

Earth experiment could buy precious time



VIEWPOINT
Alan Gadian

As the UK's Royal Society prepares to publish its conclusions on whether geo-engineering can help combat climate change, physicist Alan Gadian argues that geo-engineering techniques, in particular cloud whitening, must be properly tested - and soon.



“The research needs to be carried out; otherwise we will not know, five to 10 years from now, if we could have done anything to slow down the warming and the irreversible change in the Earth system

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Planet Earth has become a huge science experiment, and the consequences will affect all of us.

"Global warming poses a greater threat than world terrorism and agreement must be reached within two years to mitigate global warming and minimise environmental catastrophe," Sir David King, the UK's chief scientist, wrote in 2007.

On 8 July this year, the G8 proposed a 50% reduction of global emissions of carbon dioxide by 2050. It remains to be seen whether this will be fast enough.

And carbon dioxide is not the only problem.

Methane is a greenhouse gas 21 times more potent, and the wastelands of Siberia are now releasing fountains of methane as the permafrost melts, adding to the greenhouse warming effect.

So how can geo-engineering help?

I define geo-engineering as man-made environmental change; and I would include in its definition the unprecedented burning of fossil fuels that has pumped large quantities of carbon dioxide into the atmosphere, and the massive increase in the number of farm

animals with consequential methane production.

Changes in agriculture, in Africa for example, have resulted in the felling of large areas of forest and have removed the water storage capacity of the land. This has led to the rapid advance of the desert in the Sahel region.

The planet has been and is warming further. This will also lead to significant changes in precipitation, and flooding will remove prime agriculturally productive land.

Whiter clouds

In a 1990 paper in the journal *Nature*, John Latham, a scientist at the National Center for Atmospheric Research in Colorado, US, suggested that increasing the number of droplets in maritime layer clouds (stratocumulus) could significantly increase their reflectance.



Smaller glass beads, and smaller water droplets appear whiter

These clouds cover a third of the ocean.

The water droplets in clouds reflect solar radiation back to space. And the numbers of droplets they contain are largely controlled by the number of cloud condensation nuclei (CCN), such as specks of dust.

Many of these nuclei are produced over the land. Land-locked clouds therefore contain many hundreds of cloud droplets per cubic centimetre, whilst clouds that form over the sea contain substantially fewer.

Generally, the more droplets that are present in a cloud, the smaller they are.

For a given mass of water in a cloud, clouds with smaller droplets tend to be whiter. This was illustrated by the Edinburgh University scientist Stephen Salter's example of glass beads in a jar - the smaller the beads, the whiter they appear.

So the proposal is to inject a fine spray of sea salt from the ocean surface into the clouds; to artificially increase the number of drops, reduce their size and increase the reflectance of the clouds, making them whiter.

This one-off increase in reflectance - and the resulting cooling - could buy us precious time; maybe as much as 25 years.

But we need numerical models and field experiments to determine the ideal size of the sea-salt nuclei.

Results from climate models show that a modest increase of nuclei in marine stratocumulus clouds could produce the desired cooling.

Further research is required, but preliminary results suggest this could compensate for up to a doubling of atmospheric carbon dioxide from pre-industrial levels.

Initial results suggest that the biggest cooling would occur in the polar regions, which is consistent with theory, and is exactly the place where cooling is most needed.

The big advantages of this scheme are that it uses sea water spray, a naturally occurring substance, and that it can be turned off immediately if there are any undesirable consequences.

The technology

Professor Salter has even suggested a design for a fleet of about 2000 of wind-powered yachts, which incorporate a sophisticated spray mechanism that is now being developed.

My colleagues and I propose to carry out detailed research of the scheme and provide an

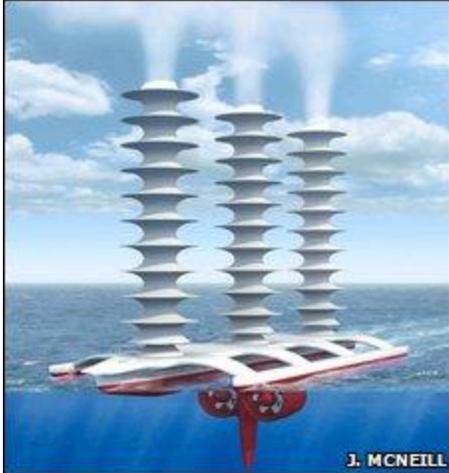
answer on its viability within five years.

There are four elements to this research:

- cloud physics modelling; there are many questions about the optimal size of sea-salt CCN and how the clouds will respond to their increased numbers
- further climate modelling
- developing and building Stephen Salter's test yachts
- a field experiment; a limited-area field experiment is needed in a region of stratocumulus clouds, and we already have advanced-stage plans with potential collaborators in the US

The cost

Initial estimates suggest that we could complete the research for approximately £6m (\$10m), and produce a result that will determine if the proposed scheme is viable or not.



Stephen Salter suggests a fleet of wind-powered yachts to inject sea salt into the clouds

The research needs to be carried out, otherwise we will not know, five to 10 years from now, if we could have done anything to slow down the warming and the irreversible change in the Earth system.

It is an insignificant sum compared to the cost of doing nothing.

As James Lovelock states: "There have been seven disasters since humans came on the Earth, very similar to the one that's just about to happen."

He argues that billions of people are likely to die in the ensuing famine. "Enjoy life while you can.

"Because if you're lucky it's going to be 20 years before it hits the fan".

We can do something to provide a breathing space. That something should start now.

Dr Alan Gadian is a senior research lecturer in the School of Earth and the Environment at the University of Leeds, UK

Dr Gadian would like to extend his thanks to collaborators Alan Blyth, John Latham and Stephen Salter

The Green Room is a series of opinion articles on environmental topics running weekly on the BBC News website