



Black Carbon Validation of a Novel Sensor for Traffic- Related Indoor Air Pollution

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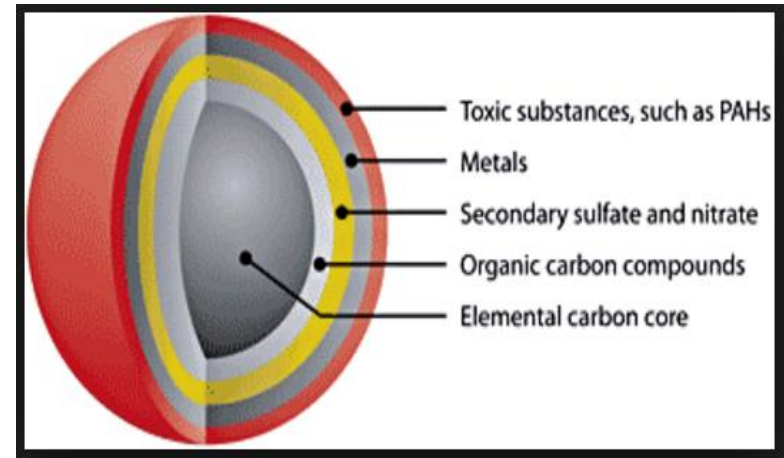


Traffic Related Air Pollution (TRAP)

Traffic Related Air Pollution (TRAP) emitted by gasoline and diesel-fueled compression engines

- Highly complex mixture of gases and vapors composed of
 - Elemental Carbon
 - NO_x
 - Volatile Organic Compounds (VOC)
 - Polycyclic aromatic hydrocarbons (PAH)
 - Major source of ambient PM_{2.5}

Diesel Exhaust Particle



<http://amicuscuria.com/wordpress/?p=685>

Indoor Air Quality



- **Infiltration of outdoor particles**

- Important source of indoor air pollution
- Almost 70% of U.S. workers are employed in non-industrial, non-agricultural indoor settings
 - 40 hours a week in office buildings

- 30% to 45% of people in large North American cities are likely to be inside one or more exposure zones
 - Exposure zone, is within a range of up to 300 to 500 meters from a major road and the area most highly affected by traffic emissions
- Approximately 11.3 million people (or 3.7% of US population) live within 150 meters of a major highway



Health Effects and NORA

Health Effects

- Exposure to traffic air pollution, results in an elevated risk of adverse health outcomes (CDC, 2013).
- Many studies have linked TRAP with reduced respiratory health and asthma symptoms, lung cancer and cardiovascular outcomes



National Occupational Research Agenda (NORA)

- This project aligned with the future goals for the NORA Indoor Environment Team (IET) which called for improved methods for measuring exposures and better understanding of the reduction of indoor exposure through environmental interventions.

Objective

- To test a novel device, AethLabs microAeth® Black Carbon (BC) sensor side-by-side with two other methods to provide a simple evaluation of indoor traffic-related air pollution within the Cincinnati region
 - Analysis of BC using an SKC PM2.5 filter
 - Analysis of BC using a MicroPEM™ PM2.5 filter

Novel Air Sampling Devices

microAeth
BC Direct Reading
Instrument



MicroPEM
PM2.5 Direct Reading
PM2.5 on a Teflon filter
BC on a Teflon filter



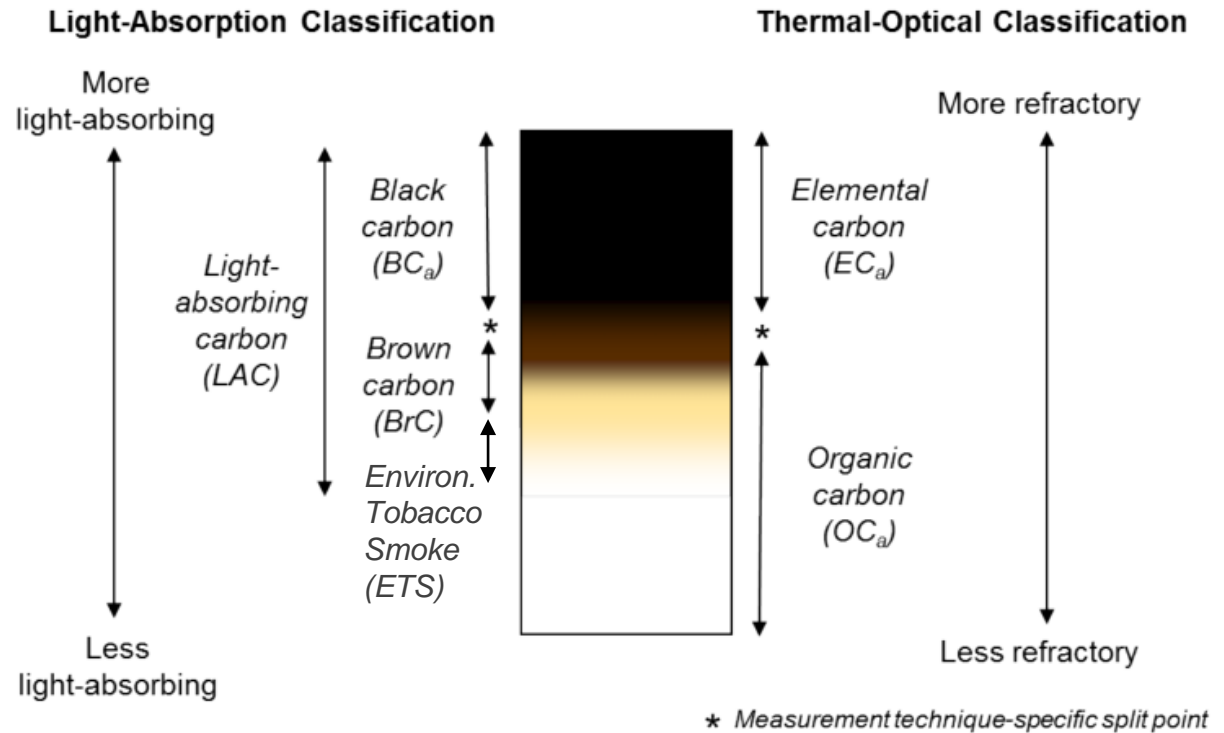
SKC
PM2.5 on a Teflon filter
BC on a Teflon filter



Research Triangle Institute (RTI) Micro-personal exposure monitoring (PEM) device is capable of direct reading measurement of PM2.5 with a simultaneous collection to a Teflon filter.

Black Carbon Analysis

- Teflon filter can be used for assessment of PM2.5 mass, black carbon (BC), brown carbon (BrC) and environmental tobacco smoke (ETS) using a multiwavelength optical absorption technique



Measurement of the Carbonaceous Components of Particles

Collaboration

- U.S. Housing and Urban Development (HUD) Healthy Homes Technical Studies (HHTS) Grant



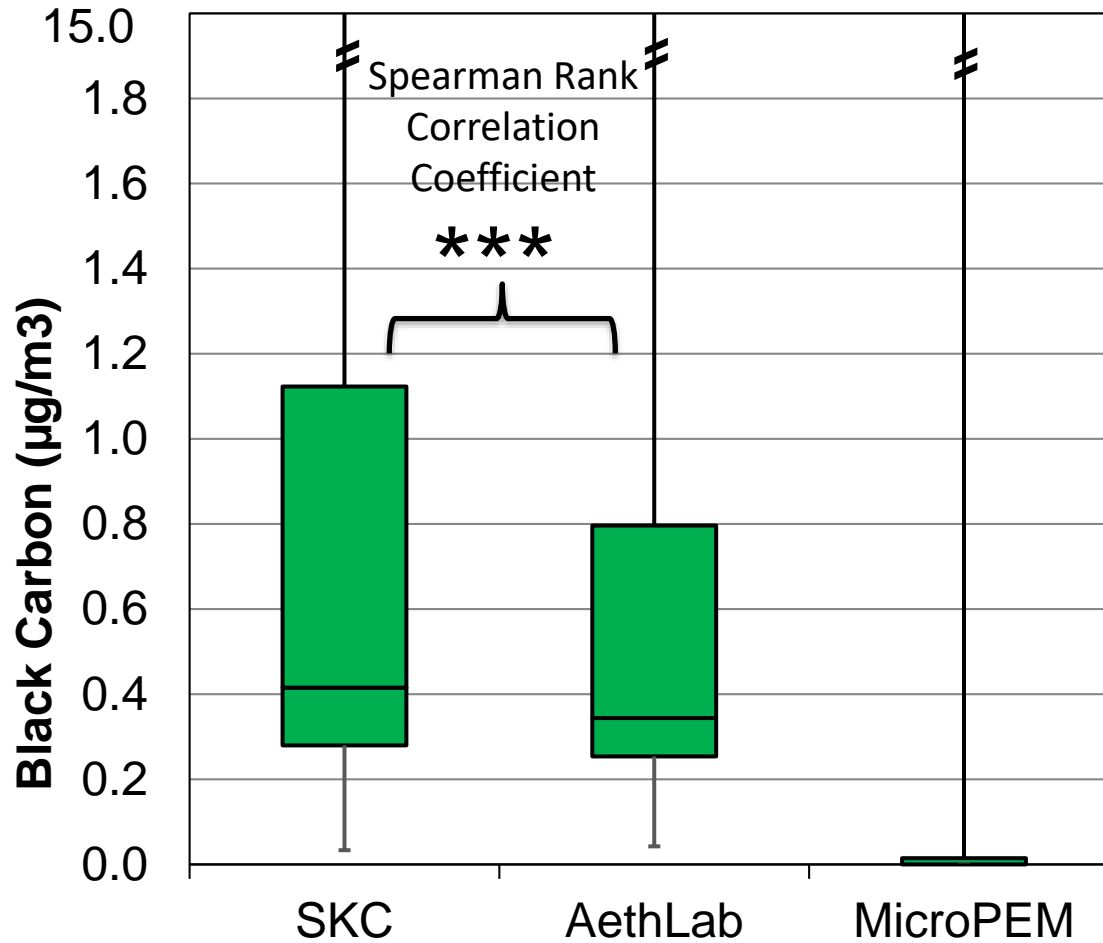
- Efficiency of HEPA air purification in reducing traffic-related particle exposures in the homes of asthmatic children residing near major traffic sources
- Recruitment of homes and coordination of sampling
- SKC PM2.5 and Black Carbon Analysis
- Sampling: In child's bedroom for 48 hours
- RTI International
 - MicroPEM devices provided at no cost

Specific Aim 1

- Determine the association between the averaged microAeth® BC sensor data and the BC concentrations collected on MicroPEM™ filter and SKC PM2.5 filter
- Hypothesis: To establish that the microAeth® BC sensor and the BC collected on MicroPEM filter and SKC filter would yield a correlation coefficient within 20% of one.

Black Carbon

n=30



***p<0.001

Black Carbon Analysis

Wilcoxon rank-sum test and Spearman Rank Correlation Coefficient

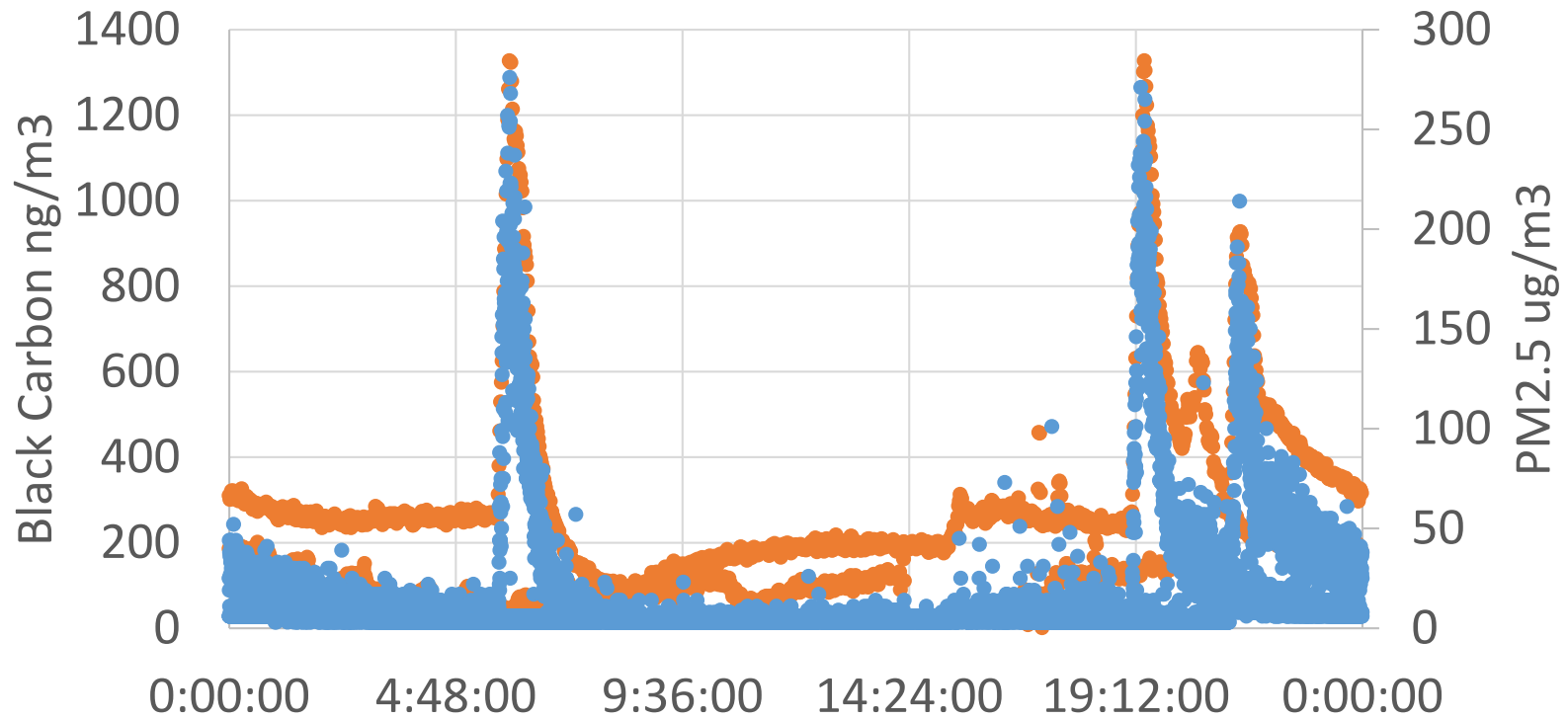
	Averaged microAeth® Black Carbon Sensor	SKC Black Carbon Filter	MicroPEM™ Black Carbon Filter	
Averaged microAeth® Black Carbon Sensor		p=0.51	p<0.001	Wilcoxon
SKC Black Carbon Filter	r=0.80, p<0.001		p<0.001	
MicroPEM™ Black Carbon Filter	r=0.12, p=0.54	r=-0.07, p=0.71		
Spearman Rank Correlation Coefficient				

Specific Aim 2

- Determine the association for the real-time data from the MicroPEM™ PM2.5 and the microAeth® BC sensor in the Cincinnati region for indoor air.
- Hypotheses:
 - Patterns over the 2 day period will fluctuate and the devices will mimic each other.
 - It is expected that a correlation coefficient within 20% of 1 will be determined.

Real Time Data

Home 25 Visit 2

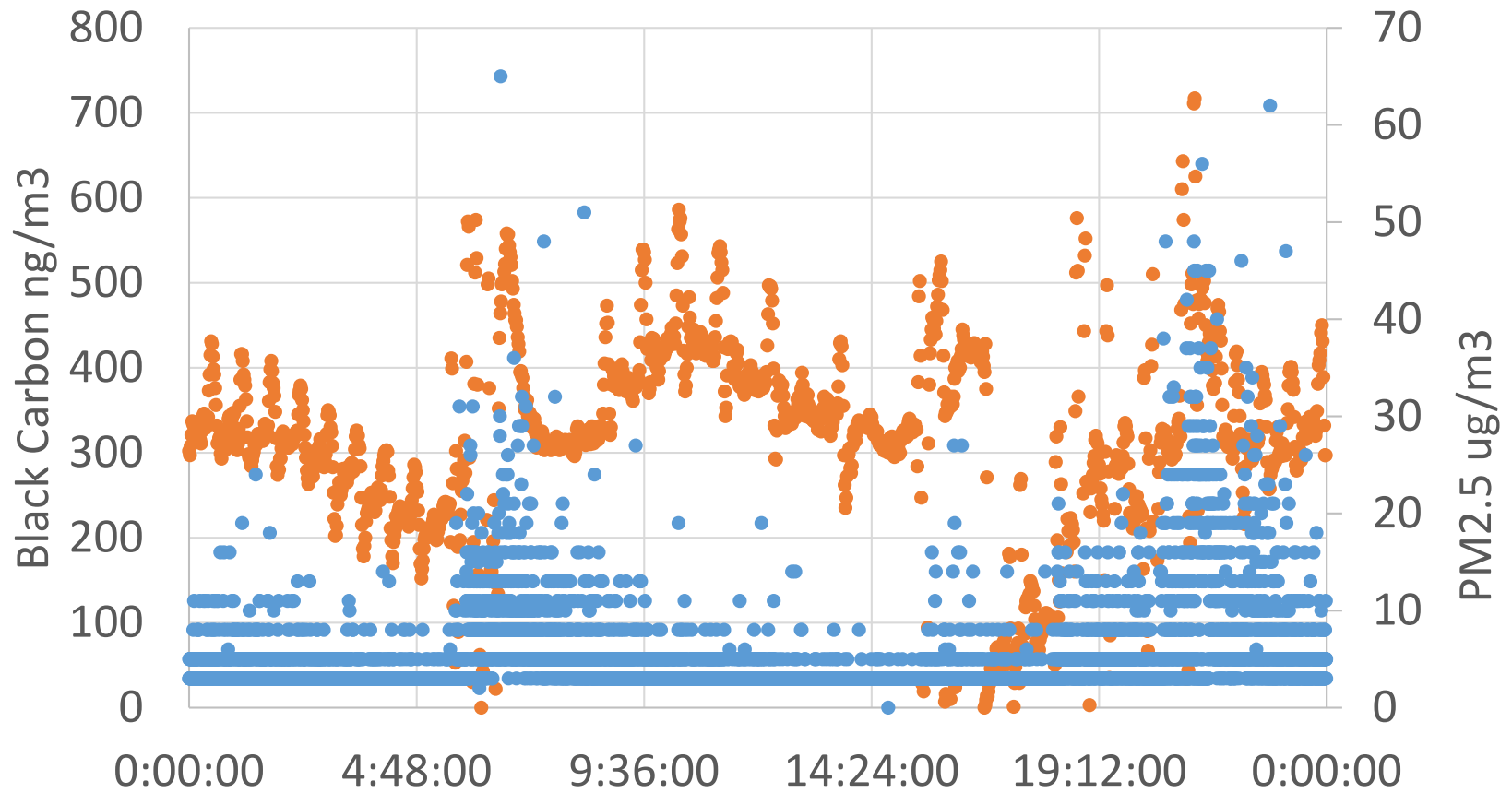


48-hour overlapped midnight to midnight

• microAeth BC • MicroPEM PM2.5

Real Time Data

Home 2 Visit 6



48-hour overlapped midnight to midnight

● microAeth BC ● MicroPEM PM2.5

Real Time Data

- Trend: both PM2.5 and BC tend to spike around 6:00-7:00am, 7:00-8:00pm and 9:00-10:00pm
- Spearman Rank Correlation Coefficient:
 - **p<0.01** for 21 of 30 paired data sets
 - Correlation coefficients ranged from low to high (r = -0.05 to 0.70, average 0.05)
- Wilcoxon:
 - All were significantly different **p<0.001**

Conclusions

- SKC filter BC results validated the AethLab Real Time Sensor data
 - Within 20% of one for the correlation coefficient
 - MicroPEM filter collection would need a longer sample time to reach sufficient volume to validate the AethLab Real Time BC Sensor data
- AethLab BC Real Time data and MicroPEM PM2.5 Real Time data had similar trends
 - Significantly correlated with varied correlation coefficients

Impact of Results

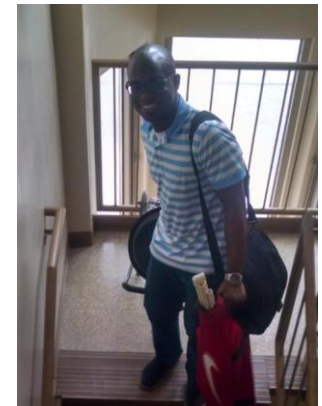
- AethLab will provide a easy and cost-effective tool to monitor indoor air quality
- This data provides direction for the future:
 - Evaluate if the AethLab is validated with traditional Elemental Carbon quartz filter analysis

R2P Potential & Research to Future Funding

- Practicing Industrial Hygienists could potentially use this device instead of multiple devices and with no laboratory analysis costs
- Further research could include evaluating occupational locations for TRAP by using the AethLab at:
 - Older schools, offices, and manufacturing locations in high traffic areas could rely on open windows for ventilation, leading to increased exposure to outdoor air traffic-related pollution.

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Thank you!



Any Questions?