

## Appendix 3

# Studies Estimating Global and Regional Health Benefits of Reductions in Black Carbon

Geographic Scale	Results of Study	Mitigation Measures	Pollutants	Reference
<b>Studies of Mitigation Strategies for Ambient Reductions in BC</b>				
Global, Arctic	Fossil fuel soot (FS) and biofuel soot and gases (BSG) contribute to global warming, with FS being the greater contributor per unit mass. However, BSG may contribute 8 times more in premature mortalities than FS due to greater population exposures to BSG.	Elimination of global anthropogenic FS and BSG.	PM <sub>2.5</sub> from fossil fuel soot, biofuel soot, & methane	Jacobson (2010)
Global	Avoid 240,000 annual premature mortalities in China, 30,000 elsewhere globally. Find reductions in sulfates, OC, and BC collectively lead to loss in net negative radiative forcing.	50% reduction in China's 2030 SO <sub>2</sub> , OC, BC emissions from 2000 levels.	SO <sub>2</sub> , OC, BC	Saikawa et al. (2009)
Global	Relative to no extra controls, imposing tighter vehicle emission standards in developing countries avoids 120,000-280,000 premature air-pollution related deaths in 2030.	Imposition of tighter vehicle emission standards (e.g. Euro 6 standards for light-duty vehicles) in China, India, Africa, Middle East, Brazil, and the rest of Latin America by 2030.	SO <sub>2</sub> , OC, BC, NO <sub>3</sub> , O <sub>3</sub>	Shindell et al. (2011)
Global	Halving global anthropogenic BC emissions avoids 157,000 premature deaths annually worldwide, the vast majority of which occur within the source region. Most of the avoided deaths are achieved by halving East Asian emissions, but South Asian emissions have 50% greater mortality impacts per unit BC emitted than East Asian emissions. Residential and industrial emissions contribute disproportionately to mortality due to co-location with global population. About 8 times more avoided deaths estimated when anthropogenic BC+OC emissions halved compared with halving BC alone.	50% reductions in anthropogenic BC emissions globally, from 8 major world regions, and from 3 major economic sectors (residential, industrial, transportation).	BC, OC	Anenberg et al. (2011)
Global	Implementing all measures would avoid 1-5 million PM <sub>2.5</sub> and O <sub>3</sub> -related premature deaths annually based on 2030 population, with the vast majority achieved by BC emissions controls. About 80% of the avoided deaths occur in Asia. Avoided deaths occur regardless of simultaneous implementation of low-carbon CO <sub>2</sub> measures.	Suite of methane mitigation measures, "technical" BC mitigation measures (ex. improving coke ovens and brick kilns and increasing use of diesel particulate filters), and "non-technical" BC mitigation measures (ex. eliminating high-emitting vehicles, banning open burning of agricultural waste, and eliminating biomass cook stoves in developing countries).	SO <sub>2</sub> , OC, BC, NO <sub>3</sub> , O <sub>3</sub>	UNEP and WMO (2011a)

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Geographic Scale	Results of Study	Mitigation Measures	Pollutants	Reference
<b>Studies of Indoor and Ambient Mitigation Strategies for BC</b>				
China, India, Africa	Benefits of mitigation exceeded costs by factors of 3.6 to 13.6 to one.	Improved stoves in China and India for domestic heating and cooking, coal to briquette use for domestic cooking and heating, and community forestry programs to control savannah and open burning in Africa.	BC, OC, SO <sub>2</sub>	Baron et al. (2009)
China, India	Find BC mitigation strategies involving indoor BC stove emissions and diesel BC emissions reductions in urban cities are win-win opportunity for climate and public health.	Indoor reduction of BC from replacement of stoves used for cooking and home heating, and strategies to reduce BC emissions from diesel vehicles used in urban cities.	BC, OC, SO <sub>2</sub>	Kandlikar et al. (2009)
<b>Studies of Indoor Mitigation Strategies to Reduce BC</b>				
China	Climate and human health benefits to cost ratio of 6 with about 69% of these benefits associated with human health.	Household fuel intervention.	BC, OC, SO <sub>2</sub>	Smith et al. (2008)
India and UK	Low emission stoves in India result in 12,500 fewer DALYs annually and energy efficiency in the UK households results in 850 fewer DALYs per year.	Energy efficiency in UK household heating and 150 million low-emission cookstoves in India.	BC, OC, sulfates	Wilkinson et al. (2009)