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RESEARCH HIGHLIGHTS

Dec 15, 2009

Saving Greenland's ice by geoengineering

The world's greenhouse-gas emissions show no sign of slowing at present. In the worst-case scenario this means that melting of the Greenland ice sheet could pass beyond the point of no return within 150 years, committing us to metres of sea-level rise over the coming millennia. The eventual complete melting of the Greenland ice sheet would push global sea level up by around 7 metres. Add to this the melting of glaciers and the Antarctic ice sheet, plus thermal expansion of the oceans, and the picture looks even worse.

More than 70% of the world's population lives on coastal plains, within 9.1 metres of sea level; two thirds of the world's largest cities are on the coast or estuaries. Just 40 cm of sea-level rise in the Bay of Bengal would flood 11% of Bangladesh's coastal land, creating 7 to 10 million climate refugees. Seven metres or more of sea-level rise is unthinkable.

So what happens if we can't put the brakes on global warming fast enough to prevent this change? One way of slowing the global temperature rise and the accompanying melting of the Greenland ice sheet might be to deflect some of the Sun's rays away from Earth.

With this in mind Peter Irvine, from the University of Bristol, UK, and his colleagues calculated how much solar-radiation management would be required to prevent the Greenland ice sheet from melting.

Current estimates suggest that it would be impossible to prevent the Greenland ice sheet from melting completely if atmospheric carbon dioxide is allowed to climb to four times pre-industrial levels (1120 ppmv) and remain around or above this concentration. With "business as usual" emissions we are predicted to reach this particular tipping point by 2150, jamming the Greenland ice sheet into melt mode and leading to complete melting within a few thousand years at most.

Using a global-climate model coupled with an ice-sheet model, Irvine and colleagues assessed the impact of varying levels of solar-radiation management on a world with carbon dioxide levels four times those of pre-industrial times.

To bring the average global temperature down to pre-industrial levels in this scenario they found the amount of sunlight reaching the top of the atmosphere had to be reduced by 4.2%. "To achieve this reduction in sunlight you would need to inject millions of tonnes of sulphur into the stratosphere per year," Irvine told **environmentalresearchweb**.

However, the modified climate would have some important differences to the pre-industrial one. The extra carbon dioxide in the atmosphere would have an insulating effect at the poles, making them a little warmer than in pre-industrial times. Meanwhile, the tropics would become a little cooler because of the reduction in direct sunlight.

Because of regional effects for Greenland, including increased precipitation as a result of the geoengineering, the researchers estimate that a 2.5% reduction in sunlight – 60% of the amount required to obtain pre-industrial temperatures – would be sufficient to prevent the Greenland ice sheet from melting in a four times pre-industrial carbon dioxide world. This would equate to 60% of the sulphur required in the stratosphere for full geoengineering. Alternatively the same effect could be achieved by placing a bank of satellites between the Earth and the Sun, to act like a giant sunshade. But the model doesn't include the Antarctic ice sheet, glaciers or thermal expansion of the ocean, so it is still unclear what impact solar-radiation management would have on these potential causes of sea-level rise.

Nonetheless, the new study, which is published in Environmental Research Letters, indicates that the degree of solar geoengineering required to mitigate the worst effects of global warming, such as sea-level rise, need not be as extensive as previously assumed.

But solar geoengineering can't prevent all of the unwelcome impacts that come with increased atmospheric carbon dioxide. Ocean acidity would continue to rise, destroying corals and making life exceedingly difficult for shelled organisms. And some parts of the world might get a raw deal out of a geoengineered climate. "A solar-radiation management-geoengineered world would be drier on average and the climate would differ from its natural (pre-industrial) state," said Irvine. In addition, we could come to rely on solar geoengineering, leaving us vulnerable to attacks on the solar shield; something akin to the threat of nuclear war.

Irvine and his colleagues stress that reducing carbon dioxide emissions now is likely to be an easier and cheaper option. "If we spend less on carbon dioxide cuts now, then we may rely more heavily on solar-radiation management in future," said Irvine. "If we spend more on cuts now then we will not have to rely so heavily or at all on solar-radiation management."

Will the world's governments decide to rely on the solar geoengineering "sticking plaster" or are they going to "swallow the medicine now", drastically cutting emissions and curing the problem? Either way, the decision will have to be made within the next decade or so.

About the author

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