Controlling Soot Might Quickly Reverse a Century of Global Warming | Wired Science

A massive simulation of soot's climate effects finds that basic pollution controls could put a brake on global warming, erasing in a decade most of the last century's temperature change.

Compared to the larger, longer term task of getting greenhouse-gas pollution under control, limiting soot wouldn't be hard. Unlike new energy technology and profound changes in lifestyle, the tools — exhaust filters, clean-burning stoves — already exist.

"Soot has such a strong climate effect, but it has a lifetime in the atmosphere of just a few weeks. Carbon dioxide has a lifetime of 30 to 50 years. If you totally stop CO2 emissions today, the Arctic will still be

totally melted," said Stanford University climate scientist Mark Jacobson. If soot pollution is immediately curtailed, "the reductions start to occur pretty much right away. Within months, you'll start seeing temperature differences."

Jacobson's simulation, currently in press at the *Journal of Geophysical Research-Atmospheres*, is the latest in a line of studies showing a powerful climate role for fine soot, also known as black carbon. (That's a somewhat misleading appellation, since some carbon is brown, and the pollution in soot contains a host of other compounds.)

Soot comes from the incomplete combustion of fossil fuels, and also from the burning of wood or dung for fuel. Crop residue and forest-burning are another major source. When aloft, the dark particles absorb sunlight, raising local temperatures and causing rain clouds to form, which in turn deprive other areas of moisture. When soot lands on snow or ice, its effects are magnified, because melts reveal fresh patches of heat-absorbing dark ground.

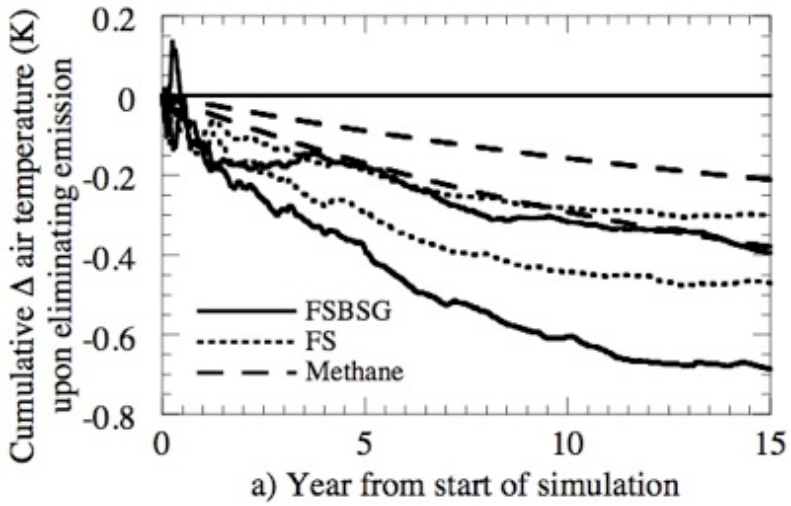
In 2003, a NASA simulation blamed soot for 25 percent of the past century's observed warming. A study last year suggested that soot was responsible for almost half of a 3.4-degree Fahrenheit rise in average Arctic temperatures since 1890 — a greater rise than anywhere else on Earth.

Soot also appears to be a culprit in drastic melts of Himalayan glaciers which provide water to much of South Asia, and in disrupting the monsoon cycles on which the region's farmers rely. The United Nations puts the soot-related death toll at 1.5 million people annually.

Jacobson's simulation, the culmination of 20 years of research on the dynamics of soot and its interaction with local, regional and global climate dynamics, reinforces those findings. It also studies a question implicit in the earlier studies, but not yet modeled: What would happens if soot pollution stopped?

"If you just eliminate soot, you get a significant climate benefit, and you can do it on a short time period, because soot has a life of just a few weeks," said Jacobson. "You don't get the full response for a while, as there are deep ocean feedbacks that take a long time, but it's a lot

faster than controlling CO2."



Jacobson simulated the effects of curtailing soot from fossil-fuel emissions, something that's already possible with tailpipe and smokestack filters. He simulated the effects of replacing wood- and dung-burning cookfires with clean-burning stoves. And he simulated both advances simultaneously.

If soot disappeared overnight, average global temperatures would drop within 15 years by about 1 degree Fahrenheit, maybe a little more. That's about half the net warming — total global warming, minus cooling from sun-reflecting aerosols — experienced since the beginning of the industrial age. The effect would be even larger in the Arctic, where sea ice and tundra could rapidly refreeze.

"It will take some decades to phase down fossil-fuel emissions, so reducing dirty aerosols [soot] while we are doing that may help retain Arctic sea ice," said NASA climatologist James Hansen, one of the first researchers to study soot dynamics. But he emphasized that soot control is only a stopgap measure. "We should reduce soot for several reasons, especially its health effects, but it is only a modest help in controlling global warming," he said.

Nevertheless, soot could ease the delay between controlling greenhouse gas emissions and cooling. It might also help "avoid tipping points — nonlinear, abrupt and potentially irreversible climate change, especially in the Arctic," said Erika Rosenthal, a climate policy expert at the progressive nonprofit Earthjustice.

Soot-control policy, however, is scattered. According to Jacobson, climate policymakers have paid little attention to soot. Compared to well-studied greenhouse gases, its climate role is new and unfamiliar. “There are international efforts to limit greenhouse gases, but they completely ignore soot as something to control from a climate perspective,” said Jacobson.

The draft international climate treaty negotiated last year in Copenhagen doesn’t contain soot-specific provisions, but the United Nations Environmental Program is meeting in February to discuss policy options on soot. A relatively little-known U.N. effort called the Convention on Long-Range Transboundary Air Pollution has also established a black-carbon working group.

In the United States, a rare bipartisan environmental bill sponsored in 2009 by climate skeptic James Inhofe (R-Oklahoma) and environmentalist Barbara Boxer (D-California) foundered after its inclusion in massive energy legislation that recently died in Congress. It would have required the EPA to study and possibly regulate black-carbon emissions.

In anticipation of these legislative difficulties, the EPA was charged this year with launching a black-carbon study. More immediately, Congress is now debating reauthorization of the Diesel Emissions Reduction Act, a federal program that pays for putting clean tailpipes on diesel-fuel–burning automobiles, a prime source of black carbon. According to Rosenthal, the program has been fantastically successful, with retrofit requests exceeding available funds by $2 billion.

Controlling crop and forest burns isn’t so easy, but clean stoves could be provided to the developing world for relatively little money. “We have the technology now. It’s a matter of implementing it,” said Rosenthal.

“It’s low-hanging fruit,” said Jacobsen. “It’s straightforward to address, and it can be addressed.”

Images: 1) Rennett Stowe/Flickr. 2) Average global air temperature decline following elimination of fossil-fuel–based soot (dotted line) and fossil-fuel– plus biofuel–based soot (solid line).

Citation: "Short-term effects of Controlling Fossil-Fuel Soot, Biofuel Soot and Gases, and Methane on Climate, Arctic Ice, and Air Pollution Health." By Mark Jacobson. Journal of Geophysical Research-Atmospheres*, in press.*

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