A cocktail geo-engineering approach to reversing global warming

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GLOBAL WARMING — the continuing rise in global temperatures — is attributed to the rapidly increasing concentrations of carbon dioxide in the atmosphere. Attempts to fight global warming, and the consequent climate change, are therefore mainly aimed at stabilising and then reducing the atmospheric carbon dioxide concentrations. These strategies, even in the best-case scenarios, are likely to start yielding results only in the long term, after at least four to five decades. In the meanwhile, temperatures are expected to continue to rise.

Scientists have for long been trying to look for alternative strategies to keep a lid on rising temperatures in a more immediate time-frame. Planetary scale geo-engineering solutions have often been suggested. One of the ideas that has been explored for quite some time involves placing of artificial reflectors -giant mirrors or very small reflecting particles - in outer space that can reflect back some part of solar radiation incident on earth's surface. By blocking a part of sun rays, temperatures on the earth can be brought down. Injection of sulphate aerosols, very fine solid particles, into the stratosphere is one of the most widely discussed ideas to achieve this objective. Sulphate aerosol particles are very good reflectors of sunlight, and it has been shown, through various climate models, that even if 1% of current incident solar radiation is reflected back in space, a very significant amount of temperature rise on earth can be offset.

Another way of instantly cooling the planet is to reduce the amount of high-altitude clouds, formed at heights of around 10 km from the earth's surface. These cloud, called cirrus, are composed mainly of ice crystals. Like the carbon dioxide in the atmosphere, these clouds also have greenhouse property. They let the solar radiation pass through and reach the surface, but trap the higher wavelength infrared radiation emitted from the earth, thereby contributing to the heating. If these clouds are reduced by some engineering interventions, it would allow the IR radiation from the earth, too, to pass through to space, thus allowing some of the heat to dissipate and hence cool the planet.

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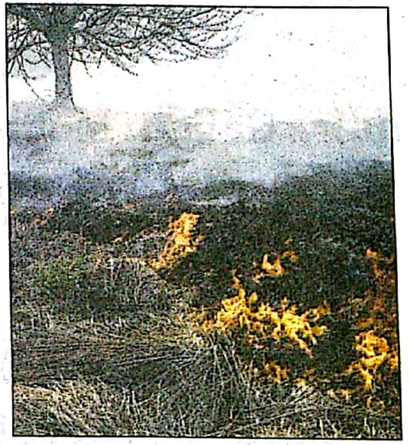
Several studies over the years have assessed the feasibility and the likely impacts of geo-engineering solutions like these using climate models. Computer simulations using these models have shown that desired decline in temperatures can be achieved by both these approaches.

However, both of them also have an inherent problem. In their simulations, scientists have been trying to achieve pre-industrial levels of both global temperature and rainfall when the carbon dioxide concentration in the atmosphere was 280 parts per million. The problem with either of these two methods is that when the pre-industrial temperatures are reached through the simulations, the precipitation levels in those conditions are wide of the mark as compared to what is expected at 280 ppm carbon dioxide concentration.



In the aerosol injection method, the amount of precipitation change per degree change in temperatures is greater than what carbon dioxide concentrations produce, while it is less if the cirrus cloud reduction method is used.

In either case, there is imbalance and scientists have so far not succeeded in restoring both temperature as well as precipitation simultaneously to the pre-industrial levels by using either of the two simulated geo-engineering models.

For the first time, recently we have succeeded in achieving this simultaneous balance by combining the two methods. In our computer simulations, we studied the effects of sulphate aerosol injection in the upper stratosphere combined with the impacts of cirrus cloud thinning. By careful calibration, we have been able to restore pre-industrial levels of temperature as well as precipitation through these geo-engineering models. In our study, about 75% of the cooling of the earth's surface is achieved by sulphate aerosol injection and the rest by the thinning of clouds.

Our result has recently been published in Geophysical Research Letters, a peer-reviewed journal published by the American Geophysical Union. The study was conducted by a team of international scientists. The collaborating team includes Ken Caldeira of Carnegie Institution for Science in the US, and Long Cao and Lei Duan of Zhejiang University, China.

It is important to note that the geo-engineering solutions are still some distance away from being applied, and scientific opinion is divided over the need to deploy such methods. Geo-engineering is a controversial idea and many are opposed to it as it involves not only science but also ethical and moral issues. Unlike conventional approaches to deal with climate change, geo-engineering solutions do nothing to reduce concentrations of atmospheric carbon dioxide, the main reason for global warming. Many climate scientists, including I, are not in favour of implementing geo-engineering but it is important to continue scientific research into it as all options should be on the table for solving the climate crisis. Our first and foremost focus should be on carbon dioxide emission reductions.

For your research to be considered for this column, please write to Amitabh Sinha at amitabh.sinha@expressindia.com