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Reducing Black Carbon Emissions

Rapid Action Can Slow Climate Change, Avoid Arctic Tipping Points, and Save Lives

Recent scientific studies identify black carbon, a component of ultrafine particulate pollution, as a critical climate forcing agent. As an essential complement to deep cuts in greenhouse gases, reducing these short-lived emissions may be among the most effective strategies for slowing global and Arctic warming in the near term, and for averting catastrophic tipping points such as the melting of sea ice and the Greenland ice sheet. In addition, because black carbon is a leading cause of mortality from air pollution and accelerates the melting of glaciers upon which millions depend for freshwater, controlling black carbon emissions would improve human health and save lives, particularly in the Global South. Rapid deployment of already available technologies for reducing black carbon emissions is therefore crucial to avoiding catastrophic climate change and promoting sustainable development.

A Potent Short-Lived Climate Forcer

Commonly known as "soot," black carbon is a combustion by-product of inefficient diesel engines, smokestacks, residential heating and cook stoves.[i] It is a potent climate warming agent both in the atmosphere and when deposited on snow and ice.[ii]

The direct absorption of sunlight by black carbon heats the atmosphere. Black carbon also increases cloud droplet concentrations, thickening low-level clouds that trap the Earth's radiated heat. When black carbon falls out of the atmosphere onto on snow and ice, it reduces the albedo – or reflectivity – of these surfaces, and increases the rate of melting. When these surfaces melt, the darker water or land exposed below absorbs more incoming sunlight, causing additional warming.[iii] James Hansen of the US National Aeronautics and Space Administration (NASA) has estimated that the "soot effect on snow albedo may be responsible for a quarter of observed global warming." [iv]

Because black carbon remains in the atmosphere for only days or weeks, reducing emissions can be an effective rapid response to slow warming in the near term, buying critical time to realize reductions in long-lived greenhouse gases like carbon dioxide.[v]

Each region of the world has a unique mix of natural and pollution aerosol sources that create complex climate effects. Black carbon makes up a varying percentage of fine particulate emissions ($PM_{2.5}$) depending on the source, fuel type and combustion efficiency. Because sources of black carbon also emit other ultrafine particles (also referred to as aerosols) such as organic carbon which can have a cooling effect, mitigation approaches should target specific sources.[vi]

For example, because emissions from the inefficient combustion of fossil fuels contain significantly more black carbon than organic carbon, reducing these emissions is a particularly powerful mitigation strategy.[vii] On and off-road diesel emissions and some industrial combustion are particularly important sources in North America and Europe, while Asia also registers high emissions from residential heating and cooking and coal combustion in energy and industrial sectors.[viii] In the Arctic, black carbon emissions from diesel vehicles and generators, oil and gas flaring and marine transport have a significant impact.[ix]

As the Arctic warms, native peoples are the first to feel the impacts. (COREL)

“Ramping up mitigation efforts quickly enough to avoid an increase of 2 °C to 2.5 °C... would require very rapid success in reducing emissions of CH_4 and black soot worldwide, and it would require that global CO_2 emissions level off by 2015 or 2020 at not much above their current amount...”

Scientific Expert Group Report on Climate Change and Sustainable Development (2007), *Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable.* R. Bierbaum, et. al eds, United Nations Foundation, Washington DC.

Black carbon is a major contributor to the brown clouds that frequently cover Asian cities. (J. Aaron Farr)

The good news is that rapid increased application of existing technologies could dramatically reduce black carbon emissions from these major sources, buying valuable time for the implementation of strategies to reduce greenhouse gases.

Health Benefits

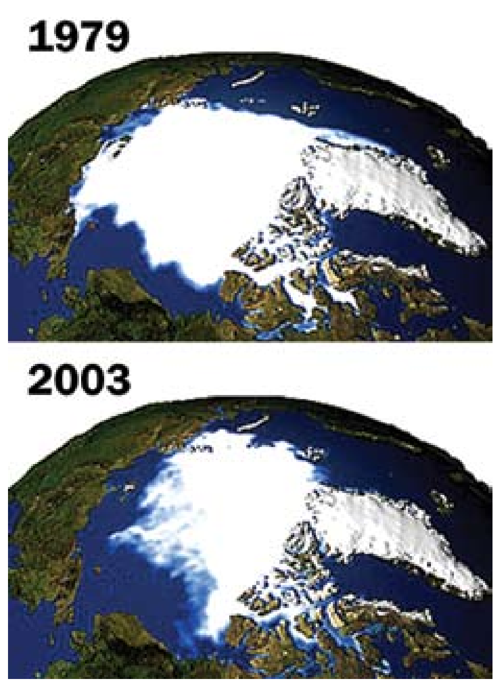
Reducing black carbon emissions will also provide significant health benefits.[x] In India alone, inhalation of black carbon-laden indoor smoke is responsible for over 400,000 premature deaths annually, mostly of women and children, as well as numerous cases of asthma and other non-fatal illnesses. Across Asia exposure to indoor and outdoor air pollution contributes to high rates of premature deaths of from respiratory infections, pulmonary disease and heart disease.[xi]

Estimated health benefits in the developed world are smaller, but still very significant. Studies in the Netherlands and the United States show that increased exposure to airborne $PM_{2.5}$ increases mortality in those countries, and that exposure to black carbon increase mortality from respiratory and heart disease, as well as certain cancers, more than exposure to $PM_{2.5}$ generally.[xii] Black carbon mitigation strategies would save lives and improve health by reducing these forms of pollution.

Black carbon also threatens lives and health indirectly by accelerating the melting of glaciers around the world, such as in the Himalayan and Andean regions, jeopardizing essential sources of freshwater for millions of people, and reducing dry-season irrigation water critical to food security across the Global South.[xiii] Because of its short-lived nature, black carbon reductions may be the best chance for reducing these threats.

Averting Arctic Tipping Points

The Arctic is warming about twice as fast as the rest of the earth, and the Greenland ice sheet is melting twice as fast than the global mean.[xiv] Black carbon deposition



Satellite imagery from NASA shows a steady decline in sea ice extent. Black carbon is a significant contributor to this phenomenon.

“increases surface melt on ice masses, and the melt water spurs multiple radiative and dynamic feedback processes that accelerate ice disintegration.” [xv] Over the course of the Arctic spring, black carbon-contaminated snow absorbs enough extra sunlight to melt earlier – weeks earlier in some places – than clean snow.[xvi]

Black carbon is often transported long distances from the source of emissions. Most black carbon that deposits in the Arctic originates as fuel combustion by-products emitted in North America and Europe (primarily north of 40º latitude) and in South and East Asia.[xvii] As sea ice melt opens up the Arctic to increased industrial development and new shipping routes, increased local black carbon emissions will further accelerate Arctic melt.[xviii]

Slowing Arctic warming is essential to averting global impacts of climate change, including potentially catastrophic tipping points such as permafrost melt and resulting methane release, melting of the Greenland ice sheet and resulting sea level rise, and changes in ocean currents. Reducing emissions of short-lived climate-forcing agents like black carbon may be the best hope for slowing Arctic warming and giving the extraordinary cultures, biodiversity and ecosystems of the region time to adapt to warming that will continue to occur as a result of past and future emissions of longer-lived greenhouse gases.

Rapid Action to Reduce Black Carbon Emissions

Rapid reduction of black carbon emissions is a key component of an effective, early action response strategy to slow global and Arctic warming, avert potentially catastrophic tipping points, and provide immediate health benefits to countries that implement mitigation measures.

Because of the short atmospheric residence time of black carbon relative to CO_2, as well as its strong climate forcing effect, control of black carbon emissions, particularly from fossil fuel sources, may be the fastest way to reduce warming in the near term. A focused effort to reduce these emissions in the next decade, without detracting from efforts to reduce CO_2, could deliver a swift climate response. Recommended elements of such an effort include:

- A fast-track international scientific assessment of black carbon and other short-lived climate forcing agents, and of available reduction strategies, conducted by the IPPC or another international body such as the International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA). A rapid process will be key to facilitate early action. Metrics, including CO_2-equivalency factors, to facilitate comparisons between the impacts and efficiencies of short-lived black carbon emissions reductions and measures to reduce long-lived greenhouse gases will be key tools for policy makers.

- Arctic nations must exercise global leadership on black carbon. At the Arctic Council Ministerial meeting in April 2009, they must adopt the recommendations of leading climate scientists gathered at the workshop on Short-Lived Pollutants and Arctic Climate held in September, 2008 in Oslo.[xix] Proposed immediate measures include the implementation of a Northern Hemisphere black carbon reduction strategy, with an emphasis on sources that result in deposition in the Arctic, and measures to minimize local emissions of short-lived pollutants in the Arctic. Each Arctic Council nation must then take rapid measures to implement these recommendations.

Black carbon is one of the leading causes of climate change in the Arctic. (istockphoto)

- The United States and Europe need to do more. Although both have adopted stricter particulate matter emissions standards (the Clean Air Act and the National Emissions Controls) for some diesel engines, these standards only apply to new vehicles and engines, phase in slowly, and do not mandate retrofit of the long-lived existing fleet. Additional actions are urgently required. California is demonstrating leadership through a suite of early action measures including use of shore power for ships at berth; increasing transportation efficiency through steps such as retrofits and turnover of pre-1994 trucks and ocean going vessel speed reducation; and heavy-duty vehicle emission reductions.[xx]

- Increase financing and technology transfer for the mitigation of air pollution from major sources of black carbon emissions in the Global South. This includes clean diesel technology, air pollution control technology for coal-fired power and industrial facilities, and resources for transitioning to cleaner residential heating and cooking. Reducing adoption costs for poor households, and supporting development of in-country supply and service infrastructure and programs, are key. Multilateral climate funds and bilateral development assistance should include financing and technology transfer targeted to black carbon mitigation.

- Increased funding must be made available for regional air pollution control measures in the Global South, and for the development of regional and global frameworks for integrated approaches for mitigating air pollution and climate change. Pollution abatement strategies that can achieve immediate health benefits, such as the commitment of many Latin American countries to switch to ultralow sulfur diesel and the UNEP Clean Cities Initiative, are a powerful means of securing climate change abatement as well as substantial health benefits.

- Black carbon should be listed under the Convention on Long-range Transboundary Air Pollution. One option is to amend the Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999) that set 2010 emission ceilings for sulfur, NOx, VOCs and ammonia.

- Develop new multilateral mechanisms to facilitate financing and technology transfer to scale up black carbon mitigation, in combination with approaches through which countries in the Global South can get credit for nationally appropriate mitigation actions that include reductions in climate forcing air pollutants like black carbon.

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[i] Bond, T.C., Testimony for the Hearing on Black Carbon and Climate Change, Oversight and Government Reform Committee, U.S. House of Representatives, October 18, 2007.

[ii] Quinn, P. K., et al., Short-lived pollutants in the Arctic: Their climate impact and possible mitigation strategies, Atmospheric Chemistry and Physics, 8, 1723-1735 (2008); see also Jacobson, M., Testimony for the Hearing on Black Carbon and Arctic, House Committee on Oversight and Government Reform United States House of Representatives, Oct. 18, 2007; Ramanathan, V. & Carmichael, G., Global and Regional Climate Changes Due to Black Carbon, Nature Geoscience (2008), and Zender, C., Arctic Climate Effects of Black Carbon. Written testimony to the Oversight and Government Reform Committee, U.S. House of Representatives, October 18, 2007 (2007).

[iii] Streets, D. G., Dissecting future aerosol emissions: warming tendencies and mitigation opportunities, Climatic Change, 81:313–330 DOI 10.1007/s10584-006-9112-8 (2007). See also Ramanathan and Carmichael 2008 supra note 2; Quinn et al., 2008 supra note and Zender, 2007; and Jacobson, 2007 supra note 2.

[iv] Hansen, J & L. Nazarenko, Soot Climate Forcing Via Snow and Ice Albedos, 101 Proc. Of the Nat'l Acad. Of Sci. 423 (13 January 2004).

[v] Ramanathan, 2008 supra note 2.

[vi] *See*: McConnell, J.R., Edwards, R., Kok, G.L., Flanner, M.G., Zender, C.S., Saltzman, E.S., Banta, J.R., Pasteris, D.R., Carter, M.M. and J.D.W. Kahl. 2007. 20th-Century Industrial Black Carbon Emissions Altered Arctic Climate Forcing. Science, 317: 1381-1384.

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[ix] Quinn et. al. 2008 supra note 2.

[x] Ramanathan and Carmichael 2008 supra note 2; See also Schwartz, J., Testimony for the Hearing on Black Carbon and Arctic, House Committee on Oversight and Government Reform United States House of Representatives, Oct. 18, 2007 and CIAM, Review of the Gothenburg Protocol: Report of the Task Force on Integrated Assessment Modelling and the Centre for Integrated Assessment Modelling. Netherlands Environmental Assessment Agency, 2007.

[xi] Ramanathan, V., et al., Atmospheric Brown Clouds: Regional Assessment Report with Focus on Asia, Published by the United Nations Environment Programme, Nairobi, Kenya (2008)

[xii] Schwartz, 2007, supra note 10.

[xiii] Ramanathan, V., et al., Atmospheric Brown Clouds: Regional Assessment Report with Focus on Asia, Published by the United Nations Environment Programme, Nairobi, Kenya (2008); see also Schwartz 2007, supra at 10.

[xiv] ACIA, 2005.Arctic Climate Impact Assessment. Cambridge University Press, Available at: http://www.acia.uaf.edu

[xv] Hansen, 2004, supra note 4.

[xvi] Zender, 2007, supra note 2.

[xvii] Ramanathan, 2007 supra note 2.

[xviii] Lack, D., B. Lerner, C. Granier, T. Baynard, E. Lovejoy, P. Massoli, A.R. Ravishankara and E. Williams, Light absorbing carbon emissions from commercial shipping, Geophysical Research Letters, 35, L13815 (2008).

[xix] For more information, See Norwegian Institute for Air Research, http://niflheim.nilu.no/spac.

[xx] *See* California Air Resources Board website, available at http://www.arb.ca.gov/cc/ccea/ccea.htm