Black carbon deposition in the respiratory tract: insight from black carbon mixing-state-resolved GCM simulations

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Global, regional and local air quality have been raising public awareness in recent decades. Of the 7 billion global population, about 90% is exposed to over 10 ug/m^3 $PM_{2.5}$ outdoor, the standard suggested by WHO. Black carbon, one of the major air pollutants, is emitted from incomplete combustions of fossil fuel, biofuel and biomass burning and is linked to increase incidence of cardiopulmonary and cardiovascular diseases. Global distribution of size distribution, mixing state, and mass concentration are obtained from simulations using the latest developed black carbon (BC) mixing-state-resolved global climate model (GCM). Respiratory deposition model computes hygroscopic growth and deposition efficiency of inhaled BC particles with mixing-state- and size- resolved GCM output. Based on 5-year average results, the deposition of BC particles is found to be sensitive to the emission particle size distribution and such sensitivity depends on the particle mixing state resolution in the GCM. Discrepancy in deposited mass concentration E of BC ranges from about -40% to +25% (10th-90th percentile) between single-mixing-state- and multiple-mixing-state- simulations. Globally, underestimation in E of BC is more prevalently found than overestimation. This study highlights that improved emission inventory containing size distribution and mixing state information and simulations at higher spatial resolution are desired to enhance predictive understanding of the impacts of BC and other pollutants on human health, particularly in highly polluted and populated areas.

Keywords: Black carbon, Respiratory deposition, Global climate model, Environmental public health, Aerosol mixing state

