The characteristic of the liquid water content of urban aerosols in Sapporo, Hokkaido

Yasuyuki Kitamori[1]; Michihiro Mochida[2]; Kimitaka Kawamura[3]

[1] Grad. School of Environ. Sci., Hokkaido Univ.; [2] IAR, Nagoya Univ.; [3] Inst. Low Temp. Sci., Hokkaido Univ.

1. Introduction

Aerosol particles affect the radiation balance of the atmosphere by scattering and absorbing solar and terrestrial radiation. The light scattering efficiency of particles strongly depends on the hygroscopic growth under various humidity conditions. Investigations on the characteristic of the liquid water content (LWC) of aerosols from viewpoints of the particle size and mixing state is therefore important to better predict the climate influence. In this study, we conducted the measurement of hygroscopicity of ambient aerosol particles in Sapporo summer 2006 using a Hygroscopic Tandem Differential Mobility Analyzer (HTDMA). Here, we report the hygroscopicity data of the Sapporo aerosols and discuss the characteristic of the LWC.

2. Method

2.1. Measurement of the hygroscopic properties

Observation of atmospheric aerosols was performed in Sapporo during 6-29 July, 2006. The hygroscopic properties of atmospheric aerosol particles are measured with a HTDMA. Particles with a specific dry diameter are classified by the first DMA. Subsequently, they are humidified to above 95% RH, and are introduced to the second DMA, in which the RH of the aerosol was varied in the range of below 10% to above 90%. The diameters of particles subjected to the hygroscopic growth measurement were 100 and 200 nm. The measurement cycle was 3 hours. The total number of measurements was 186.

2.2. Estimate of LWC

The hygroscopicity of particles is described by the hygroscopic growth factor g(RH), which is the ratio of the wet particle diameter d(RH) to the dry diameter d_{dry}:

g(RH) = d(RH) / d_{dry} —— (1)

We assessed the LWC of aerosols by the total liquid water volume (V_w(RH)) in the classified aerosol normalized by the dry volume (V_{dry}) from the measured hygroscopic growth factor distributions:

V_w(RH) / V_{dry} = (V(RH) - V_{dry}) / V_{dry} —— (2)

where V(RH) is the total particle volume in the aerosol after the humidification in the HTDMA.

3. Results and Discussion

The hygroscopic growth factors showed bimodal distributions with less and more hygroscopic properties on the two modes. The bimodal characteristics were clearly observed down to 40-60% RH. The growth factors of more hygroscopic particles were found to be similar to those of pure ammonium sulfate particles. The relationships between V_w(RH$_{ambient}$)/V_{dry} estimated from the hygroscopic measurement and the ambient relative humidity (RH$_{ambient}$) for 100 nm and 200 nm particles are shown in Figure 1. The V_w(RH$_{ambient}$)/V_{dry} values showed a strong dependence on ambient relative humidity with a trend of exponential increase. This suggests the high sensitivity of urban aerosol size distributions to ambient relative humidity. For 100 nm particles, the averaged V_w(RH$_{ambient}$)/V_{dry} values (+/-1sigma) were 0.26 (+/-0.06) and 0.73 (+/-0.33) at 60-65% and 80-85% RH bins, respectively. The averaged V_w(RH$_{ambient}$)/V_{dry} values for 200 nm particles were higher, which were 0.46 (+/-0.14) and 1.00 (+/-0.49) at 60-65% and 80-85% RH bins, respectively. The difference in V_w(RH$_{ambient}$)/V_{dry} for 100 and 200 nm particles is attributable to the difference in the average chemical composition of the two different particle sizes. It is generally known that, in urban aerosols, smaller particles are characterized by primary organic aerosols and elemental carbon which are less water-soluble, while larger particles are dominated by secondary organics and inorganics that are more water-soluble. Our result of higher V_w(RH$_{ambient}$)/V_{dry} for 200 nm particles is consistent with the general knowledge.

More details will be presented and discussed for the characteristic of liquid water contents of Sapporo aerosols.

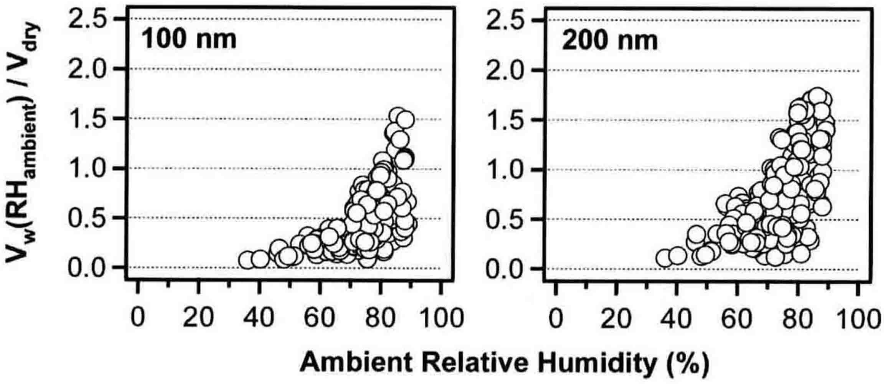

Fig.1. Relationship of the liquid water content of 100 and 200 nm particles and ambient relative humidity.