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Particle bound black carbon size distribution and mixing state in urban environments using a novel tandem differential mobility analyzer and aethalometer

Zhi Ning (1,2), Dane Westerdahl (1,3), Ka-Chun Wong (1), and Ka-Lok Chan (1)

(1) School of Energy and Environment, City University of Hong Kong, (2) Guy Carpenter Asia-Pacific Climate Impact Centre, City University of Hong Kong, (3) Ability R&D Energy Research Centre, City University of Hong Kong

Particle bound black carbon (BC) has dominant anthropogenic origins from fossil fuel combustion and biomass burning sources. It is an important component of the light absorbing aerosols in the atmosphere, playing a role in the earth's radiative balance and climate change. While the mixing states of the BC largely determine the coating on the particles, knowledge of the size distribution of BC is key to the accurate modelling of their absorption of solar radiation. Also, BC is a major component of the diesel PM emissions, recently classified by World Health Organization as Class I carcinogen, and has been widely documented with association of a variety of adverse health effects. Their sizes also determine the fraction of lung deposition. Due to the limited information of the mixing state and size distribution of BC, there still exists large uncertainty of the role of BC in climate change modelling. This study presents a novel approach of the direct and continuous measurement of atmospheric BC size distribution and coating by tandem operation of a differential mobility analyzer and a modified aethalometer. A condensation particle counter was deployed concurrently with the aethalometer to determine the particle number size distribution. Particle coating on BC was further estimated. A wide range of particle sizes (15-700nm) was investigated to determine the BC mass size distribution in fresh diesel engine tailpipe emissions and different ambient environments including urban and roadside. The results showed the evolution of BC mixing state and size distribution from fresh engine emissions to the roadside and urban ambient environments. The results provide important references for climate modelling to better determine the effect of radiative forcing from urban aerosols.