Injecting sulfate particles into stratosphere won't fully offset climate change

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A polar bear walks along an expanse of open water at the edge of Hudson Bay near Churchill, Manitoba, in 2011. The bears need pack ice to hunt for food, primarily seals, but climate change brings open water more often than it used to. Polar bears have been listed as a threatened species. Credit: Cecilia Bitz/U. of Washington

As the reality and the impact of climate warming have become clearer in the last decade, researchers have looked for possible engineering solutions – such as removing carbon dioxide from the atmosphere or directing the sun's heat away from Earth – to help offset rising temperatures.

New University of Washington research demonstrates that one suggested method, injecting sulfate particles into the stratosphere, would likely achieve only part of the desired effect, and could carry serious, if

unintended, consequences.

The lower atmosphere already contains tiny sulfate and sea salt particles, called aerosols, that reflect energy from the sun into space. Some have suggested injecting sulfate particles directly into the stratosphere to enhance the effect, and also to reduce the rate of future warming that would result from continued increases in atmospheric carbon dioxide.

But a UW modeling study shows that sulfate particles in the stratosphere will not necessarily offset all the effects of future increases in atmospheric carbon dioxide.

Additionally, there still is likely to be significant warming in regions where climate change impacts originally prompted a desire for geoengineered solutions, said Kelly McCusker, a UW doctoral student in atmospheric sciences.

The modeling study shows that significant changes would still occur because even increased aerosol levels cannot balance changes in atmospheric and oceanic circulation brought on by higher levels of atmospheric carbon dioxide.

"There is no way to keep the climate the way it is now. Later this century, you would not be able to recreate present-day Earth just by adding sulfate aerosols to the atmosphere," McCusker said.

She is lead author of a paper detailing the findings published online in December in the *Journal of Climate*. Coauthors are UW atmospheric sciences faculty David Battisti and Cecilia Bitz.

Using the National Center for Atmospheric Research's Community Climate System Model version 3 and working at the Texas Advanced Computing Center, the researchers found that there would, in fact, be

less overall warming with a combination of increased atmospheric aerosols and increased carbon dioxide than there would be with just increased carbon dioxide.

They also found that injecting sulfate particles into the atmosphere might even suppress temperature increases in the tropics enough to prevent serious food shortages and limit negative impacts on tropical organisms in the coming decades.

But temperature changes in polar regions could still be significant. Increased winter surface temperatures in northern Eurasia could have serious ramifications for Arctic marine mammals not equipped to adapt quickly to climate change. In Antarctic winters, changes in surface winds would also bring changes in ocean circulation with potentially significant consequences for ice sheets in West Antarctica.

Even with geoengineering, there still could be climate emergencies – such as melting ice sheets or loss of polar bear habitat – in the polar regions, the scientists concluded. They added that the odds of a "climate surprise" would be high because the uncertainties about the effects of geoengineering would be added to existing uncertainties about climate change.

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