



URBAN SCALE VARIABILITY OF PM_{2.5} COMPONENTS

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BACKGROUND

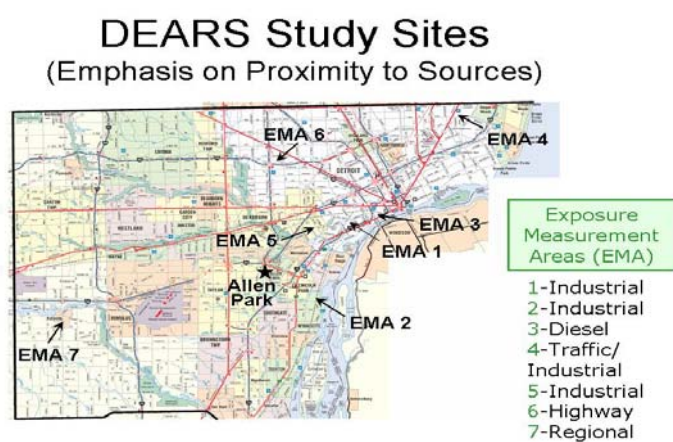
Introduction

An objective of the Detroit Exposure and Aerosol Research Study (DEARS) is to determine the associations between concentrations measured at central site monitors and outdoor residential, indoor residential and personal exposures for selected air toxics, PM constituents, and PM from specific sources.

PURPOSE

The focus of this poster is to demonstrate that a central site monitor adequately represents ambient concentrations of PM_{2.5} mass and its secondary constituents over a county-level scale in an urban area (Fig.1). Primary aerosol components, however, are much more spatially variable due to local source contributions in the Detroit urban air shed and more spatially resolved measurements are necessary.

Fig.1. Environmental Monitoring Areas (EMAs)



MATERIALS AND METHODS

Materials and methods

Residential outdoor and central site monitoring are being performed during the DEARS to assess the variability in composition and concentrations of fine particulate matter across the urban air shed. Participants are monitored for 5 days each in the summer and winter. Their residences are located in seven different environmental monitoring areas (EMA) across a 1400km² area. The sources potentially impacting each EMA vary from industrial and mobile source categories including coal combustion, coke production, iron and steel production and oil refineries. Sample collections were performed with personal environmental monitors (PEM) using Teflon and quartz filters. Gravimetric analysis were used to determine the PM_{2.5} mass. The elemental concentrations (Si, Mn, S, Ni, Cu, Zn, As, Pb, Se, Sr, Cr, Ca, & Fe) were determined using XRF analysis. Concentrations of OC and EC were measured using the thermal-optical reflectance method on the quartz filters.

RESULTS

Preliminary data analysis indicated that the concentrations of PM_{2.5} mass were fairly consistent across the air shed, varying no more than 10% across an area of 1400km². However, the composition of PM_{2.5} in each EMA was highly variable for the primary components (Table 1) when compared to the central site at Allen Park. The differences were as great as 36% for the metals. The PM_{2.5} mass composition was determined to be seasonally-dependent (Figs. 2 & 3). The particle bound nitrate was approximately 45% of the total ambient PM_{2.5} mass concentration during the winter, and only 7% during the summer. The percentages of the PM_{2.5} composed of the secondary aerosol components (sulfates and nitrates) were highly correlated and statistically significant across the urban air shed for the summer and winter seasons (Table 2).

Table.1. Species Formation and Sources.

Species	P/S	Sources	Comments
Sulfate	S	Fossil fuel combustion	Primary component of PM _{2.5} (eastern U.S.)
Nitrate	S	Fossil fuel combustion	Primary component of PM _{2.5} (western U.S.)
Metals	P	Smelters, soil, incinerators	Manganese, nickel, copper, zinc, etc
Crustal	P	Soil, Coal fired boiler	Silicon, calcium, iron, titanium
Elemental Carbon	P	Fossil fuel combustion	Inert and small size long transport
Organic Carbon	S/P	Fossil fuel combustion	A primary component of PM _{2.5}

P = primary, local sources S = secondary, regional sources

fig.2. PM2.5 Composition-Summer

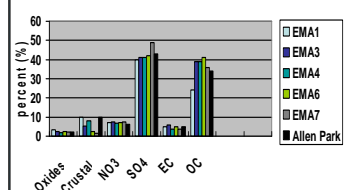


fig.3. PM2.5 Compositions-Winter

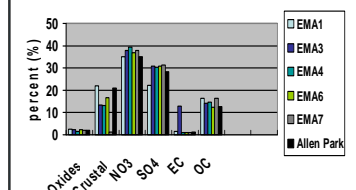


Table.2. Pearson correlation coefficients between PM2.5 components measured at the various EMAs and Allen Park during Summer 2004

Species	EMA				
	1	3	4	6	7
OC	0.558	0.476	0.537	0.652	0.718
NO ₃	0.897	0.856	0.893	0.832	0.958
SO ₄	0.968	0.978	0.975	0.983	0.983

Table.3. Pearson correlation coefficients between PM2.5 components measured at the various EMAs and Allen Park during Winter 2005

Species	EMA				
	1	3	4	6	7
OC	0.677	0.755	0.500	0.754	0.571
NO ₃	0.885	0.997	0.785	0.940	0.971
SO ₄	0.946	0.975	0.989	0.988	0.984

CONCLUSIONS

These data suggest that a central site monitor may adequately represent the spatial distribution of secondary components (Nitrates & Sulfates) of PM_{2.5}, but not adequately represent the primary components (primary OC, EC, metals, crustal, etc.) contributed by local sources. Additional source monitoring will be needed with the inclusion of survey, activity, source apportionment and meteorological results to provide better estimates for modeling spatial distributions and exposures to these pollutants across the air shed.

ACKNOWLEDGEMENTS

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