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Giant pipe and balloon to pump water into the sky in climate experiment

Field test by British academics marks first step towards recreating an artificial volcano that would inject particles into the stratosphere and cool the planet

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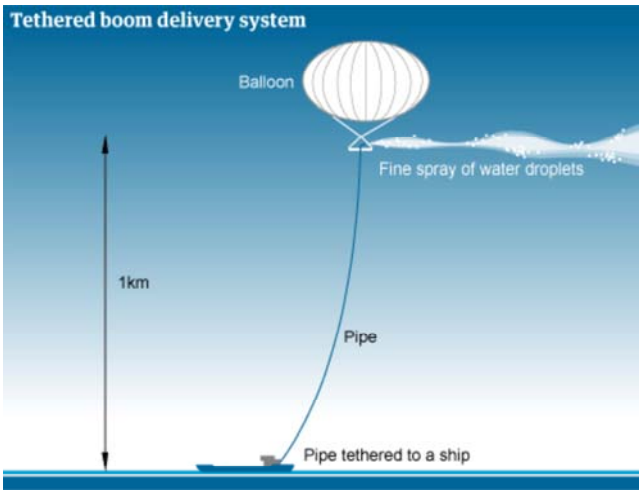

It sounds barmy, audacious or sci-fi: a tethered balloon the size of Wembley stadium suspended 20km above Earth, linked to the ground by a giant garden hose pumping hundreds of tonnes of minute chemical particles a day into the thin stratospheric air to reflect sunlight and cool the planet.

But a team of British academics will next month formally announce the first step towards creating an artificial volcano by going ahead with the world's first major "geo-engineering" field-test in the next few months. The ultimate aim is to mimic the cooling effect that volcanoes have when they inject particles into the stratosphere that bounce some of the Sun's energy back into space, so preventing it from warming the Earth and mitigating the effects of man-made climate change.

Before the full-sized system can be deployed, the research team will test a scaled-down version of the balloon-and-hose design. Backed by a £1.6m government grant, the team will send a balloon to a height of 1km over an undisclosed location. It will pump nothing more than water into the air, but it will allow climate scientists and engineers to gauge the engineering feasibility of the plan. Ultimately, they aim to test the impact of sulphates and other aerosol particles if they are sprayed directly into the stratosphere.

If the technical problems posed by controlling a massive balloon at more than twice the cruising height of a commercial airliner are resolved, then the team from Cambridge, Oxford, Reading and Bristol universities expect to move to full-scale solar radiation tests.

The principal investigator, Matthew Watson, a former UK government scientific adviser on emergencies and now a Bristol University lecturer, says the experiment is inspired by volcanoes and the way they can affect the climate after eruptions.

"We will test pure water only, in sufficient quantity to test the engineering. Much more research is required," he said, in answer the question of what effect a planetary-scale deployment of the technology could have.

Other leaders of the government-funded Stratospheric particle injection for climate engineering (Spice) project have investigated using missiles, planes, tall chimneys and other ways to send thousands of tonnes of particles into the air but have concluded that a simple balloon and hosepipe system is the cheapest. The research is paid for by the government-funded Engineering and Physical Sciences Research Council.

"The whole weight of this thing is going to be a few hundred tonnes. That's the weight of several double-decker buses. So imagine how big a helium balloon do you need to hold several double-decker buses – a big balloon. We're looking at a balloon which is possibly 100-200m in diameter. It's about the same size as Wembley stadium," said the Oxford engineering lecturer Hugh Hunt in an interview earlier this year.

"This hose would be just like a garden hose, 20km long and we pump stuff up the pipe. The nice thing about it is that we can really have a knob, if you like, which we can control to adjust the rate at which we inject these particles."

While the October experiment is expected to have no impact on the atmosphere, it could also be used to try out "low-level cloud whitening", a geo-engineering proposal backed financially by Microsoft chairman and philanthropist Bill Gates.

In this case, fine sea salt crystals would be pumped up and sprayed into the air to increase the number of droplets and the reflectivity in clouds. Together, many droplets are expected to diffuse sunlight and make a cloud whiter.

However, environment groups in Britain and the US said the government's experiment was a dangerous precedent for a full-scale deployment that could affect rainfall and food supplies. Even if the approach successfully cools the planet by bouncing some of the Sun's energy back into space, it would do nothing for the build up of CO_2 in the atmosphere, which leads to increased ocean acidity.

"What is being floated is not only a hose but the whole idea of geo-engineering the planet. This is a huge waste of time and money and shows the UK government's disregard for UN processes. It is the first step in readying the hardware to inject particles into the stratosphere. It has no other purpose and it should not be allowed to go ahead," said Pat Mooney, chair of ETC Group in Canada, an NGO that supports socially responsible development of technology.

Mike Childs, head of science, policy and research at Friends of the Earth UK, said: "We are going to have to look at new technologies which could suck CO_2 out of the air. But we don't need to do is invest in harebrained schemes to reflect sunlight into space when we have no idea at all what impact this may have on weather systems around the globe."

But the principle of large-scale geoengineering has been backed strongly by Sir Martin Rees, the former president of Royal Society, which in 2009 concluded in a report that it may be necessary to have a "plan B" if governments could not reduce emissions.

"Nothing should divert us from the main priority of reducing global greenhouse gas emissions. But if such reductions achieve too little, too late, there will surely be pressure to consider a 'plan B' – to seek ways to counteract the climatic effects of greenhouse gas emissions by 'geoengineering'," said Rees.

Members of the British public who were consulted by researchers in advance of the Spice experiment were broadly sceptical.

"Overall almost all of our participants were willing to entertain the notion that the test-bed as an engineering test – a research opportunity – should be pursued. Equally, very few were fully comfortable with the notion of stratospheric aerosols as a response to climate change," the Cardiff University-based researchers concluded.

Hacking the planet - potential geo-engineering solutions

Ocean nourishment

Billions of iron filings are deposited in the ocean to stimulate a phytoplankton bloom. The aim is to enhance biological productivity to remove carbon dioxide from the atmosphere. Many experiments have been conducted, including fertilisation of 900 square kilometers (350 sq miles) of the Atlantic. Results so far are disappointing.

Space mirrors

Giant "mirrors", made of wire mesh, could be sent into in orbit to deflect sunlight back into space. But the scale needed, the expense and the potential unintended consequences are so great that it is widely considered unrealistic. In the same league as the idea to mine the moon to create a shielding cloud of dust.

Cloud whitening

The idea is to increase the water content in low clouds by spraying sea water at them. This makes them reflect more sunlight. It would be pretty harmless, and cheap but would have to be done on an immense scale to have any global effect. Backed by Bill Gates.

Artificial trees

Proposed by climate scientist Wallace Broecker who imagines 60m artificial "trees" dotted around the world, "scrubbing" the air by capturing CO_2 in a filter and then storing it underground. The trees could remove more carbon dioxide than an equivalent -sized real tree.

Albedo changes

Painting roofs and roads white, covering deserts in reflective plastic sheeting, dropping pale-coloured litter into the ocean and genetically engineering crops to be paler have all been proposed to reflect sunlight back into space.

Carbon capture and storage (CCS)

Carbon dioxide is collected from coal or other fossil fuel power plants and is then pumped underground. Works in principle but it is expensive and increases the fuel needs of a coal-fired plant by 25%-40%. More than 40 plants have been built with many others planned.

• This article was amended on 7 September to remove a reference to the Royal Society

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