

Aerosol Hygroscopicity during the Haze Red Alert Period in Winter 2016 at a Rural Site of the North China

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Aerosol hygroscopic growth reflects the effect of relative humidity (RH) on the physical and chemical properties of the particles, which is one of the important properties of aerosols. A humidification system was deployed to measure aerosol hygroscopicity at a rural site of the North China Plain during the haze red-alert period 17–22 December 2016. The aerosol scattering coefficients under dry (RH<30%) and wet (RH in the range of 40%–85%) conditions were simultaneously measured at wavelengths of 450, 550, and 700 nm. Scattering enhancement factor $f(80\%)$ and backscattering enhancement factor $f_b(80\%)$ showed a negative correlation with the percentage of organics and a positive correlation with that of inorganics. There are similar trends for $f(80\%)$ and $f_b(80\%)$ but with different magnitudes. The $f(80\%)$ ranged from 1.12 to 1.62 with an average of 1.29, while $f_b(80\%)$ varied from 1.02 to 1.24, with an average of 1.10. Both $f(80\%)$ and $f_b(80\%)$ showed a diurnal pattern that peaked in the late afternoon (approximately 1400 LT), especially during the first 3 days. Aerosol hygroscopicity is highly dependent on the aerosol chemical composition. The fraction of nitrate was strongly correlated with the aerosol scattering coefficient at RH = 80%, which suggests that nitrate played an important role in aerosol hygroscopic growth during the heavy pollution period. The scattering enhancement factors do not show significant differences at the three wavelengths. Only an approximate 2% shift to higher $f(80\%)$ values with a larger standard deviation was observed as the wavelength increased, which is similar for the backscatter enhancement factors. Therefore, only slight spectral dependency of $f(\text{RH})$ was observed during the red-alert period.

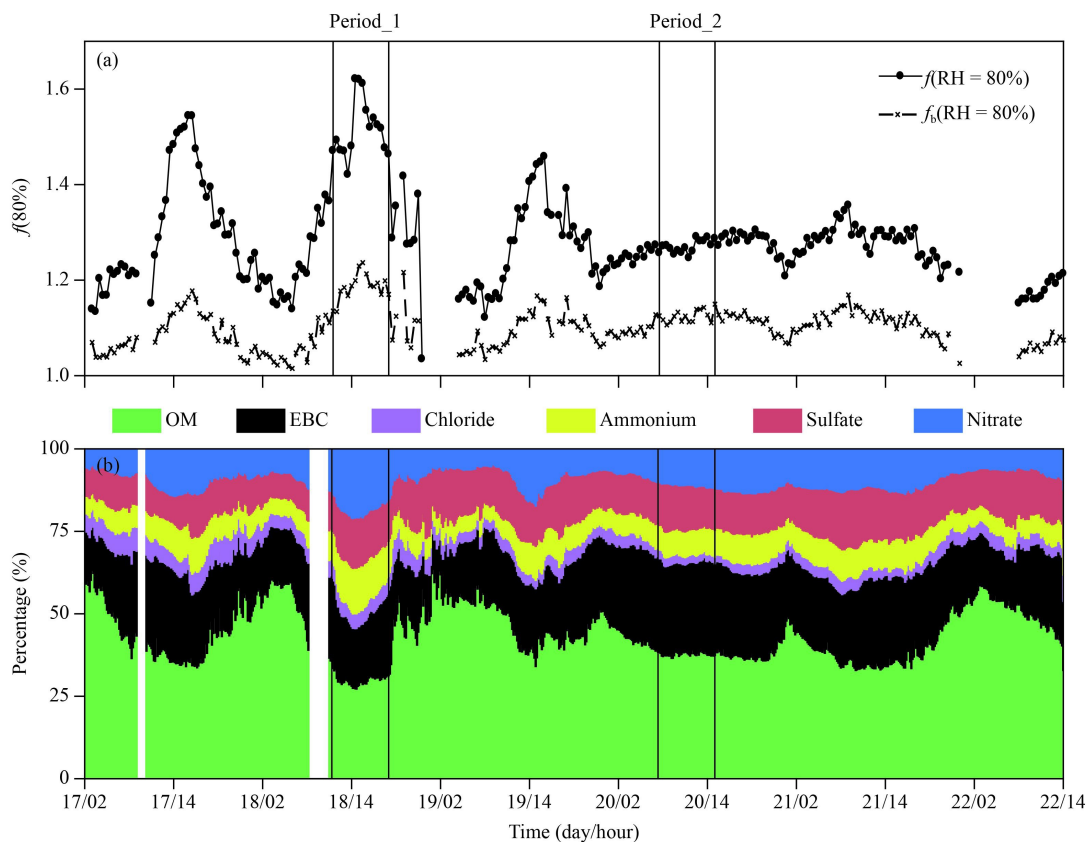


Figure 1. Time series of the (a) scattering enhancement factor $f(80\%)$ and backscattering enhancement factor $f_b(80\%)$, and (b) percentage of mass concentration of aerosol chemical composition. Two periods are defined: period_1 from 11:00 to 19:00 (Beijing Time) 18 December and period_2 from 07:00 to 15:00 20 December 2016.