Earth sunblock only needed if planet warms easily

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Ship exhaust creates long streaks of clouds across the ocean's dark surface, making the sky brighter and reducing the amount of heat trapped in the atmosphere. Some researchers are exploring ways to make clouds brighter to reflect more sunlight back into space. Credit: NASA.

(Phys.org)—An increasing number of scientists are studying ways to temporarily reduce the amount of sunlight reaching the earth to potentially stave off some of the worst effects of climate change. Because these sunlight reduction methods would only temporarily reduce

temperatures, do nothing for the health of the oceans and affect different regions unevenly, researchers do not see it as a permanent fix. Most theoretical studies have examined this strategy by itself, in the absence of looking at simultaneous attempts to reduce emissions.

Now, a new computer analysis of future climate change that considers emissions reductions together with sunlight reduction shows that such drastic steps to cool the earth would only be necessary if the planet heats up easily with added greenhouse gases. The analysis, reported in the journal Climatic Change, might help future policymakers plan for a changing climate.

The study by researchers at the Department of Energy's Pacific Northwest National Laboratory explored sunlight reduction methods, or solar radiation management, in a computer model that followed emissions' effect on climate. The analysis shows there is a fundamental connection between the need for emissions reductions and the potential need for some sort of solar dimming.

"It's a what-if scenario analysis," said Steven Smith with the Joint Global Change Research Institute in College Park, Md,, a joint venture between PNNL and the University of Maryland. "The conditions under which policymakers might want to manage the amount of sun reaching earth depends on how sensitive the climate is to atmospheric greenhouse gases, and we just don't know that yet."

The analysis started with computer-based virtual worlds, or scenarios, that describe different potential pathways to reduce greenhouse gas emissions, which limits the amount of heat in the earth system due to greenhouse gas accumulation. The researchers combined these scenarios with solar radiation management, a type of geoengineering method that might include shading the earth from the sun's heat by either brightening clouds, mimicking the atmospheric cooling from volcanic eruptions or

putting mirrors in space.

"Solar radiation management doesn't eliminate the need to reduce emissions. We do not want to dim sunlight over the long term—that doesn't address the root cause of the problem and might also have negative regional effects. This study shows that the same conditions that would call for solar radiation management also require substantial emission reductions in order to meet the climate goals set by the world community," said Smith.

How much sun blocking might be needed depends on an uncertain factor called climate sensitivity. Much like beachgoers in the summer, the earth might be very sensitive to carbon dioxide, like someone who burns easily and constantly slathers on the sunscreen, or not, like someone who can get away with SPF 5 or 10.

Scientists measure climate sensitivity by how many degrees the atmosphere warms up if the concentration of carbon dioxide doubles. Smith said if the climate has a medium sensitivity of about 3 degrees Celsius (5.4 degrees Fahrenheit) per doubling of carbon dioxide, "it's less likely we'd need solar radiation management at all. We'd have time to stabilize the climate if we get going on reducing emissions. But if it's highly sensitive, say 4.5 degrees Celsius (8.1 degrees Fahrenheit) per doubling, we're going to need to use solar radiation management if we want to limit temperature changes."

According to NOAA's August report, the earth's temperature has already risen about 0.62 degrees Celsius (1.12 degrees Fahrenheit) since the beginning of the 20th century as the carbon dioxide in the atmosphere has grown from 290 parts per million to 379 parts per million.

But the atmosphere hasn't reached equilibrium yet—even if humans stopped putting more carbon dioxide into the air, the climate would still

continue to change for a while longer. Scientists do not know what temperature the earth will reach at equilibrium, because they don't know how sensitive the planet is to greenhouse gases.

Further, the study showed that, when coupled with emission reductions, the amount of solar radiation management needed could be far less than the amount generally considered by researchers so far.

"Much of the current research has examined solar radiation management that is used as the sole means of offsetting a doubling of carbon dioxide concentrations. What we showed is that when coupled with emissions reductions, only a fraction of that amount of 'solar dimming' will be needed. This means that potential adverse impacts would be that much lower," said Smith. "This is all still in the research phase. We do not know enough about the impacts of potential solar radiation management technologies to use them at this time."

The study will also help decision-makers evaluate solar reduction technologies side-by-side, if it comes to that. Smith and his coauthor, PNNL atmospheric scientist and Laboratory Fellow Phil Rasch, devised a metric to quantify how much solar radiation management will be needed to keep warming under a particular temperature change threshold. Called degree-years, this metric can be used to evaluate the need for potential sunlight dimming technologies.

Whether such technologies will be needed at all, time will tell.

More information: Steven J. Smith and Philip J. Rasch, 2012. The Long-Term Policy 1 Context for Solar Radiation Management, *Climatic Change Letters*, doi: 10.1007/s10584-012-0577-3.

Provided by Pacific Northwest National Laboratory