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Influence of aerosol hygroscopicity and mixing state on aerosol optical properties in the Pearl River Delta region, China

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Both the effects of aerosol hygroscopicity and mixing state on aerosol optical properties were analyzed using ground-based measurements and a Mie model in this study. The sized-resolved particle hygroscopic growth factor at RH=90% (Gf(90%)) and the enhancement factor for the scattering coefficients (f(RH)sp) were measured by a self-constructed Hygroscopic Tandem Differential Mobility Analyzer (H-TDMA) and two nephelometers in parallel (PNEPs) respectively from 22nd February to 18th March 2014 in the Pearl River Delta, China. In addition, the particle number size distribution (PNSD) and BC mass concentration (MBC) were measured simultaneously. During the observation period, the f(RH)sp increased sharply along with increasing RH (40%-85%) and the value of f(80%)sp was 1.77±0.18. The mean Gf(90%) for all particles are 1.44(80nm), 1.48(110nm), 1.52(150nm) and 1.55(200nm), and the mean Gf(90%) for more-hygroscopic particles are 1.58(80nm), 1.63(110nm), 1.66(150nm) and 1.67(200nm) respectively. Based on Gf, PNSD and MBC, the enhancement factor of the aerosol optical properties (extinction (f(RH)ep), scattering (f(RH)sp) backscattering (f(RH)hbsp), absorption (f(RH)absp), and hemispheric backscatter fraction (f(RH)hbsp) were calculated under three aerosol mixing state assumptions. The results show that the calculated f(80%)sp values agreed well with the ones measured by PNEPs, illustrating that the Gf size distribution fittings are reasonable. The f(RH)ep, f(RH)sp and f(RH)hbsp increased along with increasing RH for three mixtures, while f(RH)HBF decreased. The f(RH)absp increased for the homogenously internal mixture, but remained stable for the external mixture. For the core-shell mixture, the f(RH)absp increased from RH=0 to 75% and then decreased, due to a decrease of light entering the BC core. The enhancement factor of aerosol direct radiative forcing (f(RH)Fr) increased sharply as the RH elevated for the external mixing state. However, f(RH)Fr increased or decreased along with the elevated RH for the homogenously internal mixture and the core-shell mixture depending on initial value of the aerosol direct radiative forcing in a dry condition.