Abstract

Tandem differential mobility analyzers (TDMAs) were operated at the Moody Tower and the Aldine, Bayland Park, and Deer Park sites of the Houston Triangle during TexAQS-II. These instruments were used to continuously measure submicron particle size distributions and size-resolved particle growth in response to increased relative humidity. Such hygroscopic growth measurements provide insight into both the size-dependent particle composition and the compositional variability within a particle population. This poster is focused on those measurements made as part of the Houston Triangle, which were coordinated with those of an array of gas and particulate properties made by other researchers supported by HARC. Beyond characterization of the spatial variability and evolution of particulate concentration and properties, these measurements were designed to provide details of the liquid water content present in the particulate populations, which is needed to estimate the conversion rate of $\text{NH}_3$ to HNO$_3$, both of which were concurrently measured.

Consistent with measurements made during previous studies, the size-resolved hygroscopic growth factor distributions were frequently bimodal, reflecting the presence of distinct particle types in an external mixture. Ongoing work is directed at examining study-averaged and time-dependent variability among the distributions measured at the three sites and at integrating our data with those collected by the other project participants.

Aerosol Properties

The hygroscopic growth factor, the fractional representation of an aerosol’s wet diameter to its dry diameter ($D_{p}/D_{p^*}$) as measured by a Tandem Differential Mobility Analyzer (TDMA), for a given particle is unique to that particle type. For example, a purely organic or carbonaceous aerosol will not grow when exposed to a high relative humidity and therefore has a growth factor of 1.0. To the left are shown hygroscopic growth factor intensity plots of 200nm particles for each of the three locations associated with the Houston Triangle in 2006 with the growth factor on the y-axis and the x-axis showing time in decimal day.

The disparity between the two is likely explained by an increased contribution to PM$_{2.5}$ by those particles larger than the 0.75 mm measured using the TDMA. The most likely responsible particle types are dust and/or sea salt, both of which typically have a supermicron mass median diameter. The figures to the right are time series graphs showing the hygroscopic growth factor of 0.6mm particles. Despite the noise, it is clear that during the period of interest here the hygroscopicity of the 0.6 mm particles is greater than that measured during most of the remainder of the study. Particles composed of dust or primary organics, sulfates or nitrates, and sea salt have growth factors of roughly 1.0, 1.5, and 2.0, respectively identified as types 1, 2, and 3 in the figure. Sea salt production rate is very strongly related to wind speed, as is the efficiency with which the very large and hygroscopic particles can be transported. As expected during periods of elevated sea salt concentration, strong southerly winds were recorded at Houston Hobby throughout this period, which is shown in the figure to the right.

Relationship between hygroscopicity and particle composition

Mass Concentration

Time series of growth factor distributions for 0.6 mm particles. A description of the graphs was provided in a previous report and is also available through our project website.