Indoor and Outdoor Particulate Matter at an Elementary School: Implications for Recess Activities and Asthma

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INTRODUCTION

Winter inversions lead to high concentrations of ambient particulate matter, especially in valley cities that are surrounded by mountains. The mass concentration of particulate matter (PM) is generally lower indoors during air pollution episodes, but building design, air handling equipment operation, and occupant activities all affect the composition and size distribution of the indoor aerosol. (Lillquist, 1998) During high pollution events, health advisories are issued recommending that sensitive individuals stay indoors and that everyone avoid outdoor exercise. However, there is little peer- reviewed data quantifying the reduction in particle exposure that is achieved by staying indoors or the health benefits of this exposure reduction to groups such as children with asthma.

An urban elementary school is the test site for an exciting collaborative project between physicians and aerosol scientists that includes the Salt Lake City School District, the University of Utah Departments of Pediatrics, Family and Preventative Medicine, Pharmacology and Toxicology, and Meteorology, the Utah Department of Health, the Utah Division of Air Quality.

The overall project is being coordinated though the Utah Asthma Task Force, and is centered around a study of the effect of a 15-minute recess on lung function as measured by spirometry in children with and without asthma. The goals of the air sampling are 1) to provide indoor air quality data to the asthma study investigators; and 2) to allow using receptor-based source apportionment modeling and particle transfer function modeling to understand the contributions of indoor and outdoor sources to the indoor exposure. 3) to provide quantitative data to support guidance for school administrators and parents regarding when it is better for children to play indoors. The long range goal of this research is to contribute to the scientific basis for improved community health advisories and for improved operation of public building air handling systems to reduce exposure to the pollutants that cause or exacerbate attacks in children with asthma. (Thurston, 2003)

METHODS

This poster describes measurements of indoor and outdoor PM that were made during the winters of 2004-5 and 2005-6 at Hawthorne Elementary School in Salt Lake City, Utah. A permanent ambient air monitoring station, located in the school playground, provides long-term Federal reference method data on O_3, CO, NO_2, PM_{10} and $PM_{2.5}$ mass and $PM_{2.5}$ speciation. A tapered element oscillating microbalance (TEOM) temporarily located in the school library provides time resolved data on the indoor $PM_{2.5}$ mass.

For the winter of 2006, a pair of Grimm aerosol spectrometers provided data on indoor and outdoor particle size distribution. A pair of Airmetrics Mini-Vol samplers located in the library provided filter samples for chemical speciation of the indoor aerosol. A rotary drum impactor was used to demonstrate the feasibility of generating time-resolved elemental composition data at indoor concentrations. Canister samples were also collected for measurement of indoor gas-phase pollutants.

The heating, ventilating, and air conditioning system (HVAC) is designed with a variable air volume system and has an indoor air quality damper that provides minimum outside air to the building in accordance with ASHRAE standards. The computer-based control system logs data on the building air handling system operation.

A pilot spirometry study is being conducted to describe the correlation between air quality measurements and lung function results before and after recess in children with and without asthma. The human study protocol was approved by the University of Utah Institutional Review Board.

RESULTS

During the winter of 2004-5 the indoor and outdoor averages for $PM_{2.5}$ were 7.6 and 17 microgram/m^3 respectively by the TEOM and 7.4 and 27.3

respectively by filter weight. Figure 1 shows the daily values for indoor and outdoor $PM_{2.5}$ mass as measured by the TEOM in January 2005. There appears to be a base level of 2–4 $\mu g/m^3$ of indoor PM on clean air days, and a substantial reduction from outdoor $PM_{2.5}$ mass concentration on days with high ambient PM. Figure 2 illustrates the indoor and outdoor particle size distribution. Size data are the average for a 6-day period in January 2006. The submicron particle number is lower indoors, but indoor sources appear to contribute to the larger particles.

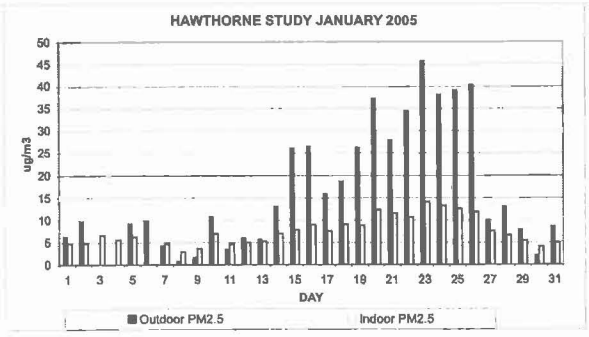

Figure 1. Indoor and outdoor $PM_{2.5}$ for one month at an elementary school (Data from R. Dalley, Utah Division of Air Quality).

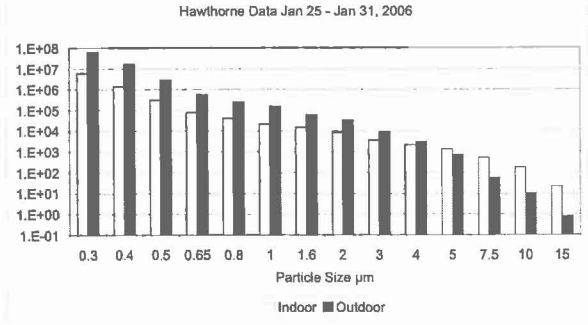

Figure 2. Indoor and outdoor size distribution. Number/m^3, average for a 6-day period.

Keywords: *Particulate matter, Environmental health, Comparison of indoor and outdoor*

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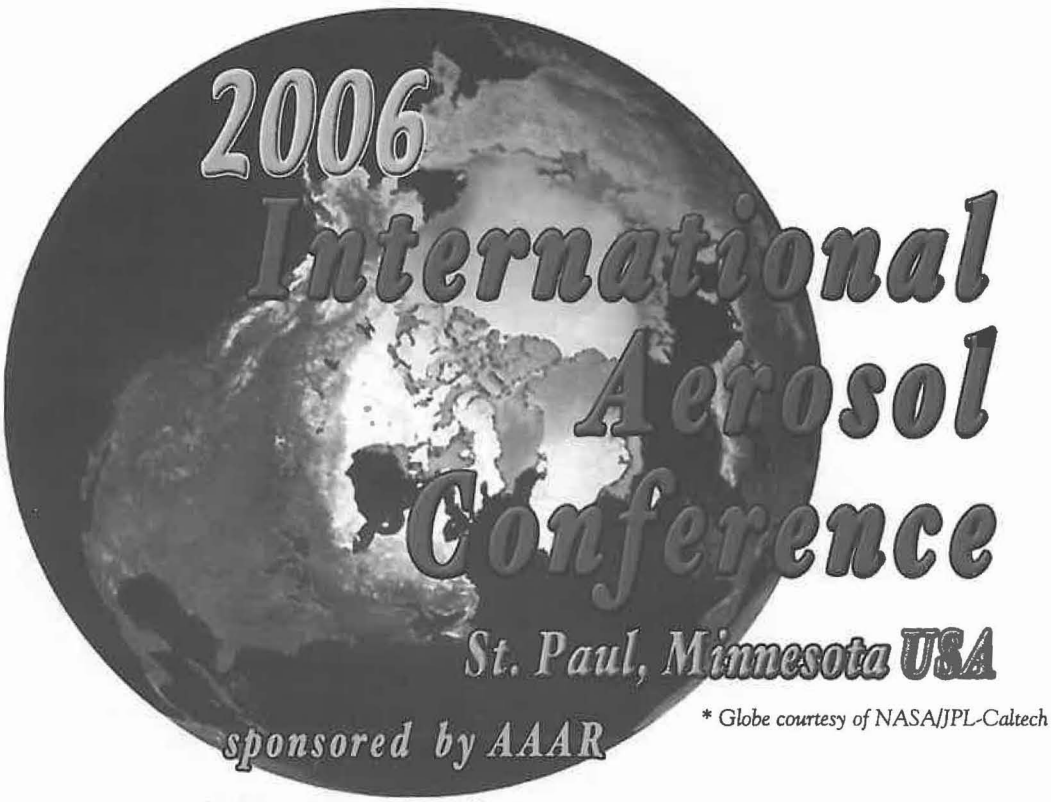

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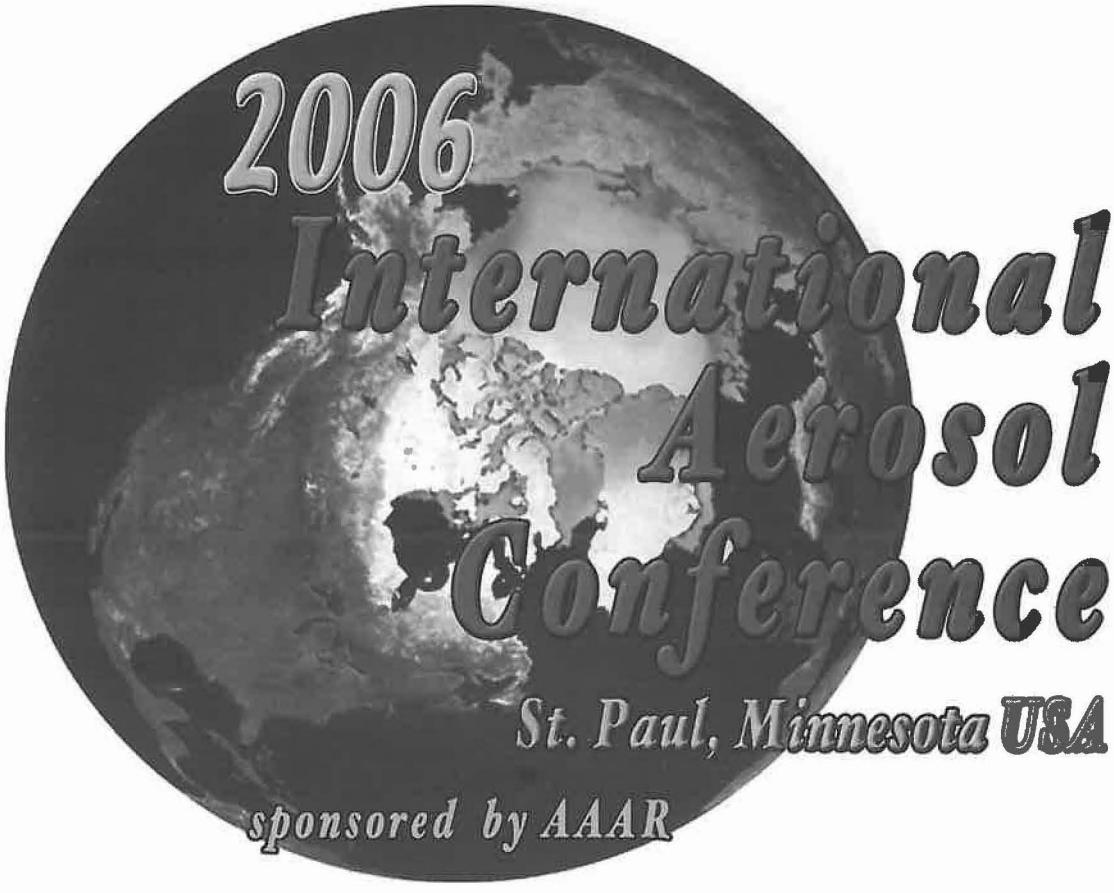

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