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Editor Note: A photo of Jacobson is available at http://newsphotos.stanford.edu.
Relevant Web URLs:

Mark Z. Jacobson's website
American Meteorological Society

Forest burning is a net contributor to global warming, scientist says
What is the net effect on global temperature of the gases and particles produced when biomass is burned? That long-standing question in climate change has finally been answered, according to Mark Z. Jacobson, a Stanford associate professor of civil and environmental engineering. In a study published in the Aug. 1 issue of the American Meteorological Society's Journal of Climate, he concludes that the particles cause short-term global cooling, but over decades the gases overwhelm this cooling effect to cause long-term global warming.

Scientific consensus is that global warming results from an atmospheric buildup of greenhouse gases, primarily carbon dioxide. Of the carbon dioxide that we humans contribute, roughly two-thirds is from the burning of fossil fuels and one-third is from the burning of biomass, such as forests, grasslands and agricultural crops.

But biomass burning also emits particles, many of which reflect light, causing cooling. Whereas previous studies, summarized in the comprehensive Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report, have examined instantaneous changes in heat radiation due to the gases and particles produced by biomass burning, no study has examined the combined effects of gases and particles on temperature or climate over time.

"The control of biomass burning, particularly during permanent deforestation, is a near-certain long-term method of slowing global warming, despite the particles," Jacobson says. "In the worst case, no net [temperature] change will occur."

Biomass is sometimes burned for fuel, as when people in villages burn dung to heat homes or cook meals. In a process called "open burning," biomass is also burned to clear land, rid debris from old crops or perform rituals. Of the three main types of open burning, 32 percent occurs in forests, 60 percent in grasslands and 8 percent in croplands. By far the most carbon is tied up in trees, so burning forests has a much larger effect on climate change than does burning grasses or crops.

Of forest burning, about 80 percent results in permanent deforestation - meaning the land is now used for some other use, such as grazing, agriculture or buildings. The remaining 20 percent of trees are regrown. When forests are permanently replaced by other plant types - shrubs, grasses, crops, all of which contain less carbon than do trees - the carbon difference accumulates in the atmosphere. "The total carbon dioxide emission from permanent deforestation is on the order of 7 to 10 percent of global fossil-fuel-carbon-dioxide emission," Jacobson says.

Jacobson's calculations used a model honed over 14 years and emission data from a variety of sources. He is an author of two textbooks - Fundamentals of Atmospheric Modeling (Cambridge University Press, 1999) and Atmospheric Pollution: History, Science, and Regulation (Cambridge University Press, 2002).

Another finding of Jacobson's study is that biomass, including biofuel, is not a completely "renewable" source of energy, as many biofuel industry advocates suggest. Many people mistakenly think that when oils from soy or ethanol from corn, for example, are burned as fuel, no net carbon is added to the atmosphere because carbon from the atmosphere is required to grow the fuel. But that's not the case, Jacobson says. "Because of the time lag between burning and full regrowth, burning always results in a net accumulation of carbon."

Atmospheric carbon accumulation is greatest during forest burning and regrowth. For example, about 70 percent of a forest may regrow in, say, 25 years, but it may take 100 to 200 years for full recovery. During that period, about 20 times more carbon than is emitted annually can accumulate in the atmosphere, enhancing global warming, Jacobson says.

"The regrowth times of agricultural land and savannahs, which are one to nine years, are much shorter than are those of forests," Jacobson explains. "So the accumulation is smaller in those cases. Nevertheless, any type of burning together with regrowth results in a net accumulation of carbon dioxide."

Eliminating all biomass burning would reduce the global average temperature by 0 to 0.2 degrees F over 100 years, which is comparable to the increase in global temperature of 0.6 to 0.7 degrees F since pre-industrial times, Jacobson says. Reducing permanent deforestation, especially in tropical regions of Africa and South America, would be the most effective means of reducing the effects of biomass burning.

Jacobson says his study lays to rest a long debate about whether forest burning results in more cooling, due to particles produced, or more warming, due to gases emitted.

"With this information, policymakers are on firmer ground when they consider control of biomass burning," he says. "Such control is also beneficial from a public health point of view, since the particles from biomass burning are health hazards."

The next steps in Jacobson's research include refining the model in response to updated emission inventories and new knowledge of physical processes, and examining related issues, such as the effects of power plants and vehicles on climate.

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BY Dawn Levy