

The measurements of size-resolved CCN spectra and mixing state of aerosol particles conducted in Beijing, China

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The Chinese emission of anthropogenic pollutants is increasing due to the rapid economical growth of the country. It is becoming clearer that these pollutants are changing the regional climate of the East Asia. Especially, the optical properties of cloud are changing because of the increase of cloud condensation nuclei (CCN) active particles caused by Chinese emissions. Thus, it is needed to understand the CCN activity of atmospheric particles in China for the quantitative assessment of the impact of the anthropogenic pollutants on the regional climate. For this reason, we have measured size-resolved CCN spectra in Beijing city during August and September of 2006. The observation was performed at supersaturations (SSs) of 0.1- 0.8%. Simultaneously, mixing state of aerosol particles and aerosol chemical composition were measured using a volatility tandem differential mobility analyzer (VTDMA) and an aerosol mass spectrometer (AMS), respectively. We set the heater temperature of the VTDMA to be 400 degree C, thus the main component of non-volatile compounds can be assumed as black carbon.

The size-resolved CCN spectra showed that larger particles are activated as CCN more efficiently. For the quantitative analysis of the spectra, each spectrum was fitted to a sigmoid function. Then, we derived two parameters: CCN activation diameters and the fraction of CCN inactive particles which causes incomplete activation. The average values of the activation diameters were 131 nm and 43 nm at SS = 0.1% and 0.8%, respectively. We calculated B parameter which is associated with Raoult's effect in the Koehler theory. In the case of SS = 0.1%, the calculated value of B was similar with that of inorganic compounds such as ammonium sulfate and ammonium nitrate. On the other side, the value of B was close to that of oxalic acid for SS = 0.8%. These results indicate that large particles were mainly composed of inorganic compounds, and small particles were enriched by organic compounds. The AMS data also showed the similar trend.

In addition, we compared the CCN inactive fraction and less volatile fraction measured using the VTDMA. As the less volatile particles do not change its diameter significantly in the VTDMA heater, it is likely that freshly emitted soot particles are less volatile. The values and the variations of less volatile fraction and the CCN inactive fractions were very close. This result indicates that the mixing state of black carbon have the significant influence on the CCN activity of the atmospheric particles.