AEROSOL CHARACTERIZATION AT A FOREST SITE IN SOUTHEASTERN UNITED STATES

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INTRODUCTION

The Great Smoky Mountains National Park (GSMNP) in East Tennessee is a Class I region, and has been visited annually by more than 10 million people, making it the most popular national park in the continental United States. Mobile source emissions from nearby urban areas (e.g., Knoxville, Sevieville) and interstate highways (I40, I75, I81), and stationary source emissions from industrial activities and coal-fired power plants are potential contributors of pollutants to the park. These sources emit nitrogen oxides, sulfur dioxide, carbon monoxide, and hazardous air pollutants. Millions of trees and shrubs in the GSMNP give off a series of biogenic organic compounds (principally isoprene) as well as water vapor. The combination of man-made and biogenic emissions and abundant sunshine and water vapor in summertime is conductive to production of ozone and ultrafine particles, and reduced visibility. All these conditions potentially affect the health of the community residents in the nearby areas and tourists, and will possibly impact economy of the region in the near future.

METHODS

Cheng and Tanner (2002) detailed the sampling site, probe configuration, methods and sampling protocols, and campaign schedule for 2000. Semi-volatile organic compounds and FRM particulate matter have been collected using filter methods. 12-hr filter samples were collected using a PC-BOSS sampling train (Modey *et al*., 2001). Several precursor gaseous species and particle size distributions were measured by continuous monitors during the campaigns. An aerosol beam focused laser-induced plasma spectrometer developed by Oak Ridge National Laboratory (Cheng, 2001) was also used intermittently to measure the metal contents of aerosols. A long differential mobility analyzer was used to classify particle size from 10 nm up to 650 nm, while an ultrafine condensation particle counter was used to measure the number of particles in each classified size bin. Samples of size distribution were taken every 30 minutes. Samples of gaseous species, taken at 1-min interval, were also averaged into a 30-min interval. Data analysis was performed using Sigmaplot™ for Windows® and MATLAB™ on a Silicon Graphics Octane workstation.

RESULTS AND DISCUSSION

A classical varimax-rotation factor analysis was performed to explore the relationship of the particle number concentration, gaseous species concentration, mean wind speed, and solar radiation. A 5-factor model was found to resolve 78% of the variability embedded in the data. The model suggests that ultrafine particles (the diameters smaller than or equal to 100 nm) be grouped into the first factor that explained 40% of the data variability. The second factor included $PM_{2.5}$ mass measured by TEOM, number concentrations of particles in the diameter range of 101 to 626 nm, concentrations of O_3 and CO. The third factor included CO, NO_2, reactive odd nitrogen (NO_y), and SO_2. The fourth factor indicates that 30-min averaged wind speed did not contribute to the data variability and it could be removed from the analysis. Solar radiation was included in the fifth factor plus a weak loading from SO_2 indicating an involvement of photolytic reaction for this species, whereas nitrogen species and ozone were not loaded in this factor. A multiple regression analysis further indicated that TEOM was best explained by CO, O_3, and number concentrations of particles in the diameter range between 0.1 and 0.4 μm. We had also observed interesting changes in the particles of size from 31- to 51-nm range. Significant events were identified during the campaign in which the number concentrations of 31-51 nm particles dramatically increased, in 30 minutes, by a factor of 10 reaching 40,000 cm^{-3}, lasting for a couple of hours. Smaller and larger particles than those in the size range of 31 to 51 nm observed during these events also followed the same change patterns of the 31-51 nm particles, but the magnitudes of increase were much less dramatic. The results also suggest that micrometeorological variables (e.g., turbulent flux), in addition to synoptic flow, will need to be measured at the site in order to elucidate the dynamics of ultrafine and fine particle dynamics in the future.

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