Hygroscopic properties and chemical composition of atmospheric aerosols -Laboratory and field experiments using an HTDMA-

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Hygroscopic properties of atmospheric aerosol particles is closely related to the cloud condensation nuclei (CCN) activity and the humidity dependence of aerosol light scattering/absorption. Further, the hygroscopic growth is expected to affect the chemical reactivity in the particles. A hygroscopicity tandem differential mobility analyzer (HTDMA) has become a widely used instrument to assess the aerosol hygroscopic growth, and to date, a number of field and laboratory studies have been reported based on the HTDMA measurements. The author has performed several hygroscopicity studies using an HTDMA with collaborators, in which the role of chemical components such as organics has been analyzed. The series of the hygroscopicity studies are reviewed in this presentation.

HTDMA can measure the hygroscopic growth of submicrometer aerosol particles. In the HTDMA used in our studies, an aerosol humidity conditioner composed of Nafion tubing is connected in between two DMAs. Atmospheric aerosol or aerosol generated in the laboratory is dried in diffusion driers and is classified in the first DMA. The monodisperse dry aerosol exiting the first DMA is humidified to the desired level in an aerosol humidity conditioner, and the hygroscopic growth is measured by a condensation particle counter connected to the second DMA.

The HTDMA was used for both laboratory and field based measurements. Hygroscopic growth of particles composed of organics that are abundant in biomass burning aerosols (e.g., levoglucosan) were measured in the laboratory, and compared to model predictions [Mochida et al., 2004]. A substantial contribution of anhydro- and hydrosugars to the hygroscopicity of biomass burning aerosol is inferred. A similar technique was applied by Aggarwal et al. [2007] for the hygroscopicity measurement of atmospheric aerosol samples collected on filters. In a field study in Tokyo, the HTDMA coupled to a CCN counter was deployed to assess key factors in the Koehler theory [Mochida et al., 2006]. (The HTDMA instrument was utilized by Kuwata et al. [2007], too.) Furthermore, temporal variation in the particle hygroscopicity was investigated in a different season, and a significant contribution of secondary organics on the variation is suggested [Mochida et al., 2008].

The hygroscopic properties of atmospheric aerosols and the relationship to other properties are not fully understood. Further studies using an HTDMA are to be performed, in particular to understand the external mixing state of aerosol particles in view of the particle hygroscopicity.

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