Soot and global warming

What The Science Says:
Soot stays in the atmosphere for days to weeks; carbon dioxide causes warming for centuries.

Climate Myth: It's soot
"The Intergovernmental Panel On Climate Change (IPCC) drastically understates the warming potential of soot (black carbon) in its report to policy makers. The IPCC has an agenda and that agenda is to blame manmade carbon dioxide emission for climate change. Europe and Asia emit most of the soot from burning coal, wood, dung, and diesel in open fires or without particulate filters in stoves, chimneys, smokestacks, and exhaust pipes. The United States has been restricting soot emissions in Draconian fashion since the Clean Air Act of 1963. The IPCC agenda is really about blaming the United States." (Uncommon Descent)

Soot, also called black carbon (BC), contributes to climate warming in two ways. First, black soot particles in the air absorb sunlight and directly heat the surrounding air. Second, soot falling on snow or ice changes those reflecting surfaces into absorbing ones, that is, soot decreases the albedo. Therefore, soot deposits increase the melting rate of snow and ice, including glaciers and the arctic ice.

Black carbon is a “short-term” climate forcer. Over the short term it is an important contributor to warming; so reducing soot will have immediate benefits in slowing warming over the next 40 years, perhaps by 0.1-0.2°C globally. Decreasing black carbon deposits in the arctic may also slow amplification of feedbacks from melting arctic snow and ice.

Black carbon does not accumulate in the atmosphere like CO2. So, reductions in BC have immediate, but not long-term effects on global warming. CO2 is certainly the “biggest control knob” on climate, and climate change cannot be prevented without reducing carbon emissions. Reductions in BC *and* CO2 *and* methane *and* ozone will be necessary to keep global temperatures from rising more than 2°C above preindustrial levels in the next 50 years.

> “It is important to emphasize that BC reduction can only help delay and not prevent unprecedented climate changes due to CO2 emissions.” (Ramanathan and Carmichael. Global and regional climate changes due to black carbon. Nature Geoscience (2008) vol. 1 (4) pp. 221-227)
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> “Short-lived climate forcers – methane, black carbon and ozone – are fundamentally different from longer-lived greenhouse gases, remaining in the atmosphere for only a relatively short time. Deep and immediate carbon dioxide reductions are required to protect long-term climate, as this cannot be achieved by addressing short-lived climate forcers.” (Integrated Assessment of Black Carbon and Tropospheric Ozone; United Nations Environment Programme, http://www.unep.org/dewa/Portals/67/pdf/Black_Carbon.pdf, 2011)

Because of its short lifetime in the atmosphere the effects of BC are most important regionally, especially in South and East Asia. Other hotspots occur in Mexico, Brazil, Peru, and parts of Africa. In Asia, BC contributes to regional heating and disrupts rainfall patterns. BC is of great concern in the Himalayas where it accelerates melting of glaciers, which supply water to millions.

The largest sources of BC are incomplete burning of biomass and unfiltered diesel exhaust. Major reductions could be achieved by replacing traditional cook and heat stoves in developing countries with clean-burning biomass stoves or alternative fuel systems. Installation of filters on diesel vehicles reduces BC. Industrial coke ovens and brick kilns should also be updated to employ newer, cleaner technologies. Finally, open field burning of agricultural waste should be eliminated. These old technologies are primarily used in developing countries.

In the industrialized northern hemisphere, residential wood stoves are the primary source of BC. Emissions from North America and Europe are the major controllable sources of BC to the Arctic, contributing significantly to northern warming and loss of ice.

The major sources of BC (biomass burning for cooking and heating, and diesel engines) are not the biggest sources of CO2 (coal and fossil fuel burning). Therefore, both problems can and must be addressed independently and simultaneously. Immediate reductions in BC can buy a little time as we convert to low carbon energy sources.

There are reasons besides climate change to reduce BC emissions. Black carbon has serious and well documented health effects; worldwide reductions in soot emissions would prevent an estimated 2.4 million premature deaths. Emissions of BC are accompanied by CO, and volatile organic compounds (VOCs), which have additional adverse health effects.

References

Integrated Assessment of Black Carbon and Tropospheric Ozone: Summary for Decision Makers. United Nations Environment Programme and World Meteorological Organization (2011) pp. 1-36.

Lacis et al. Atmospheric CO2: Principal Control Knob Governing Earth's Temperature. Science (2010) vol. 330 (6002) pp. 356-359.

Ramanathan and Carmichael. Global and regional climate changes due to black carbon. Nature Geoscience (2008) vol. 1 (4) pp. 221-227.

Skeptical Science explains the science of global warming and examines climate misinformation through the lens of peer-reviewed research. The website won the Australian Museum 2011 Eureka Prize for the Advancement of Climate Change Knowledge. Members of the Skeptical Science team have authored peer-reviewed papers, a college textbook on climate change and the book Climate Change Denial: Heads in the Sand. Skeptical Science content has been used in university courses, textbooks, government reports on climate change, television documentaries and numerous books.