Monitoring Air Toxic Particulate Pollutants from Heavily Trafficked New Jersey Turnpike
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Introduction

NJ turnpike connects New York and Philadelphia with more than 1/2 million cars per day.

Traffic emissions have lead to elevated concentration of HAPs near highways compared to the average urban background

This study measured pollutant levels at different distances from the NJ turnpike, seasonal effects and traffic and weather effects on PAH's, TSP and PM2.5 and associated metals

Objective

- Measure ambient concentration gradients of **PM$_{2.5}$,TSP, PAHs** and their associated **Trace Metals** at different distances from the NJ Turnpike.

- Determine how particulate concentration from vehicle emission is affected by **seasons, day/night, traffic flow variations and meteorological conditions**.

- Design and test a **visualization tool** for interactively displaying spatial-temporal patterns of highway Air quality.
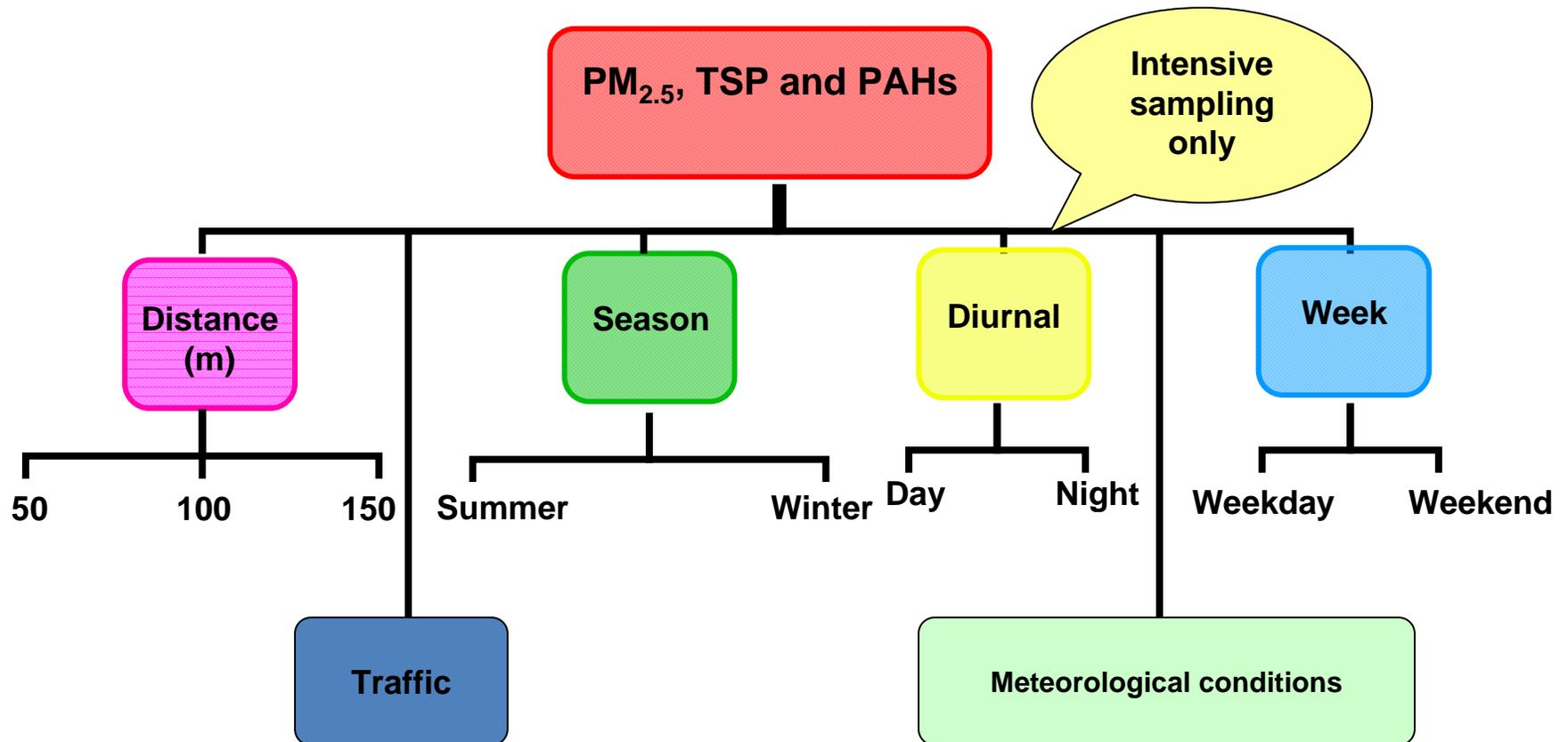
Experimental Design

Carlstadt, New Jersey Turnpike

- **Sampling Periods:**

  09/07-09/08 with EPA 6-day Monitoring Schedule

- **Sampling Duration:**

  -Long term: 24 hrs (12 months)
  -Intensive: 12 hrs (one week in each season)

- **Sampling Distances:**

  50, 100 and 150 m from TPK

Measured Variables

Turnpike

PM$_{2.5}$, TSP, 16 PAHs & 10 Trace Metals Sampling
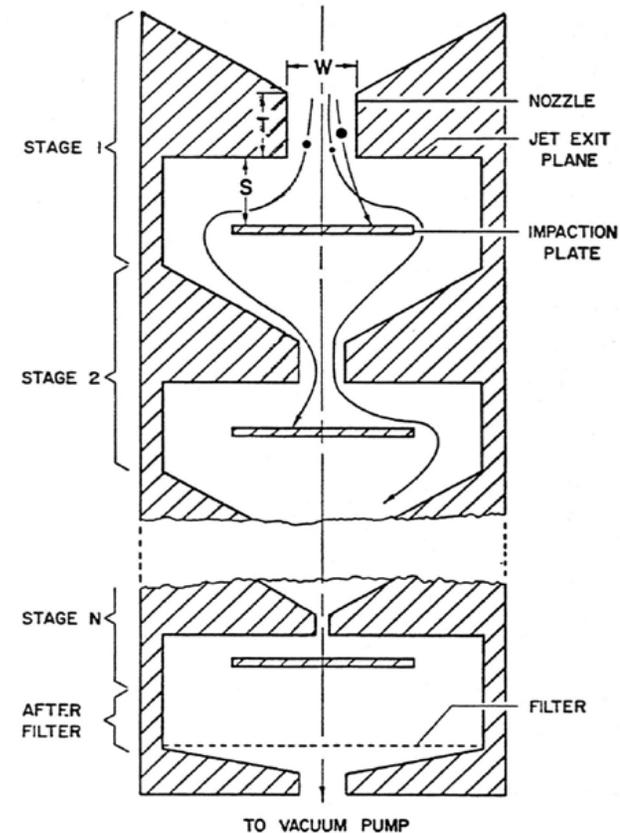

PM$_{2.5}$ & Metals

TSP & PAH(p)

PAH(g)

PM$_{2.5}$ Sampler:
- **Model: Partisol-FRM 2000**
- **Flow rate: 16.7 L/min**
- **Duration: 24 hours**
- **Media: PTFE Filter (47 mm ID)**
- **Compounds: PM$_{2.5}$ and Metals**

Hi-vol. Sampler:
- **Model: Tisch-PNY1123**
- **Flow rate: 0.5~0.7 m³/min**
- **Duration: 24 hours**
- **Media: Quartz Fiber Filter and PUFs (3" height)**
- **Compounds: TSP, PAHs**

Schematic Diagram of Cascade Impactor

MRS Model 100 has 8 cut off size : 0.18, 0.32, 0.56, 1.0, 1.8, 3.2, 5.6 and 10 um

Marple & Olson, KONA, 2009

MOUDI (Micro Orifice Uniform Deposit Impactor)
- Particle size distribution measurement

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Distance effects

PM2.5, TSP and PAH

Distance effect PM2.5
24 hour average
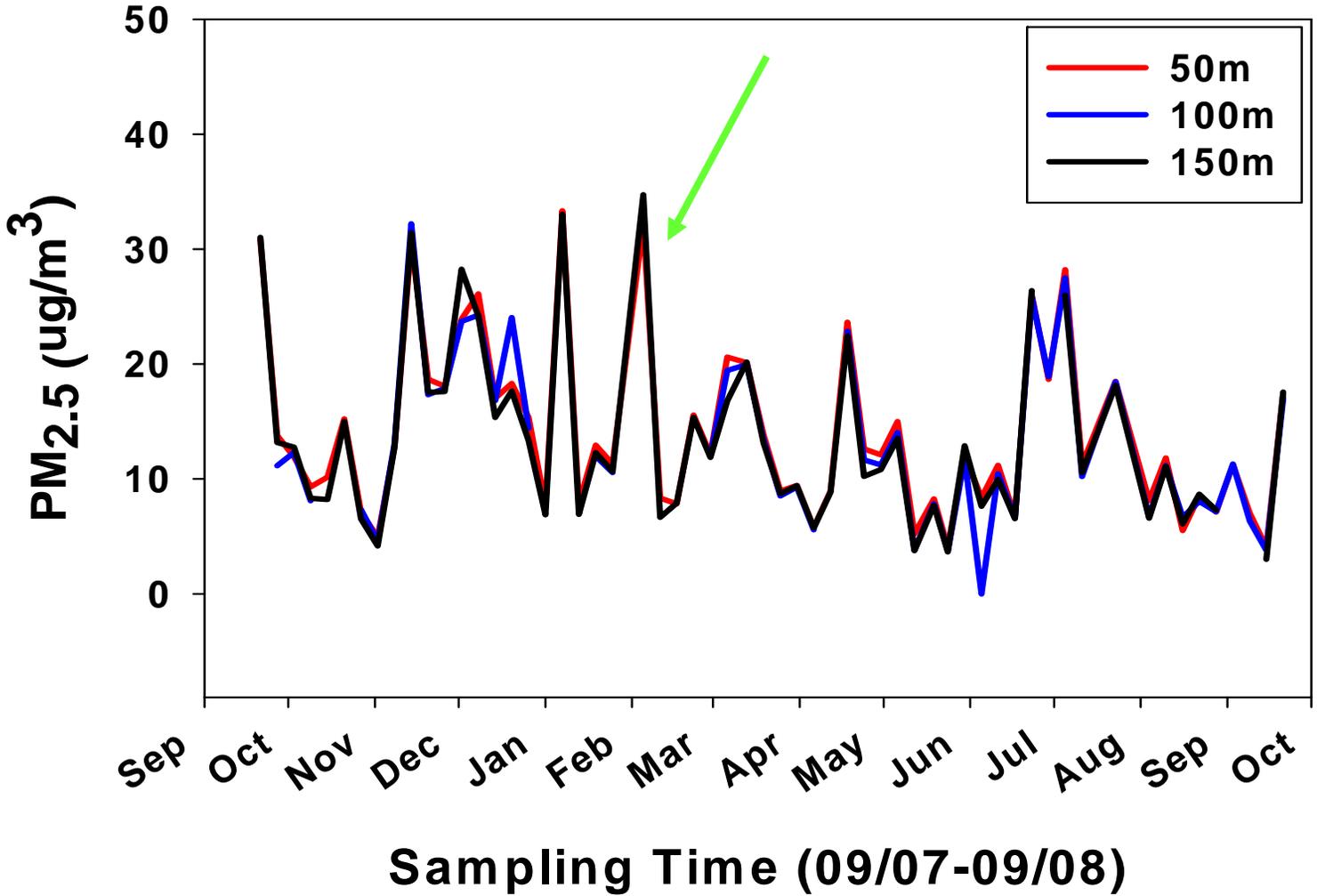
Distance Effect on Three Metals in PM$_{2.5}$
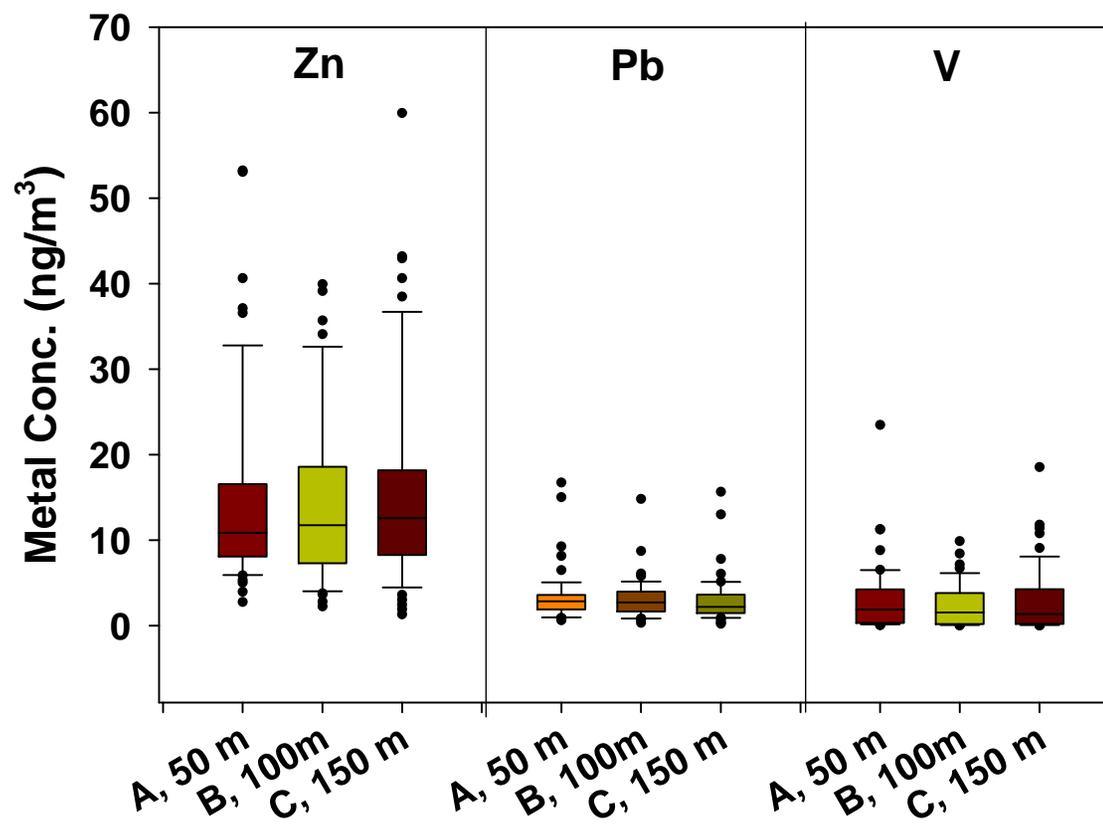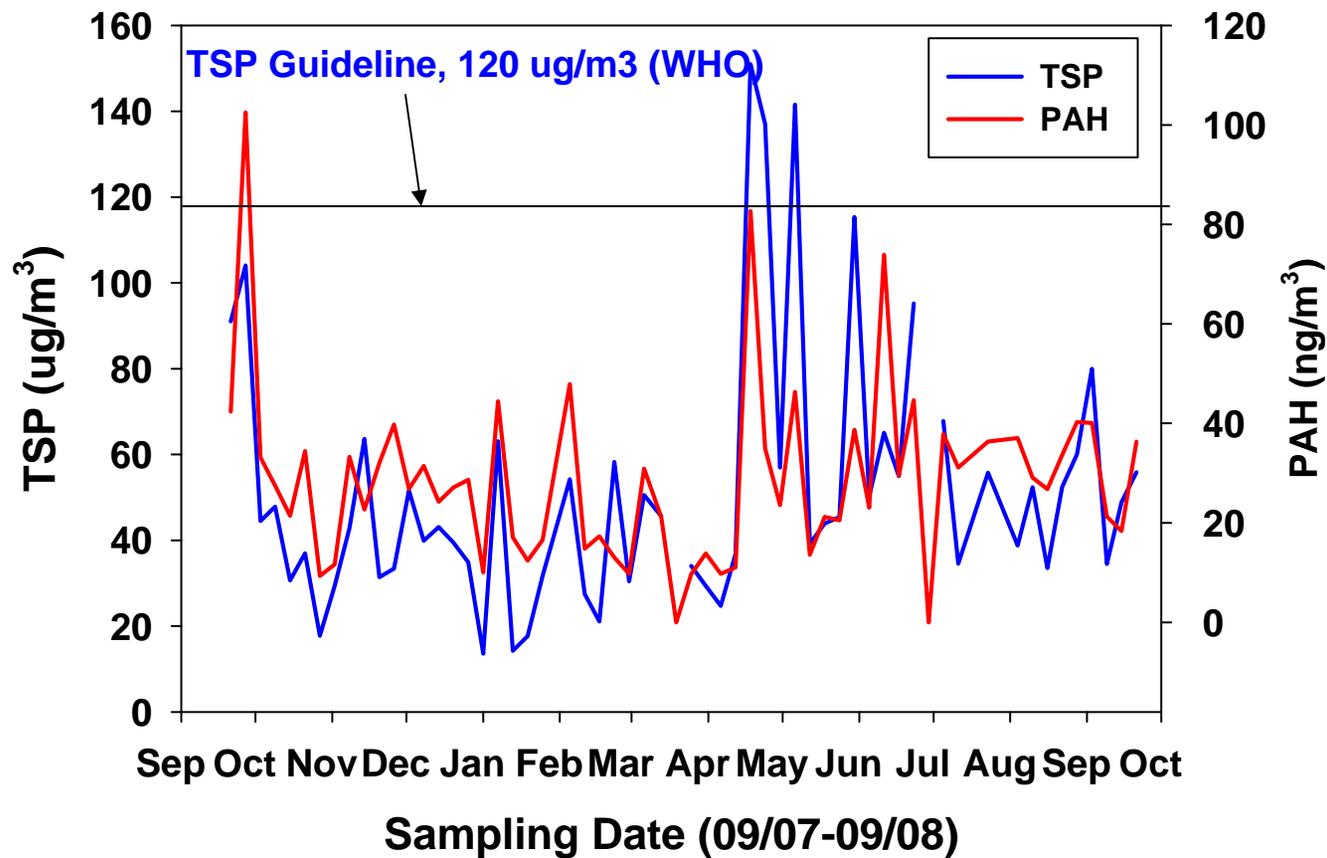
Distance effect TSP
24 hour average

Legend: 50 m, 100 m, 150 m

Y-axis: TSP (ug/m³)

X-axis: Sampling Date (09/07-09/08)
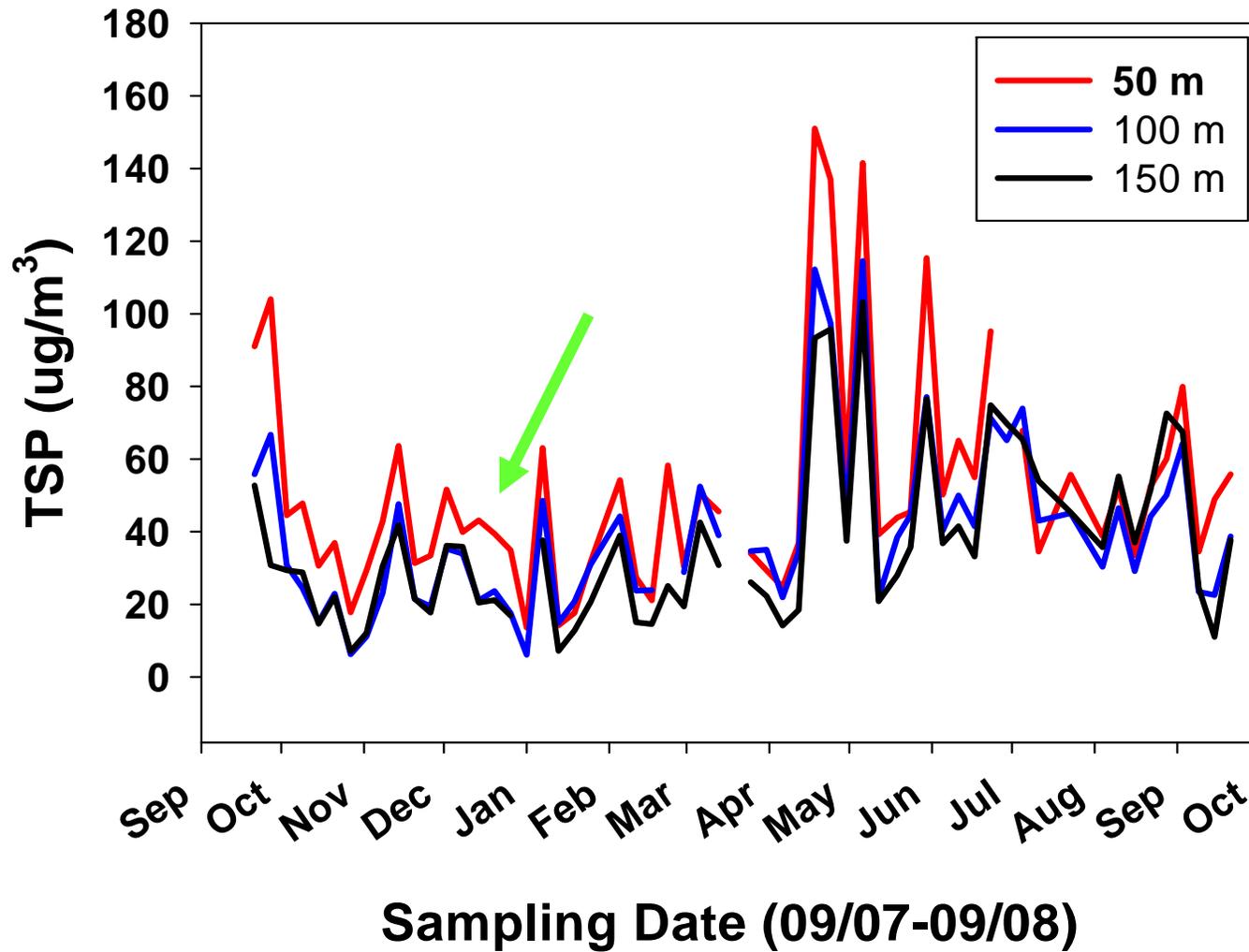
Distance effect on PAH
24 hour average
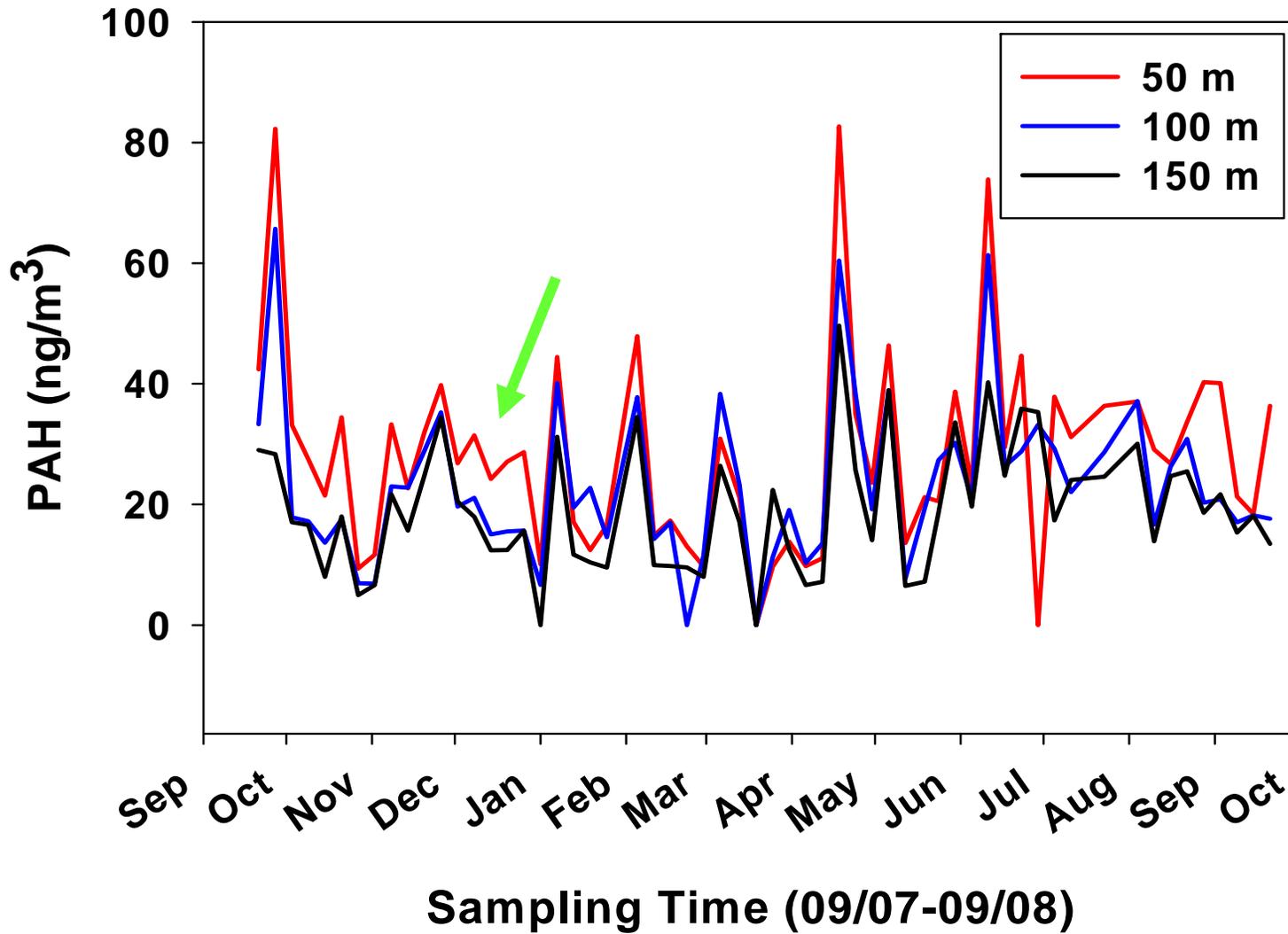
PAHs and TSP 24 hrs Average Ambient Air Concentration at Site A

PM2.5 and PAH 24 hrs Average Ambient Air Concentration at Site A
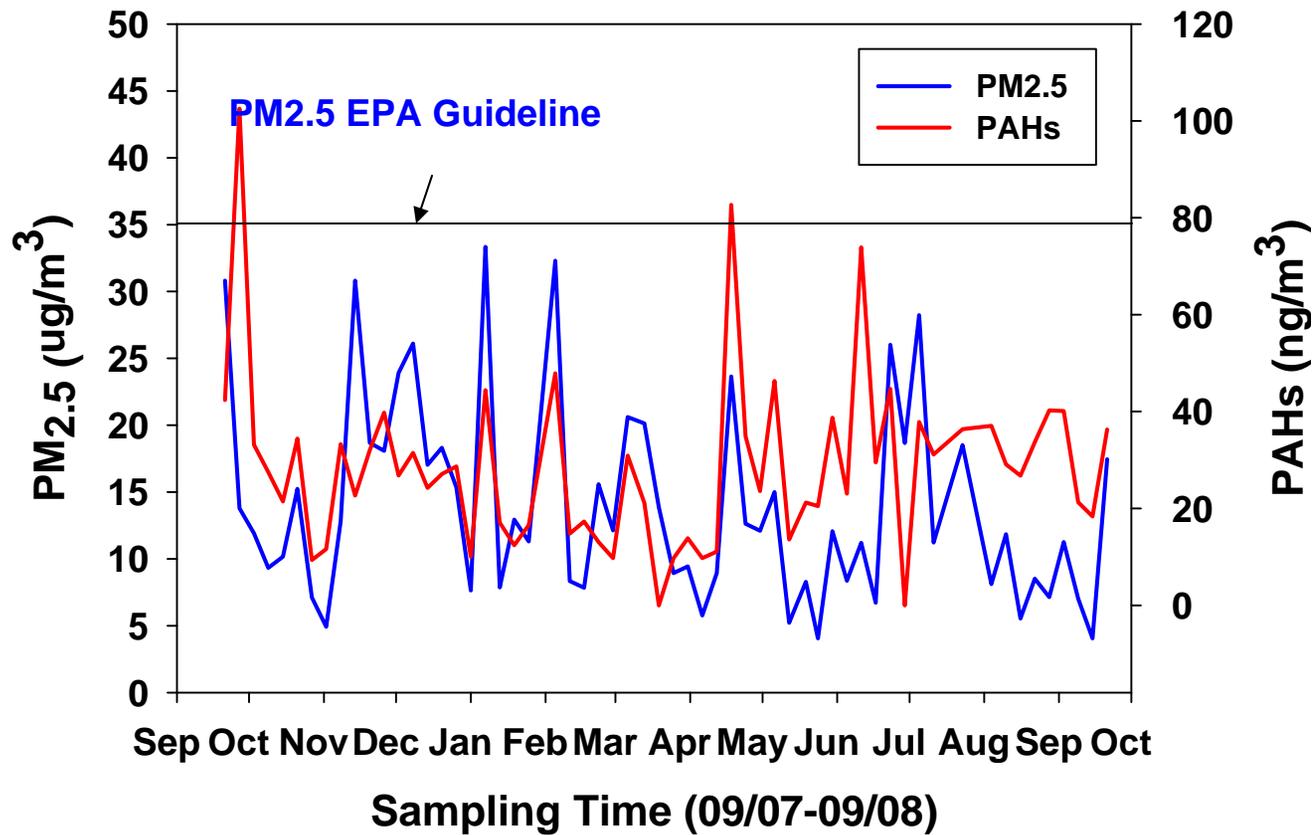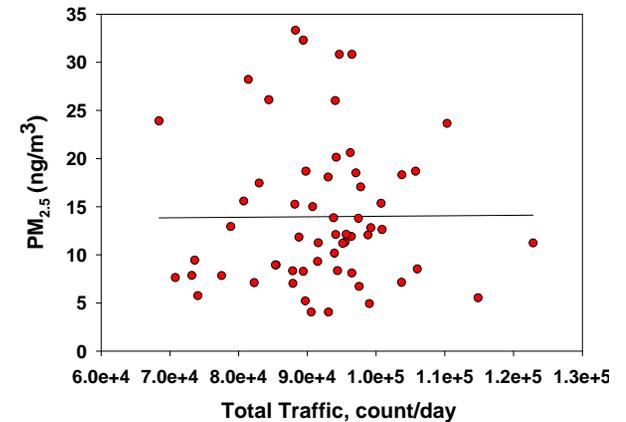
Traffic effects

Total Traffic Count Effects on PAH, TSP and PM$_{2.5}$

PAH

TSP
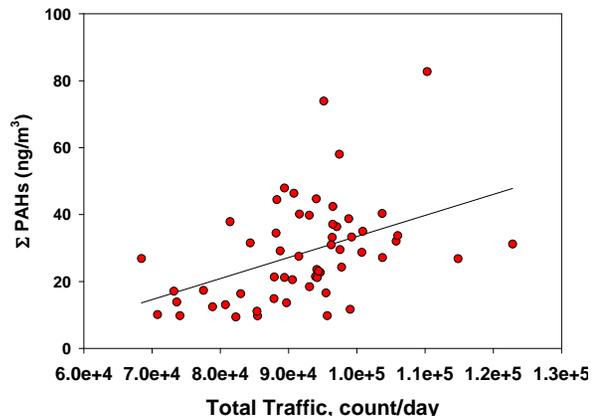
PM$_{2.5}$

$\Sigma_{16}PAH = 0.0007 \times Traffic - 31.91$ ($r^2 = 0.19$, $p < 0.001$)
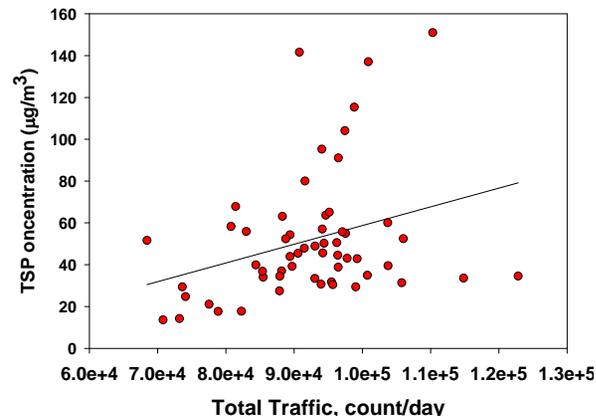
$TSP = 0.0012 \times Traffic - 58.26$ ($r^2 = 0.18$, $p < 0.001$)

$PM_{2.5} = 0.0001 \times Traffic - 4.50$ ($r^2 = 0.02$, $p > 0.05$)

Gasoline and Diesel Traffic Counts Effects on Total PAHs
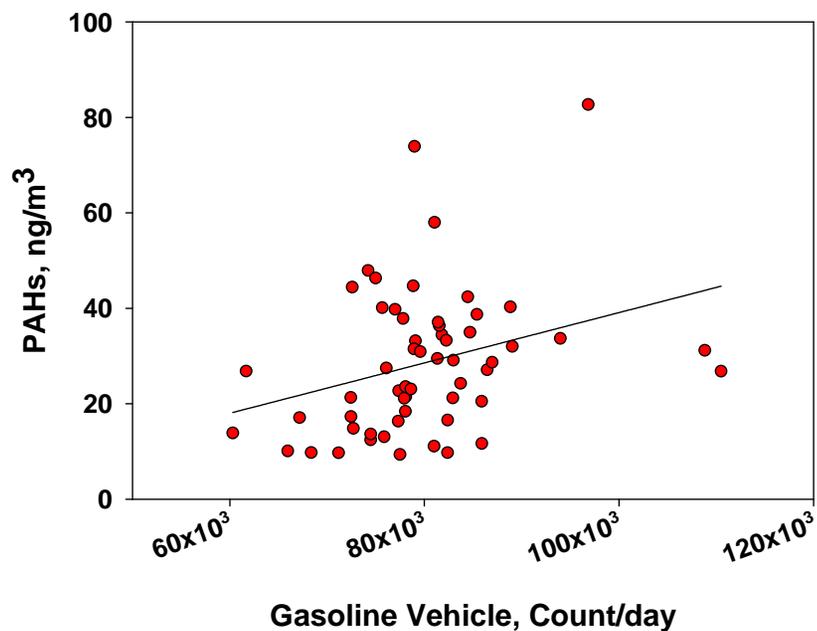
Σ_{16}PAH=0.0005×gasoline+14.05 (r^2=0.09, p<0.05)
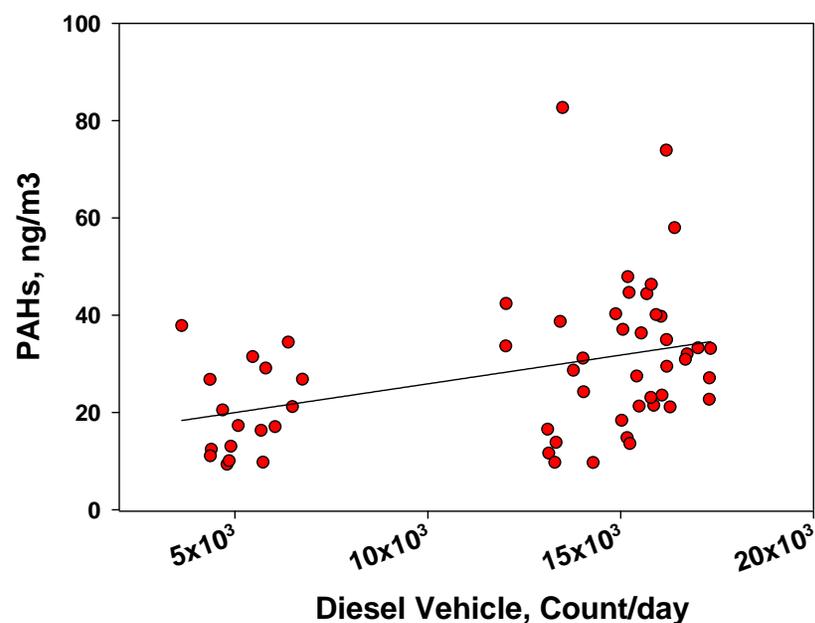
Σ_{16}PAH=0.001×diesel+13.24 (r^2=0.14, p<0.05)

Gas and Particle Partitioning of 16 PAHs
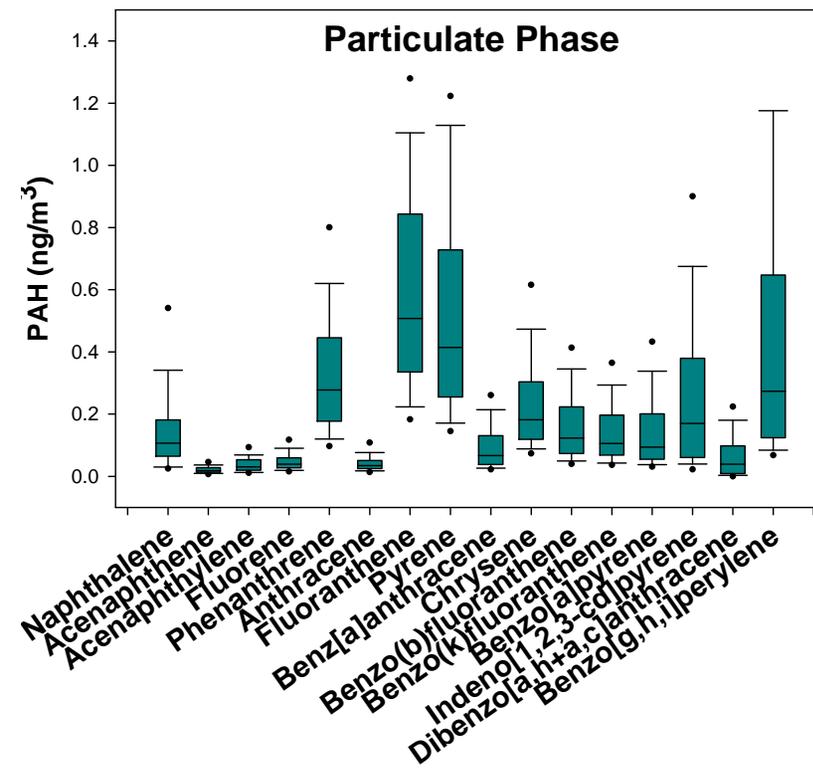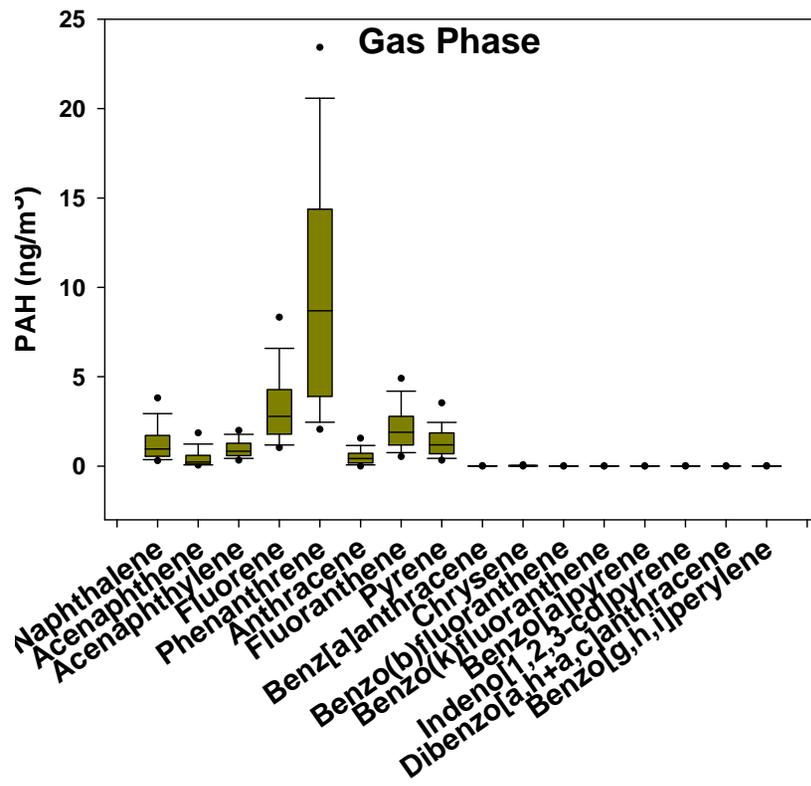
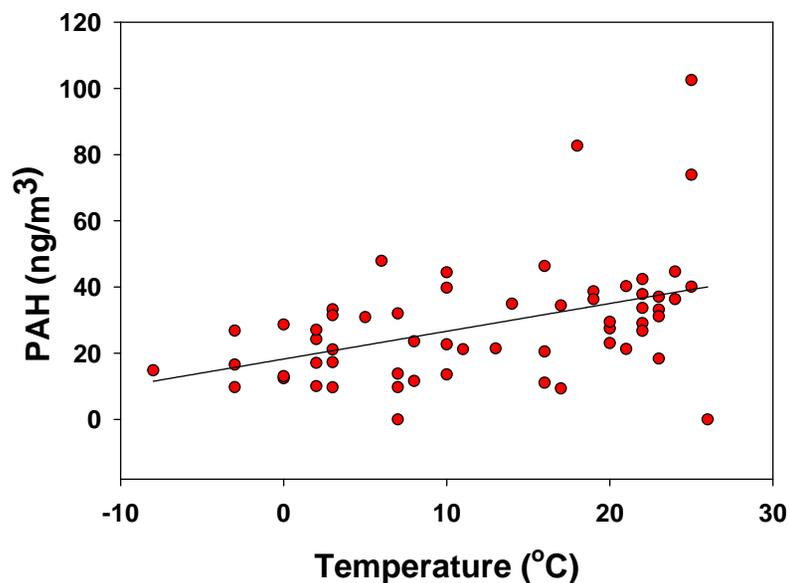# ∑PAH concentration at Various Locations in the East Coast
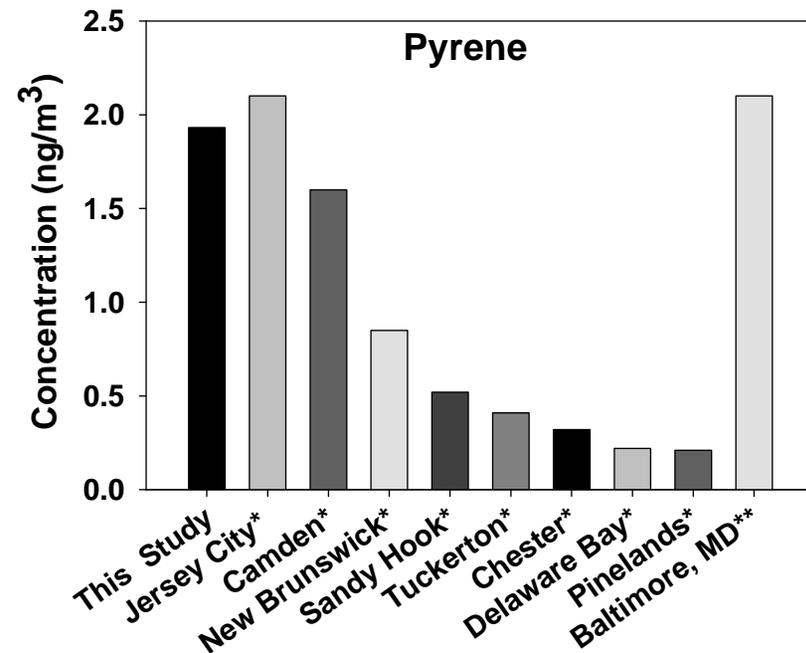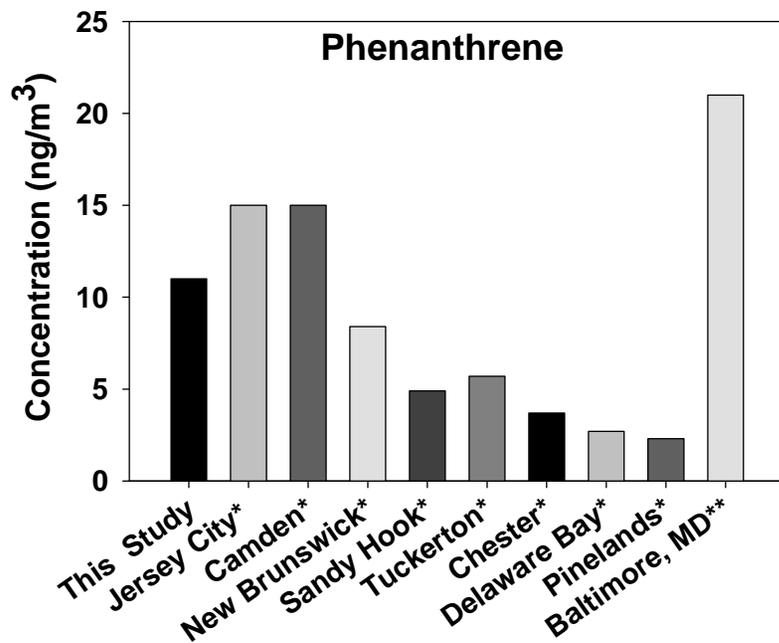
*Gigliotti et al, *Environ. Sci. Technol*, 2005, 39,5550-5559
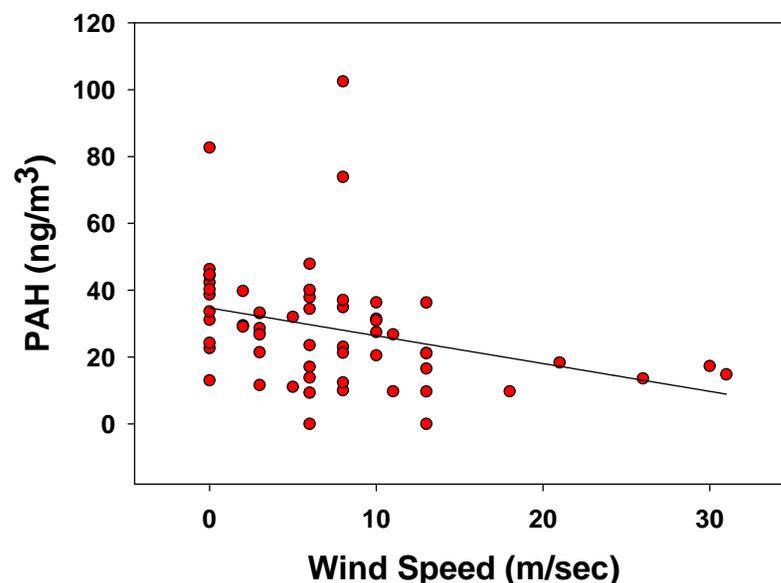**Offenburg, et al, J. Air Waste Manage. Assoc., 1999, 49, 959-965

Meteorological effects

PAHs vs Temperature, Wind speed (Site A)

$\Sigma16$PAHs$=0.839\times$Temperature$+18.25$

($r^2=0.20$, $p<0.05$)

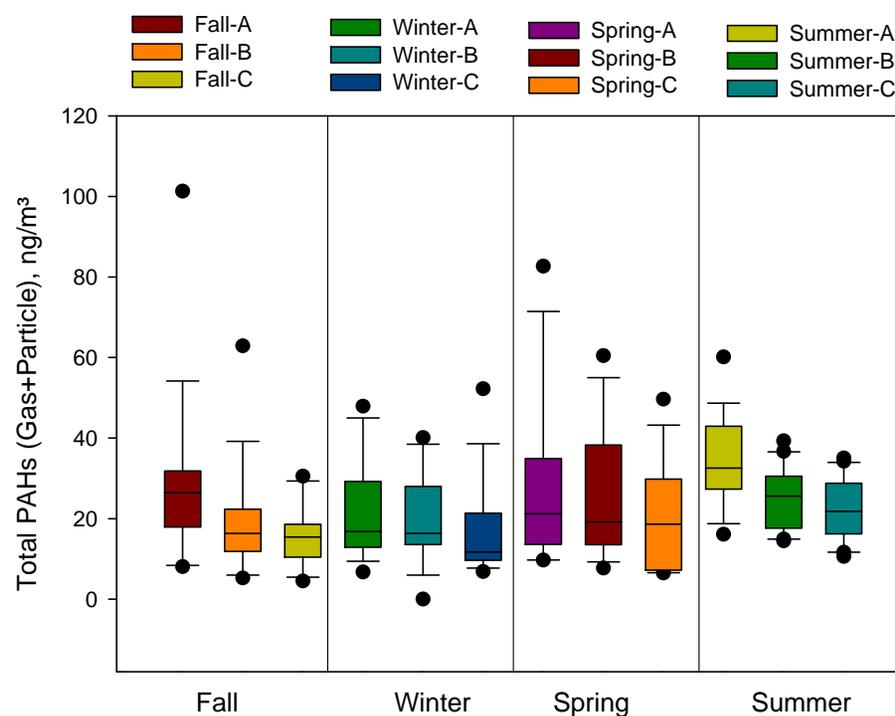$\Sigma16$PAHs$=-0.832\times$Wind speed$+34.7$

($r^2=0.11$, $p<0.05$)

Seasonal effects
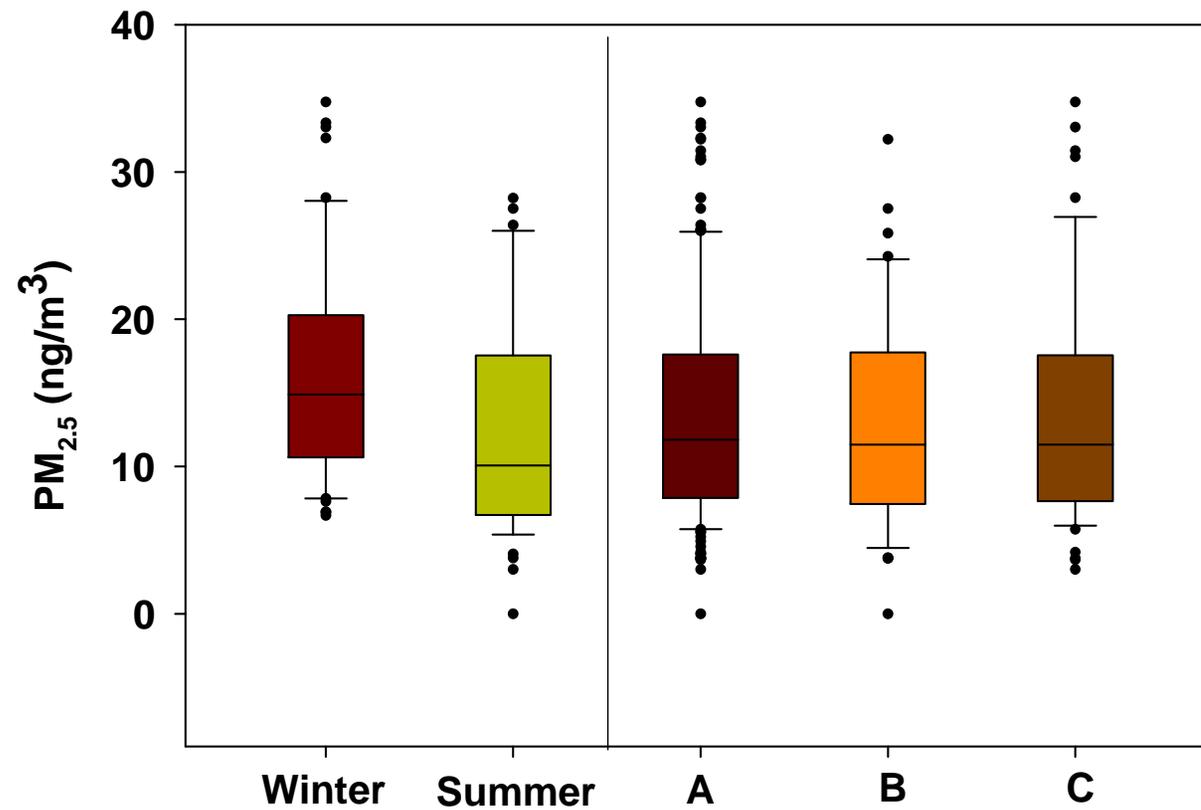
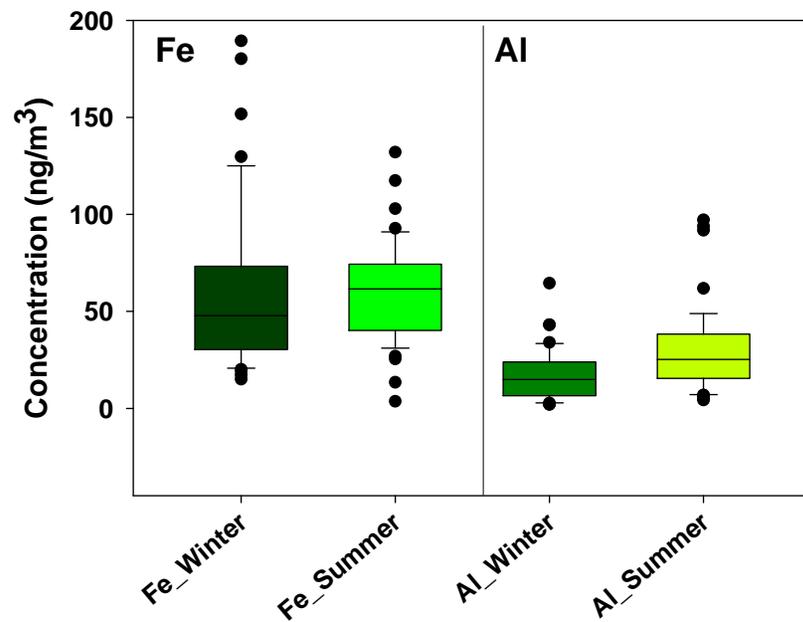# Seasonal and Distance Effect on TSP and PAHs
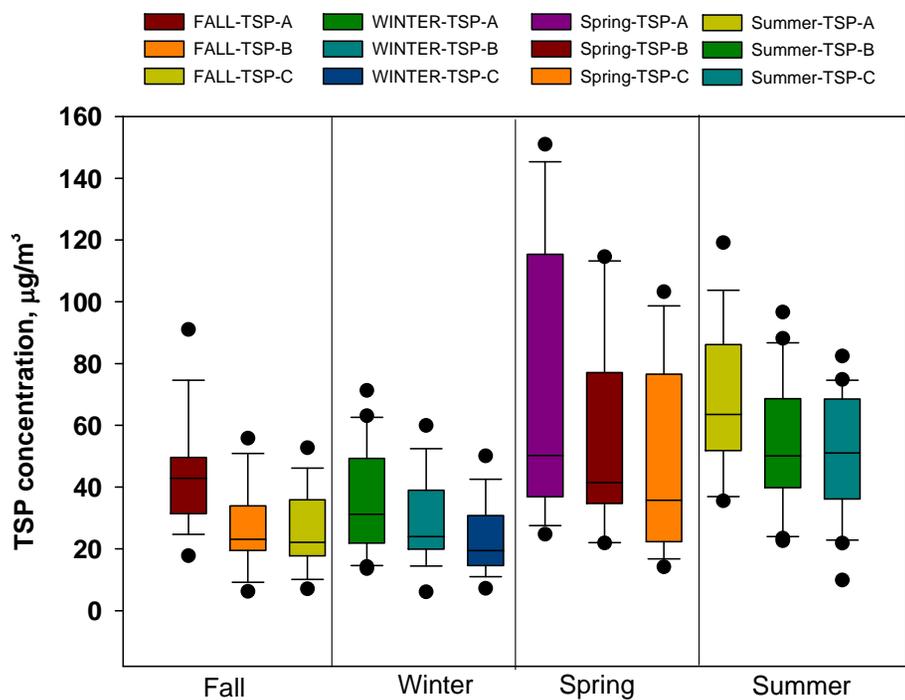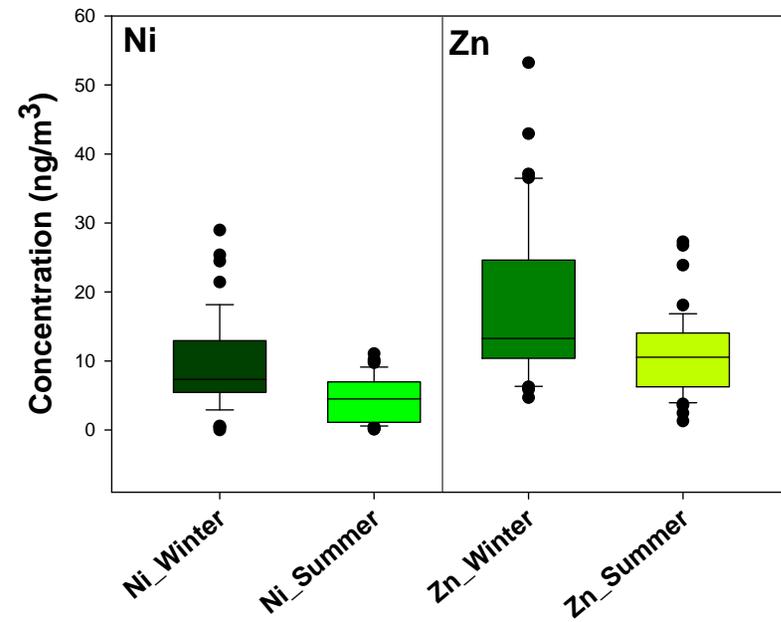
Seasonal and Distance Effect on PM$_{2.5}$

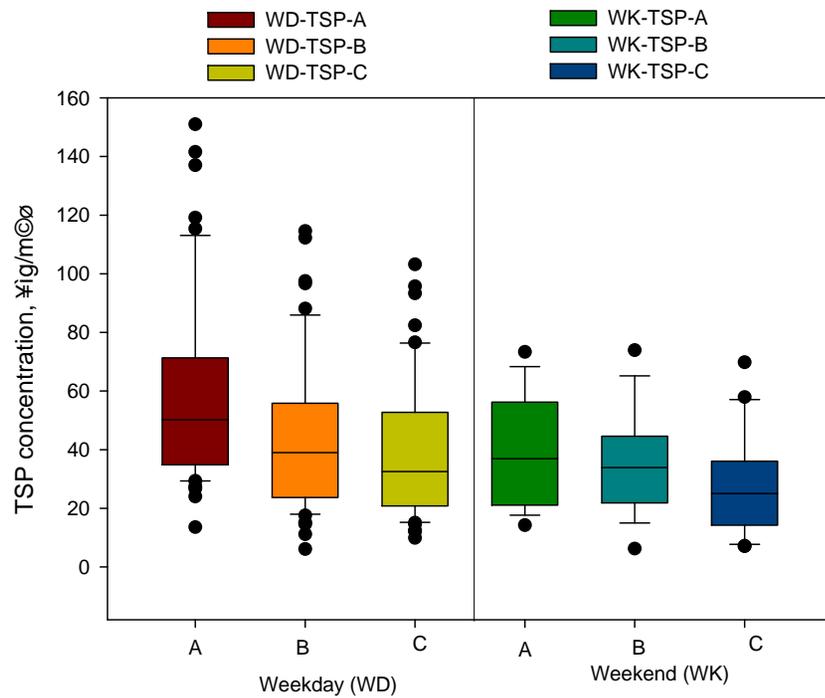# Seasonal Effect on Metals
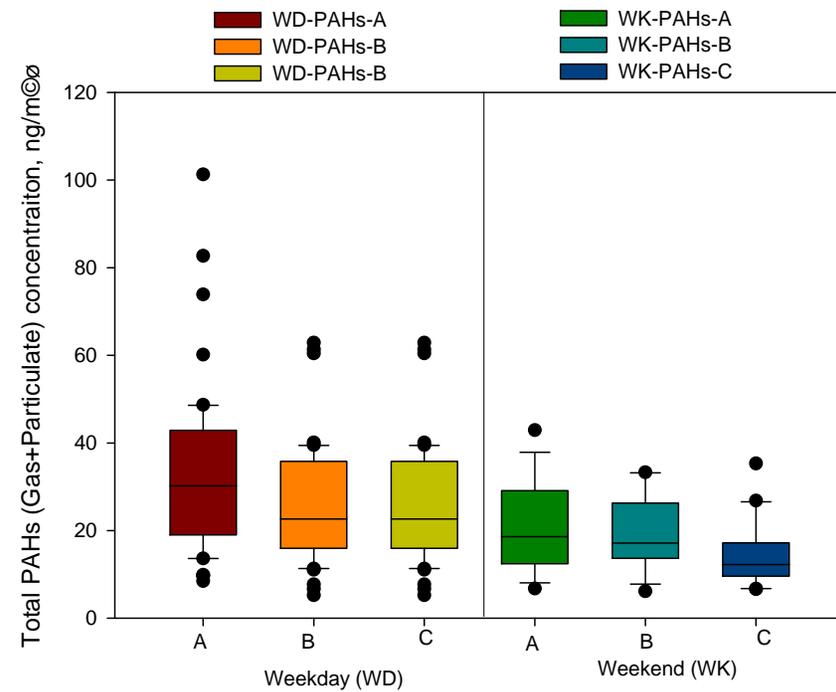

Seven of ten behave like Fe, Al

Ni and Zn behave opposite

Day of the week
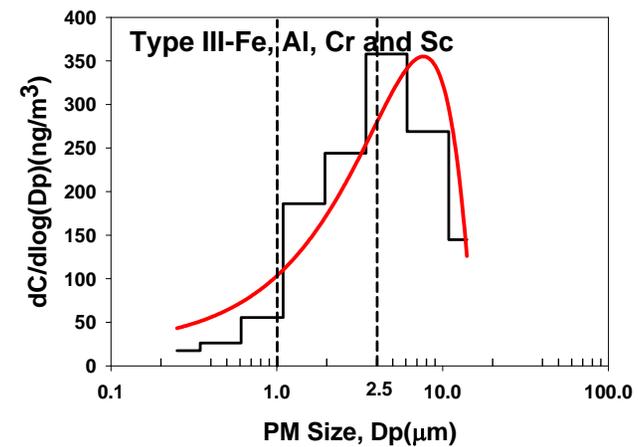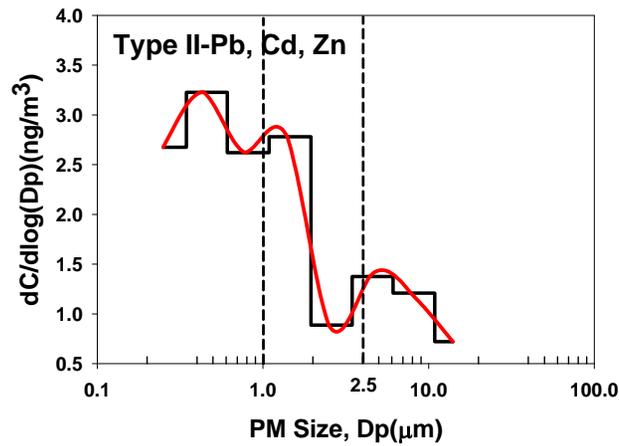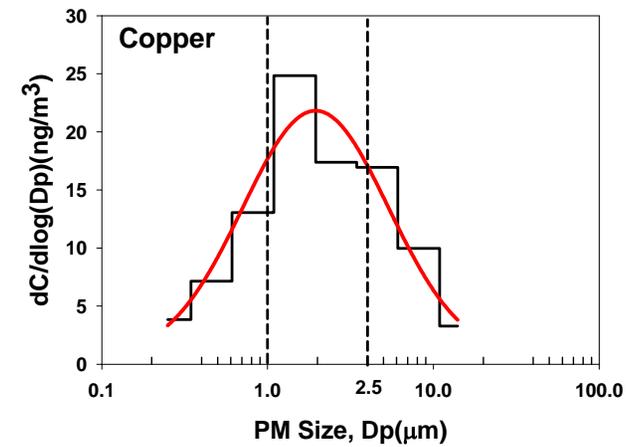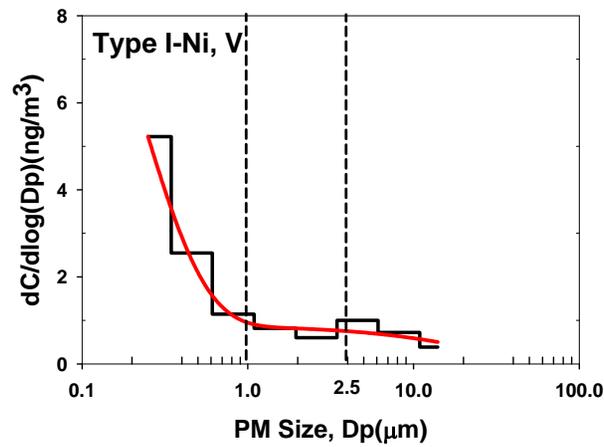
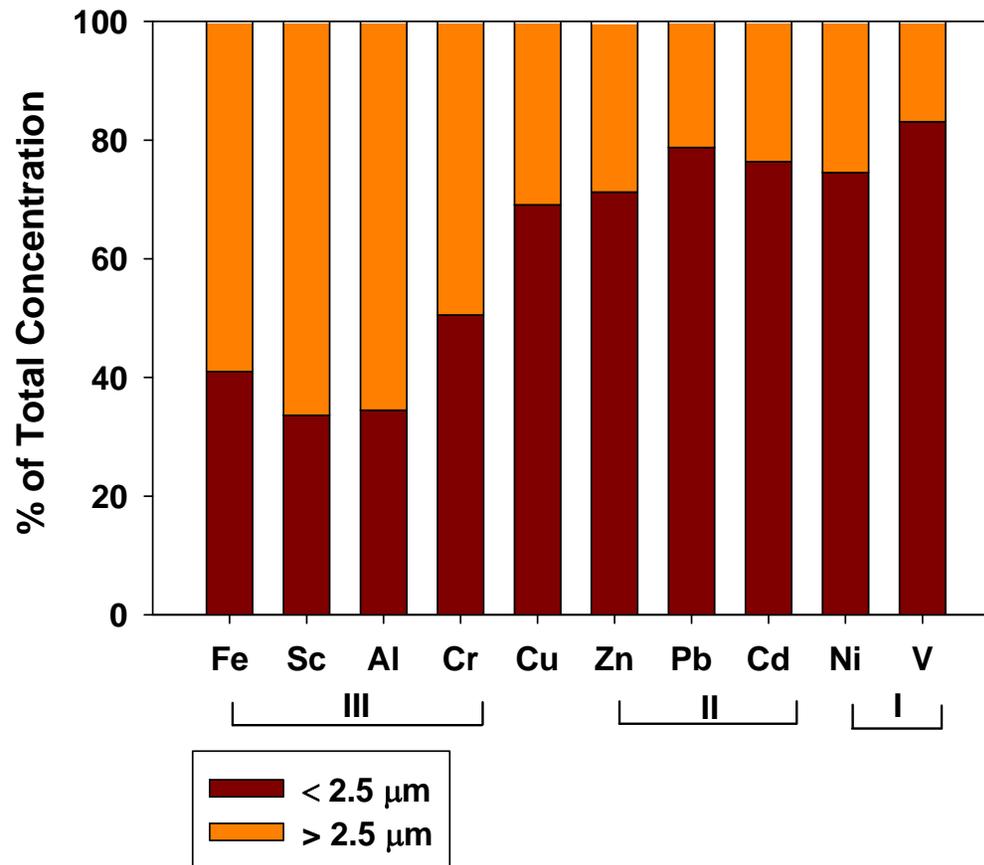# Effect of Day-of-Week on TSP and PAHs

Metal concentrations associated with particle size

Types of Trace Metal Size Distribution From Turnpike, NJ

Distribution of Individual Metals According to Size Fraction

Conclusions

- Near roadway emissions did not significantly affect the concentration of $PM_{2.5}$ mass

- There were no significant differences in seasonal $PM_{2.5}$ concentration ($p > 0.05$).

- The concentrations of TSP and PAHs at 50 m were higher than at 100 and 150 m.

- The higher TSP concentration was observed in the spring and summer compared to the fall and the winter ($p < 0.05$).

Conclusions (continued)

- Total PAHs concentrations were higher in the summer compared to winter at site A ($p < 0.05$).

- There was no distance gradient of trace metals associated with $PM_{2.5}$.

- Of the 10 metals, 7 were higher in the summer than winter, Ni and Zn were higher in the winter than summer.

- The distribution of metal concentrations associated with particle sizes followed 4 distinct patterns.

MERI Webpage

http://meri.njmeadowlands.gov/Current_Projects/