한국대기환경학회 2004 춘계학술대회 논문집
Proceeding of the 37th Meeting of KOSAE(2004)
Korean Society for Atmospheric Environment

2C4) Continuous Measurement of Aerosol Ionic Composition during Yosemite National Park Special Study (2002), Special Nitrate Study (2003-2004), and Fresno Fog Study (2003-2004)

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1. Introduction

To improve understanding of the chemical characteristics of aerosol particles and their temporal variability, high time resolution measurements of $PM_{2.5}$ composition are of great value. A PILS (Particle-Into-Liquid Sampler)/IC (Ion Chromatography) system allows quantification of concentrations of major ionic species (Cl^-, SO_4^{2-}, NO_3^-, Na^+, NH_4^+, K^+, Mg^{2+}, and Ca^{2+}) with 15 minute time resolution (Weber et al., 2001; Orsini et al., 2003). Continuous PILS/IC measurements were conducted in Bondville, Illinois (February, 2003), San Gorgonio Wilderness Area, California (April and July, 2003), Grand Canyon National Park, Arizona (May, 2003), and Brigantine National Wildlife Refuge, New Jersey (November, 2003) as part of special study examining aerosol ion composition in rural locations. The PILS was also operated as part of an air quality study in Yosemite National Park, California (July-September, 2002) and in a study of aerosol scavenging by radiation fogs in Fresno, California (December-January, 2003-2004). Additional 24hr filter pack (URG) and impactor (MOUDI) measurements provide additional insight into the accuracy of PILS measurements and size-resolved aerosol ionic composition.

2. Experiment

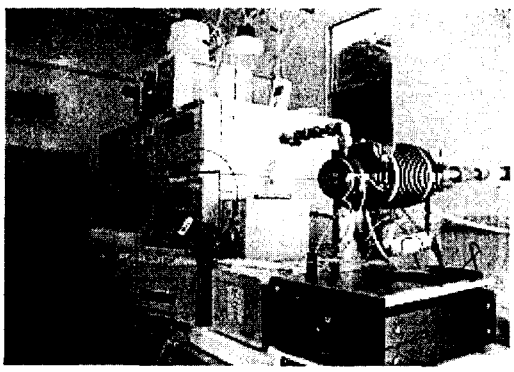

Fig. 1. The Particle Into Liquid Sampler/Ion Chromatograph (PILS/IC) system deployed in the CSU mobile laboratory

A PILS/IC system was used to provide semi-continuous measurement of $PM_{2.5}$ major ionic species. Ambient air was drawn through a cyclone (URG, D_{50}=2.5μm) and through two denuders (URG) which have been coated with Na_2CO_3 and phosphorous acid to remove acidic and basic gases.

The overall principle of PILS/IC is to collect particles that comprise the $PM_{2.5}$ aerosol mass into a small continuous flow of high purity water. The sample liquid is then continually drawn to two IC systems (DIONEX 500) for major anion and cation analyses.

3. Results and Discussion

Timelines of major aerosol chemical species reveal strong diurnal cycles at Yosemite National Park and at San Gorgonio, located in the mountains downwind of Californias Central Valley and of Los Angeles, respectively. High concentration peaks are associated with upslope flow to the sites from impacted air basins upwind. Aerosol ion composition in Yosemite and San Gorgonio was observed to be dominated by ammonium sulfate and ammonium nitrate, respectively. PILS measurements of soluble potassium reveals frequent, extended periods of smoke from wildfires in Yosemite National Park and some impacts in the July study at San Gorgonio.

Observations at Bondville reveal rapid changes of ionic composition, from sulfate to nitrate dominated aerosols. These rapid changes may reflect the proximity of nearby SO_2 emission sources. The results from Grand Canyon National Park indicate that crustal compounds (Ca^{2+} and Mg^{2+}) play an important role in the formation of non-ammoniated aerosol. Nitrate concentrations were correlated with Na^{+} and Ca^{2+} reflecting likely reactions between gas phase nitric acid and soil dust (or sea salt) (Spurny, 2000; Padgett et al., 2001; Lee et al, 2004). $NaNO_3$ resulting from reaction of nitric acid or precursor species with sea salt was also frequently observed at Yosemite.

Acknowledgements

Special thanks are given to Chuck McDade and the IMPROVE team at UC Davis for logistical support and study planning. We are grateful to R. Weber and D. Orsini of Georgia Tech for providing the PILS sampler. The studies presented were funded by the National Park Service and National Science Foundation.

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