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The surface aerosol optical properties in urban areas of Nanjing, west Yangtze River Delta of China

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Observational studies of aerosol optical properties are useful for reducing uncertainties in estimating aerosol radiative forcing and forecasting visibility. In this study, the observed near-surface aerosol optical properties in urban Nanjing are analyzed from Mar 2014 to Feb 2016. Results show that near-surface urban aerosols in Nanjing are mainly from local emissions and the surrounding regions. They have lower loadings but are more scattering than aerosols in most cities in China. The annual mean aerosol extinction coefficient (EC), single scattering albedo (SSA) and asymmetry parameter (ASP) at 550 nm are 381.96 Mm-1, 0.9 and 0.57, respectively. The aerosol absorption coefficient (AAC) is about one order of magnitude smaller than its scattering coefficient (SC). However, the absorbing aerosol has larger Ångström exponent (AAE) value, 1.58 at 470/660 nm, about 0.2 larger than the scattering aerosols' (SAE). All the aerosol optical properties follow a near unimodal pattern, and their values are mostly concentrated around their averages, accounting for more than 60% of the total samplings. Additionally, they have substantial seasonality and diurnal variations. High levels of SC and AAC all appear in winter due to higher aerosol and trace gas emissions. AAE (ASP) is the smallest (largest) in summer possibly because of high relative humidity (RH) which also causes considerably larger SC and smaller SAE, although intensive gas-to-particle transformation could produce a large number of finer scattering aerosols in this season. Seasonality of EC is different from the columnar aerosol optical depth. Larger AACs appear at the rush hours of the day while SC and back scattering coefficient (Bsp) only peak in the early morning. Aerosols are fresher at daytime than at nighttime, leading to their larger Ångström exponent and smaller ASP. Different temporal variations between AAC and SC cause the aerosols more absorbing (smaller SSA) in autumn, winter and around rush hours. ASP has a good quasi-LogNormal growth trend with increasing SC when RH is below 60%. The correlation between AAC and SC at the site is close but a little smaller than that in suburban Nanjing in spring. Atmospheric visibility decreases exponentially with increasing EC or SC, more sharply in spring and summer, and it could be further deteriorated with increasing SSA and ASP.