Highlights

- Black carbon (BC) is the most strongly light-absorbing component of particulate matter (PM), and is formed by the incomplete combustion of fossil fuels, biofuels, and biomass.

- BC is emitted directly into the atmosphere in the form of fine particles ($PM_{2.5}$). The United States contributes about 8% of the global emissions of BC. Within the United States, BC is estimated to account for approximately 12% of all direct $PM_{2.5}$ emissions in 2005.

- BC contributes to the adverse impacts on human health, ecosystems, and visibility associated with $PM_{2.5}$.

- BC influences climate by: 1) directly absorbing light, 2) reducing the reflectivity ("albedo") of snow and ice through deposition, and 3) interacting with clouds.

- The direct and snow/ice albedo effects of BC are widely understood to lead to climate warming. However, the globally averaged net climate effect of BC also includes the effects associated with cloud interactions, which are not well quantified and may cause either warming or cooling. Therefore, though most estimates indicate that BC has a net warming influence, a net cooling effect cannot be ruled out.

- Sensitive regions such as the Arctic and the Himalayas are particularly vulnerable to the warming and melting effects of BC.

- BC is emitted with other particles and gases, many of which exert a cooling influence on climate. Therefore, estimates of the net effect of BC emissions sources on climate should include the offsetting effects of these co-emitted pollutants. This is particularly important for evaluating mitigation options.

- BC's short atmospheric lifetime (days to weeks), combined with its strong warming potential, means that targeted strategies to reduce BC emissions can be expected to provide climate benefits within the next several decades.

- The different climate attributes of BC and long-lived greenhouse gases make it difficult to interpret comparisons of their relative climate impacts based on common metrics.

- Based on recent emissions inventories, the majority of global BC emissions come from Asia, Latin America, and Africa. Emissions patterns and trends across regions, countries and sources vary significantly.

- Control technologies are available to reduce BC emissions from a number of source categories.

- BC mitigation strategies, which lead to reductions in $PM_{2.5}$, can provide substantial public health and environmental benefits.

- Considering the location and timing of emissions and accounting for co-emissions will improve the likelihood that mitigation strategies will be

properly guided by the balance of climate and public health objectives.

- Achieving further BC reductions, both domestically and globally, will require adding a specific focus on reducing direct $PM_{2.5}$ emissions to overarching fine particle control programs.

- The most promising mitigation options identified in this report for reducing BC (and related "soot") emissions are consistent with control opportunities emphasized in other recent assessments.

  – **United States:** The United States will achieve substantial BC emissions reductions by 2030, largely due to controls on new mobile diesel engines. Other source categories in the United States, including stationary sources, residential wood combustion, and open biomass burning also offer potential opportunities.

  – **Global:** The most important BC emissions reduction opportunities globally include residential cookstoves in all regions; brick kilns and coke ovens in Asia; and mobile diesels in all regions.

  – **Sensitive Regions:** To address impacts in the Arctic, other assessments have identified the transportation sector; residential heating; and forest, grassland and agricultural burning as primary mitigation opportunities. In the Himalayas, studies have focused on residential cooking; industrial sources; and transportation, primarily on-road and off-road diesel engines.

- A variety of other options may also be suitable and cost-effective for reducing BC emissions, but these can only be identified with a tailored assessment that accounts for individual countries' resources and needs.

- Despite some remaining uncertainties about BC that require further research, currently available scientific and technical information provides a strong foundation for making mitigation decisions to achieve lasting benefits for public health, the environment, and climate.