attempts to mimic the cooling caused by large volcanic eruptions. Many fear that, when global leaders finally realize the peril of climate change, they will jump at engineering projects without any evidence base, risking side effects of unknown magnitude.

At present, research that would help predict the effects of mitigation is unfunded or prohibited. To move forward, we need a way of governing climate-engineering projects that includes oversight, regulation and enforcement. My view is that the Montreal Protocol, which my global colleagues and I helped craft to preserve Earth's protective ozone layer, could be expanded to quell concerns and guide the relevant research.

Many scientists, policymakers and activists justifiably worry that climate-engineering attempts could make matters worse. The idea of 'climate rescue' has often been spurned for fear that it might weaken the ambition to reduce emissions. The experiments currently under discussion are small-scale, or are funded by philanthropists without public accountability or other checks and balances. One high-profile field trial — which proposed injecting water into the atmosphere through a 1-kilometre-long hose suspended by a balloon — was cancelled in 2012, in part for a lack of rules on how to proceed. Academic institutions are not prepared to craft policies or evaluate strategies, and none has the necessary status to convince world leaders to follow its advice.

By contrast, the infrastructure of the Montreal Protocol has coordinated government actions and brought success: 99% of manufactured ozone-depleting substances have now been phased out; chlorine and bromine are decreasing in the stratosphere; scientists are reporting the first evidence of healing in the ozone layer; and most scientific investigations estimate recovery by mid-century.

In the 1970s, chemists and atmospheric scientists warned that industrial chemicals such as chlorofluorocarbons (CFCs) were likely to be endangering the ozone layer and acting as powerful greenhouse gases. The ozone hole, unanticipated by scientists at the time, was reported in 1985, but even when the protocol was signed in 1987, CFCs had not been definitively linked to the depletion of ozone in the atmosphere. People feared that crucial areas such as medicine, fire protection, aerospace and electronics would suffer if these chemicals were banned. There was also concern that technologies replacing CFCs would be less energy efficient and would use greenhouse gases, and thus contribute to climate change.

The Montreal Protocol applied the 'precautionary principle' to justify action before full scientific and technical consensus had been reached — and it was not alone. The US Clean Air Act of 1977 similarly took the stance that "no conclusive proof … but a reasonable expectation" of harmful effects is sufficient to justify action.

Scientists do not yet know what the adverse consequences of climate engineering could be, but they can agree that those of runaway climate change would be catastrophic and possibly irreversible.

In my 40 years engaged in ozone protection, there were times when commercial concerns or fears of adverse environmental impacts almost derailed the work. I learned to watch carefully for signs of new objections or obstruction, and to proactively resolve uncertainties to the satisfaction of the parties to the protocol (the 197 signatory countries and nations). Most often, that resolution was guided by a trio of assessment panels — standing committees of technical experts who weigh scientific evidence, forecast impacts, make recommendations and guide negotiations.

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Over the past three decades, the panels have built up enough trust for the ratifying countries to agree unanimously several times to add new controlled substances or to accelerate the phasing out of a substance.

The tasks essential for governing climate-engineering experiments are well within the panels' expertise. The Scientific Assessment Panel could deepen understanding of the atmospheric system, especially models of stratospheric modification; could help to specify and validate climate-engineering methodologies such as the use of non-sulfate aerosols; and could develop strategies to monitor for unreported climate-engineering activity. In addition, it could report on climate-mitigation experiments and analyse the atmospheric response. This could provide a basis for evaluating specific proposals such as seeding clouds or injecting sulfur dioxide and non-sulfate aerosols. Members of the assessment panels could decide to expand their remit to include climate engineering or, better, could be guided to do so by the member nations.

In my view it would be irresponsible not to investigate engineering projects that might be the only solution fast enough to avert climate catastrophe. ■

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