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Light Absorption of Black Carbon Aerosol and Its Radiative Forcing Effect in an Megacity Atmosphere in South China

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The effects of black carbon (BC) aerosol on climate warming have been the study focus in the recent decade, the regional effect of BC light absorption is more significant. The reduction of BC is now expected to have significant near-term climate change mitigation. Mass absorption efficient (MAE) was one of the important optical properties of BC aerosol for evaluating the BC on its radiative forcing effect, while BC mixing state is one main influencing factor for MAE. Models have estimated that BC radiative forcing can be increased by a factor of $\sim$2 for internally versus externally mixed BC. On the other hand, some organic carbon had been found to significantly absorb light at UV or shorter wavelengths in the most recent studies, with strong spectral dependence. But large uncertainties still remain in determining the positive forcing effect of BC on global clime change due to the technical limitations. In this study, advanced instrumentation (a three-wavelength photoacoustic soot spectrometer (PASS-3) and a single particle soot photometer (SP2)) were used to measure black carbon aerosol and analyze its optical properties in a megacity in South China, Shenzhen, during the summer of 2011. It is in the southeast corner of the Pearl River Delta (PRD) region, neighboring Hong Kong to the south. During the campaign, the average BC mass concentration was 4.0$\pm$3.1 μg m-3, accounting for about 11% of PM2.5 mass concentration, which mainly came from fossil fuel combustion rather than biomass burning. The MAE of BC ranged from 5.0 to 8.5 m2 g-1, with an average value of 6.5$\pm$0.5 m2 g-1. The percentage of internally mixed BC was averagely 24.3$\pm$7.9% and positively correlated with the MAE. It is estimated that the internally mixed BC amplified MAE by about 7% during the campaign, suggesting that the BC absorption enhancement due to internal mixing in the real atmosphere is relatively low in comparison with the predictions by theoretical models, which stands in accordance with the new finding of a very recent Science magazine paper by Cappa.