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Vertical distribution characteristics of size-segregated atmospheric particulate matters measured at different altitudes of the Canton Tower, southern China

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Great progress has been made recently in the sources and formation mechanisms of atmospheric aerosols at the ground levels. However, studies on the vertical profiles and sources of size-resolved particulate matter within the urban boundary layer are lacking. In this study, vertical distribution characteristics of size-segregated particles were investigated at three observation platforms on the 610-meter-high Canton Tower in Guangzhou, the third largest city in China. Nineteen and thirteen sets of size-segregated aerosol samples were simultaneously collected at ground level, 118 m and 488 m of Canton Tower in autumn and winter seasons, respectively. Major aerosol components, including water-soluble ions, organic carbon and elemental carbon, were measured. The results showed that daily average fine-particle concentrations generally decreased with increasing height. Sulfate and ammonium in fine particles showed small vertical gradients, and nitrate concentrations increased with height in autumn. The vertical gradients of PM2.5 chemical components varied greatly in winter than in autumn. The size distributions of sulfate and ammonium were characterized by dominant unimodal peaking at 0.44–1.0 um, typical of droplet mode. In autumn, the nitrate size distribution was bi-modal, peaking at 0.44–1.0 um and 2.5–10 um. However, nitrate showed a unimodal distribution in winter, indicating that there are different formation mechanisms for nitrate particles in autumn and winter. Mass size distribution results suggest in-cloud processes may have great implication for droplet mode sulfate and nitrate formation in the PRD region, and heterogeneous reactions of gaseous nitric acid on existing sea-derived coarse particles were ascribed to the coarse mode nitrate formation in autumn. The dominant coarse mode for Na+ and Cl-, together with the major air masses from South China Sea, suggested their regional transport source (marine salt) in autumn. The results from pollution cases study suggest that there is one possible common mechanism driving the haze formation in autumn and winter seasons in the PRD region: the nighttime temrepture inversion together with aqueous phase and heterogeneous reaction resulted in the aerosol formation and haze pollution.