Best hope for saving Arctic sea ice is cutting soot emissions: researcher (w/ Video)

July 28 2010

The quickest, best way to slow the rapid melting of Arctic sea ice is to reduce soot emissions from the burning of fossil fuel, wood and dung, according to a new study by Stanford researcher Mark Z. Jacobson.

His analysis shows that soot is second only to carbon dioxide in contributing to global warming. But, he said, climate models to date have mischaracterized the effects of soot in the atmosphere.

Because of that, soot's contribution to global warming has been ignored in national and international global warming policy legislation, he said.

"Controlling soot may be the only method of significantly slowing Arctic warming within the next two decades," said Jacobson, director of Stanford's Atmosphere/Energy Program. "We have to start taking its effects into account in planning our mitigation efforts and the sooner we start making changes, the better."

To reach his conclusions, Jacobson used an intricate computer model of global climate, air pollution and weather that he developed over the last 20 years that included atmospheric processes not incorporated in previous models.

He examined the effects of soot - black and brown particles that absorb solar radiation - from two types of sources. He analyzed the impacts of soot from fossil fuels - diesel, coal, gasoline, jet fuel - and from solid biofuels, such as wood, manure, dung, and other solid biomass used for home heating and cooking in many locations. He also focused in detail on the effects of soot on heating clouds, snow and ice.

What he found was that the combination of both types of soot is the second-leading cause of global warming after carbon dioxide. That ranks the effects of soot ahead of methane, an important greenhouse gas. He also found that soot emissions kill over 1.5 million people prematurely worldwide each year, and afflicts millions more with respiratory illness, cardiovascular disease, and asthma, mostly in the developing world where biofuels are used for home heating and cooking.

Jacobson's study will be published this week in *Journal of Geophysical Research (Atmospheres)*.

It is the magnitude of soot's contribution, combined with the fact that it lingers in the atmosphere for only a few weeks before being washed out, that leads to the conclusion that a reduction in soot output would start slowing the pace of global warming almost immediately.

Greenhouse gases, in contrast, typically persist in the atmosphere for decades - some up to a century or more - creating a considerable time lag between when emissions are cut and when the results become apparent.

Jacobson found that eliminating soot produced by the burning of fossil fuel and solid biofuel could reduce warming above parts of the Arctic Circle in the next fifteen years by up to 1.7 degrees Celsius. For perspective, net warming in the Arctic has been at least 2.5 degrees Celsius over the last century and is expected to warm significantly more in the future if nothing is done.

The most immediate, effective and low-cost way to reduce soot emissions is to put particle traps on vehicles, diesel trucks, buses, and construction equipment. Particle traps filter out soot particles from exhaust fumes.

Soot could be further reduced by converting vehicles to run on clean, renewable electric power.

Jacobson found that although fossil fuel soot contributed more to global warming, biofuel-derived soot caused about eight times the number of deaths as fossil fuel soot. Providing electricity to rural developing areas, thereby reducing usage of solid biofuels for home heating and cooking, would have major health benefits, he said.

Soot from fossil fuels contains more black carbon than soot produced by burning biofuels, which is why there is a difference in impact.

Black carbon is highly efficient at absorbing solar radiation in the atmosphere, just like a black shirt on a sunny day. Black carbon converts sunlight to heat and radiates it back to the air around it. This is different from greenhouse gases, which primarily trap heat that rises from the Earth's surface. Black carbon can also absorb light reflecting from the surface, which helps make it such a potent warming agent.

Jacobson's climate model is the first global model to use mathematical equations to describe the physical and chemical interactions of soot particles in cloud droplets in the atmosphere. This allowed him to include details such as light bouncing around inside clouds and within cloud drops, which he said are critical for understanding the full effect of black carbon on heating the atmosphere.

"The key to modeling the climate effects of soot is to account for all of its effects on clouds, sea ice, snow, and atmospheric heating," Jacobson said. Because of the complexity of the processes, he said it is not a surprise that previous models have not correctly treated the physical interactions required to simulate cloud, snow, and atmospheric heating by soot. "But without treating these processes, no model can give the correct answer with respect to soot's effects," he said.

Jacobson argues that leaving out this scale of detail in other models has led many scientists and policy makers to undervalue the role of black carbon as a warming agent.

The strong global heating due to soot that Jacobson found is supported by some recent findings of Veerabhadran Ramanathan, a professor of climate and atmospheric science at the Scripps Institute of Oceanography, who measures and models the climate effects of soot.

"Jacobson's study is the first time that a model has looked at the various ways black carbon can impact climate in a quantitative way," said Ramanathan, who was not involved in the study.

Black carbon has an especially potent warming effect over the Arctic. When black carbon is present in the air over snow or ice, sunlight can hit the black carbon on its way towards Earth, and also hit it as light reflects off the ice and heads back towards space.

"It's a double-whammy over the ice surface in terms of heating the air," Jacobson said.

Black carbon also lands on the snow, darkening the surface and enhancing melting.

"There is a big concern that if the Arctic melts, it will be a tipping point for the Earth's climate because the reflective sea ice will be replaced by a much darker, heat absorbing, ocean below," said Jacobson. "Once the sea ice is gone, it is really hard to regenerate because there is not an efficient mechanism to cool the ocean down in the short term."

Provided by Stanford University

Citation: Best hope for saving Arctic sea ice is cutting soot emissions: researcher (w/ Video) (2010, July 28) retrieved 23 April 2024 from https://phys.org/news/2010-07-arctic-sea-ice-soot-emissions.html