What Is Black Carbon?

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Black Carbon *(BC) has recently emerged as a major contributor to global climate change, probably second only to CO_2 as the main driver of change.[1] BC particles[2] strongly absorb sunlight and are responsible for giving soot its black color. BC is produced by both natural processes and human activity from the incomplete combustion of fossil fuels, biofuels, and biomass; primary sources include emissions from diesel engines, cook stoves, and wood/forest fires. Because BC remains in the atmosphere for only a few weeks, controlling BC emissions would immediately reduce the rate of warming, slowing climate change and delaying potentially catastrophic tipping points in the climate system. This delay would buy time for society to realize the benefits of reduced CO_2 emissions, which because of its long atmospheric lifetime will take several decades to be expressed fully. Existing technologies can dramatically cut global BC emissions. Such reductions also would have strong co-benefits, particularly in public health and especially in the developing world.*

BC warms the climate in two ways. When suspended in air, BC absorbs sunlight and generates heat in the atmosphere, which warms the air and can affect regional cloud formation and precipitation patterns. When deposited on snow and ice, it absorbs sunlight, again generating heat, which accelerates melting and warms both the air above and the snow and ice below. BC remains in the atmosphere for only one to four weeks, meaning it has strong regional climate effects. A recent study suggests that BC may be responsible for more than 30 percent of recent warming in the Arctic,[3] contributing to the acceleration of Arctic sea ice melting. Loss of Arctic sea ice is one potential "tipping point" that could lead to rapid warming and irreversible climate change. BC is also driving increased melting of the glaciers in the Himalayan Plateau, upon which some 40 percent of the world's population depends for freshwater, and is also impacting reduced snowpack in the Pacific Northwest of the United States.

Different types of soot contain different amounts of BC—generally the blacker the soot, the more of a warming agent it is. Fossil fuel and biofuel soot are blacker than soot from biomass burning[4] (e.g., forest fires and wood fuel), which is generally more of a brownish color. Thus, controlling emissions of soot from fuel sources is an effective way of reducing atmospheric temperatures in the short term. Based on current information, the United States is responsible for about 6 percent of global BC emissions; while it has a history of making reductions to improve air quality, further improvements can be made. The majority of BC emissions come from the developing world: China and India together account for some 25—35 percent of emissions.

Control technologies include retrofitting diesel vehicles with filters to capture BC, fuel switching (e.g., from diesel to natural gas in buses), and replacement of inefficient cook stoves with cleaner alternatives. Adopting these alternatives would have positive co-benefits for public health, especially in the developing world. For example, retrofitting or replacing diesel buses and trucks would greatly improve urban air quality in densely populated cities. Replacement of dirty cook stoves with cleaner alternatives, such as solar cookers or newer models that burn fuel more completely, would improve indoor air quality, which is a major health concern in both urban and rural areas of the developing world.

Reducing BC emissions[5] represents a win-win scenario: it would have an immediate cooling effect on the Earth's climate, potentially delaying temperature increases in the short run and helping reduce the risk of irreversible tipping points in the climate system, and it would reduce air pollution, resulting in fewer premature deaths and fewer missed work and school days.

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[1] Ramanathan, V. and G. Carmichael. 2008. *Nature Geoscience*, 1:221-227.

[2] BC is a *carbonaceous aerosol*. An *aerosol* is a suspension of fine solid particles or liquid droplets within a gas. Examples include smoke, air pollution, smog, oceanic haze, and tear gas. *Carbonaceous* refers to a substance rich in carbon.

[3] The Arctic has warmed by 1.48 ± 0.28 °C from 1976—2007; BC is estimated to have caused ~0.5—1.4 °C of that change. (Shindell, D. *et. al.* 2009. *Nature Geoscience*, 2:294-300.)

[4] Soot from biomass burning generally tends to have a cooling effect on the climate.

[5] The American Clean Energy and Security Act of 2009, reported out of the U.S. House Energy and Commerce Committee on May 21, 2009, directs the EPA Administrator to investigate BC sources, impacts, and mitigation technologies.