Black Carbon an Easy Target for Climate Change

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February 2009

Could the silver bullet for climate change be black? The particulate matter called black carbon—a type of soot from burning fossil fuels, biofuels, and biomass—is now estimated to be the **second most potent** greenhouse warming agent after carbon dioxide[1]. As a result, reduction of black carbon has gained momentum as one of the fastest means to significantly impact global warming.

This creates a unique opportunity to capitalize on the intersection between climate change and clean air initiatives. For years, reducing emissions from diesel engines has been one of the most important air quality challenges. Diesel emissions aggravate asthma, cause cancer and premature death, and are especially harmful to people who are vulnerable to respiratory illness, such as children and the elderly. The EPA estimates that its diesel emission programs will provide more than $150 billion in health benefits and prevent 20,000 premature deaths annually when fully implemented.

Diesel particulate matter emissions account for 30 percent of black carbon globally and **50 percent** in the United States[2]. Thus air quality programs that reduce diesel particulate matter should also be recognized as reducing climate change. Mining this intersection would double the bang for our buck, combining the health and financial benefits of clean air programs with the financial benefits of carbon abatement in a single cost.

New Awareness of Black Carbon's Role

Previous estimates of black carbon's warming potential have been deemed too low for a number of reasons. First, the warming effect of black carbon (which absorbs light) was assumed to be essentially offset by the cooling effect of organic and sulfate aerosols (which reflect light). But it turns out that the warming effect of black carbon multiplies by a factor of two **when mixed** with these other particles[3].

Second, earlier reports tended to study the effect of black carbon at the earth's surface. However, **aerosol layers** can be more than three kilometers thick, with peak black carbon concentrations typically found at around 2km, above many clouds[4]. High in the atmosphere, black carbon is exposed to more solar radiation than at the surface, decreasing the earth's albedo (the ratio of incident sunlight to light reflected from the earth).

Additionally, black carbon at high altitudes can trap and retain energy reflected off of clouds below. Inside cloud formations, black carbon surrounded by water and ice droplets acts to decrease the albedo of clouds, absorbing still more energy.

Lastly, as black carbon falls on ice and snow, it decreases the surface albedo of the earth. While not visible to the human eye, black carbon on snow and ice is effective at trapping infrared energy. As snow and ice melt to form water, the albedo drops sharply, accelerating the effect[5]. Studies indicate that the reduction of **snow and**

sea ice by black carbon is three times that of CO2[6].

Advantage of a Short Life

The atmospheric lifetime of CO2 is commonly referenced in scientific literature as lasting between 100–120 years, and it could be as **short** as 30–95 years[7]. In sharp contrast, black carbon is airborne for only one to several weeks—orders of magnitude less than CO2.

To put this in perspective, if we stopped all CO2 emissions tomorrow, the current CO2 inventory would be with us for generations to come, just as the CO2 from my grandfather's generation is still in the atmosphere today. On the other hand, if we stopped all black carbon emissions, its atmospheric warming effects would completely disappear in a matter of weeks. Its short atmospheric lifespan makes black carbon abatement one of the most attractive means to make a significant near-term impact on global warming.

More than Just a Wedge

With 30 percent of the world's black carbon originating from diesel particulate matter, the opportunity to control climate change through the use of diesel particulate filters is unparalleled. This technology exists today and is already mandated for new diesel vehicles in the United States. While it may be impractical to equip every existing diesel engine in the world with a particulate filter, the effect of doing so would be an astounding reduction equivalent to 17.4 percent of global CO2.

With the exception of technological breakthroughs (such as an alternative to the combustion of carbon-based fuels), climate change abatement is traditionally seen as a **series of wedges**—each wedge is small individually but significant when combined and taken as a whole. No wedge, however, approaches the magnitude of a 17 percent reduction[8]. So while there are no silver bullets for climate change, tackling black carbon is as close as we can get if we plan to use diesel engines for the foreseeable future.

Intersection of Climate Change and Air Quality

Clean air policies to reduce particulate matter, such as regulations enacted by the Environmental Protection Agency, the California Air Resources Board, and the European Commission, provide hundreds of billions of dollars in benefits with **benefit-to-cost ratios** in the range of 40:1[9]. The **Stern report** highlights similar benefit-to-cost ratios for climate change, concluding that an investment of 1 percent of global GDP will prevent a 20 percent loss in global GDP[10].

On a more regional scale, California predicted that their AB32 program (to reduce 30 percent of greenhouse gases by 2020) will increase its economic production by $27 billion, personal income by $14 billion, and add more than 100,000 jobs. The intersection of clean air and climate change creates an environment where the benefits of each program are additive while the costs remain fixed.

Studies such as those from **McKinsey & Company** on the cost of carbon abatement highlight capital programs that can be achieved at "negative" marginal costs (i.e., they include a positive payback over the life of the program)[11]. In the case of black carbon, adding air quality benefits at no incremental cost makes black carbon mitigation one of the largest low-hanging fruits in the fight against global warming.

Retrofits and the Clean Development Mechanism

In developing nations, where money might be better spent on basic needs, medicines, and infrastructure, the health benefit logic doesn't provide as strong a justification for regulating emissions. But the additive benefits of tackling clean air and climate change can still serve these countries. One possible avenue is to take advantage of the Clean Development Mechanism (CDM) to finance diesel retrofits in countries that otherwise could not afford them. Defined by the

Kyoto Protocol and well understood by both developed and developing nations, the CDM could be an excellent means to accelerate deployment of particulate filters around the world.

Kyoto and Beyond

While not a technically greenhouse gas, black carbon played a role in America's saga with the Kyoto Protocol when President Bush used it as part of his rationale for pulling out of the agreement. In June 2001, President Bush labeled the Kyoto Protocol "fundamentally flawed," citing the failure to include black carbon and tropospheric ozone as key global warming agents. "Both are proven health hazards. Reducing both would not only address climate change, but also dramatically improve people's health," he said.

It is time for black carbon to once again play a role in global policy as an official global warming agent, alongside the greenhouse gases defined in the Kyoto Protocol. The recent recognition of black carbon's importance on the world stage provides a timely opportunity to demonstrate renewed climate leadership. With less than a year until the Copenhagen negotiations, the Obama administration has a lot of ground to cover reengaging with the UN Framework Convention on Climate Change and crafting policy to meet the president's stated plans to reduce America's greenhouse gases **80 percent by 2050**[12].

In the spirit of hope that has come to define everything Obama, let's hope that the 44th president sees black carbon for what it is—a chance to strike at the heart of climate change.

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[1] World Resources Institute, Earthtrends 2008 (http://earthtrends.wri.org/updates/node/295)

[2] California Air Resources Board, Health Effects of Diesel Exhaust Particulate Matter (http://www.arb.ca.gov/research/diesel/dpm_draft_3-01-06.pdf)

[3] Nature Geoscience, V. Ramanathan and G. Carmichael, Global and Regional climate changes due to black carbon, April 2008 (http://www.nature.com/ngeo/journal/v1/n4/pdf/ngeo156.pdf)

[4] Science Daily, United Nations Environment Program (2008, November 16). Dirty Brown Clouds Impact Glaciers, Agriculture And The Monsoon. January 6, 2009 (http://www.sciencedaily.com/releases/2008/11/081114191911.htm)

[5] Journal of Geophysics Res., M. Flanner, C. Zender, J. Randerson & P. Rasch, Present day forcing and response from black carbon in snow, 2007 (http://dust.ess.uci.edu/ppr/ppr_FZR07_jgr.pdf)

[6] American Geophysical Union, M. Jacobson, Correction to "Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming" July 2005 (http://www.stanford.edu/group/efmh/fossil/ClimRespUpdJGR%201.pdf)

[7] Journal of Geophysics Res., M. Flanner, C. Zender, J. Randerson & P. Rasch, Present day forcing and response from black carbon in snow, 2007 (http://dust.ess.uci.edu/ppr/ppr_FZR07_jgr.pdf)

[8] Science, S. Pacala and R. Socolow, Princeton Environmental Institute, Stabilization Wedges: Solving the Climate Problem for the next 50 Years with Current Technologies, August 13, 2004 (http://www.princeton.edu/~cmi/resources/stabwedge.htm)

[9] Environmental Protection Agency, Clean Air Nonroad Diesel Rule, EPA420-F-04-032, May 2004 (http://www.epa.gov/nonroad-diesel/2004fr/420f04032.htm#need)

[10] Stern Review on the Economics of Climate Change, Lord Stern of Brentford, October 30, 2006 (http://www.occ.gov.uk/activities/stern.htm)

[11] McKinsey & Company, Pathways to a Low Carbon Economy, January 2009 (http://www.mckinsey.com/clientservice/ccsi/pathways_low_carbon_economy.asp)

[12] Associated Press, Henry Sanderson, UN seeks broad Obama role on climate, November 9, 2008 (http://www.boston.com/lifestyle/green/articles/2008/11/09/un_seeks_broad_obama_role_on_climate/)