BNL-79289-2007-AB

RAPID MEASUREMENTS OF AEROSOL SIZE DISTRIBUTIONS USING A FAST INTEGRATED MOBILITY SPECTROMETER

J. Olfert[1], P. Kulkarni[2], and J. Wang[1]

[1] Brookhaven National Laboratory, Upton, NY
[2] Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, OH

For presentation at the
AAAR 26th Annual Conference
Grand Sierra Resort
Reno, NV
September 24-28, 2007

Environmental Sciences Department/Atmospheric Sciences Division
Brookhaven National Laboratory
P.O. Box, Upton, NY
www.bnl.gov

ABSTRACT

Measurements of aerosol size distributions with a time resolution of 1 Hz were carried out using a recently developed Fast Integrated Mobility Spectrometer (FIMS). The FIMS is capable of measuring sub-micrometer aerosol size distributions with high time resolution, size resolution, and counting statistics. These attributes make the FIMS an ideal instrument both for aircraft-based measurements and for studies of rapidly changing aerosol populations.

The FIMS consists of a classifier, condenser, and detector. Inside the classifier, under the influence of an electric field, charged particles are separated into different flow streams based on their electrical mobility. The classified particles are then carried by a butanol-saturated sheath flow into the condenser, where a supersaturation of butanol is generated through electrical cooling and the classified particles grow into super-micrometer droplets. At the exit of the condenser, a laser sheet illuminates the grown droplets, and their images are captured by a high-speed CCD camera. The images provide not only the particle concentration, but also the particle position, which directly relates to the particle electrical mobility. By simultaneously measuring particles of different sizes/mobilities, the FIMS can provide full size spectrums of submicron aerosol at a time resolution of 1 Hz, nearly 100 times faster than traditional SMPS systems. Since the individual particle and its position are detected optically using the high resolution CCD camera, the FIMS also offers high size resolution and counting statistics. High time resolution size distributions were derived from FIMS measurements using a newly developed data inversion routine. The routine employs Twomey inversion method and takes into consideration multiple charging of particles and the differences in particle residence times inside the FIMS. The performances of the FIMS, including its time resolution and sizing accuracy, were characterized under a variety of conditions using both atmospheric aerosols and laboratory generated aerosols.