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Can geo-engineering rebuild the planet?

As global warming worsens, the idea of vast projects to alter the Earth's environment is moving from fantasy to necessity.

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Troubled times: 'To continue business as usual will probably kill most of us during the century,' says Prof James Lovelock Photo: PA

In the 1960s, two Russian scientists set out ambitious plans to reshape the world around us: to reverse the flow of rivers, shoot tiny white particles into space to illuminate the night sky, and melt the Arctic to water fields of Soviet wheat. "If we want to improve our planet and make it more suitable for life," wrote NP Rusin and L Flit, "we must alter its climate."

Four decades later, we have done plenty to alter the climate, but not for the better. And as we grapple with the problems of global warming, the standard prescription – cutting greenhouse gas emissions – is proving problematic. "I cannot see that we will be able to keep carbon levels low enough to prevent catastrophe," says Professor Brian Launder, of the University of Manchester. "Over the past five years, emissions have gone up, not down."

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Which means that "geo-engineering" – using technology on an almost unimaginable scale to tinker with the environment and correct our mistakes – could move from fantasy to necessity. Professor James Lovelock, who came up with the "Gaia" hypothesis, in which the Earth is thought to behave rather like a living, self-regulating organism, thinks we have exceeded the planet's natural capacity to counteract the changes we have made, and are rapidly heading towards a situation that will be calamitous for our species.

"Whatever we do is likely to lead to death on a scale that makes all previous wars, famines and disasters small," he says. "To continue business as usual will probably kill most of us during the century."

Even those of a less alarmist bent are worried enough to be taking geo-engineering seriously. Last September, Prof Launder co-edited a special edition of a Royal Society journal which examined various proposals, such as injecting sulphur into the stratosphere to reflect sunlight back into space.

Most of the schemes suggested, there and elsewhere, involve dramatic alterations to the Earth's weather systems, whether by deflecting the Sun's rays, removing carbon from the atmosphere or cooling the oceans. Prof Lovelock has come up with one of the most ambitious: he and Professor Chris Rapley, from the Science Museum, would like a system of pipes to be held vertically below the ocean's surface. These tubes, each 100 metres long, would draw cold water from below; wave action would then mix four tons of cooler water per second into the ocean at the surface. Cooler oceans mean a cooler planet, while the nutrient-rich water brought up from the bottom could encourage algal blooms, which use carbon to grow and thereby remove it from the atmosphere.

Supporters of another approach, known as Oceanic Iron Fertilisation, believe that promoting the growth of algae should be our main objective, rather than just a side effect. According to Dr Victor Smetacek, of the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, the theory is that adding iron to the oceans will encourage algal blooms. When the algae die, they sink to the bottom of the ocean, locking away their cargo of carbon.

There are plans to test this proposal off the island of South Georgia in the Atlantic. At the very least, Dr Smetacek hopes that large blooms of algae will act as food for krill, helping resurrect declining populations of squid and even some whales.

A third oceanic idea has been suggested by Professor Stephen Salter, from Edinburgh University's School of Engineering: a wind-driven fleet of Flettner ships. Originally designed by German engineer Anton Flettner, these vessels have no sails and are powered by rotors; the first one sailed across the Atlantic in 1926.

The ships would drag propeller-like turbines behind them to generate electricity, and pump out a very fine spray of seawater into the air. These tiny drops would join low clouds, with the salt making them whiter and better at reflecting sunlight back into the atmosphere, thus cooling the oceans. The beauty of this system is that it uses natural materials – seawater – and is powered by a renewable source of energy.

Finally, instead of reflecting sunlight using sea-level contraptions, some scientists have suggested shading the Earth from space. The most recent idea was put forward by Dr Roger Angel at the University of Arizona: to launch into space trillions of thin transparent discs, each about 60cm across. This cloud of 100,000 lenses would reflect sunlight back into space, shielding us from 1.8 per cent of the Sun's radiation.

But as intoxicating as such ideas are – and as tempting as a "quick fix" to the climate would be – they are not the finished article. Not only would the costs be enormous, but in a recent paper in Atmospheric Chemistry and Physics Discussions, Dr Tim Lenton of the University of East Anglia compared the possible effectiveness of 17 different geo-engineering techniques, and found severe problems with many of them. The Lovelock/Rapley plan to cool the oceans would, he says, be ineffective at reducing carbon on a global scale, and he is similarly sceptical about the algal blooms.

"There's huge disagreement in the scientific community about ocean fertilisation," agrees Prof Launder. "The ocean is very complex – elsewhere, perhaps thousands of miles away, you might be causing an adverse effect." Scientists from Britain's National Oceanography Centre, writing in the journal Nature, have demonstrated that adding iron to the ocean does boost algae growth rates by up to three times, and lock away carbon on the sea floor. But they added that geo-engineers overestimated the amount of carbon removed by between 15 and 50 times.

Prof Salter's Flettner ships have also sailed into stormy waters. Dr Lenton has calculated that they could cope with half the projected carbon emissions during the coming century, but Professor Stephen Schneider, from Stanford University, says that oceanic currents and winds might distribute the cooling effect unevenly, resulting in even greater climatic change.

As for Dr Angel's sun shield, Dr Lenton believes it would do the most to compensate for carbon emissions – but there is a downside, in that the sunshades would need to be launched in stacks of 800,000 units every five minutes for 10 years. "They might well work," says Prof Launder, "but this system wouldn't be ready soon enough."

So instead of alleviating global warming by trying to cool the planet or creating giant algal blooms, why not simply remove the carbon? Trees are pretty good at doing this naturally – but according to Prof Lovelock, we do not have enough forested regions left and could not plant enough trees to save us.

Instead, Dr Klaus Lackner, of Columbia University in New York, has come up with the idea of an artificial tree that directly "scrubs" carbon from the sky. Each one would be around the size of a shipping container and would, he estimates, be able to capture a ton of carbon dioxide a day. Of course, the carbon dioxide still has to be disposed of; Dr Lackner suggests pumping it into greenhouses to be absorbed by crop plants.

"In a way, this sort of scheme is the most desirable," says Prof Launder, "because it doesn't just reflect sunlight, it grabs carbon dioxide in the atmosphere. Sadly, I don't think these 'trees' can sequester anything like the amount of carbon required."

The grim conclusion is that while some of these schemes have potential, there is no magic answer. "Geo-engineering is not a solution," says Prof Launder, "but it could give the world a chance to come to its senses. In 50 years we'll have carbon-free energy schemes in place, but we need a solution that can be put into place shortly, and will gain us breathing space."

Yet even if any of these schemes could be made to work, a global scheme requires global co-operation. Given how hard that has proved over the financial crisis, it is difficult to imagine world leaders reaching an agreement over a radical – and expensive – alteration to the environment.

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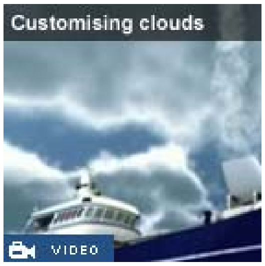

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