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Update on the Detroit Exposure and Aerosol Research Study (DEARS)

Where we have been….Where we are…Where we are going.

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U.S. Environmental Protection Agency, RTP, NC

2008 US-Canada Meeting
October 29, 2008

DEARS Impact

- Improvement of OAQPS risk estimates
- Local and regional source apportionment
- Linked epidemiological study (Healthy Heart)
- US-Canada air quality issues
- Support of the US NAAQS
- Physical factors research
- Environmental factors research
- Detroit community interests
- Human exposure modeling
- Air quality modeling
- Michigan SIP assistance
- Near-road research
- Air toxics research

Data Calendar of Events

- Completion of field data collection (March 2007)
- Recovery of final season of raw data from contractor (July 2007)
- Validated datasets by fall 2008 with exception of XRF and secondary measurements (such as real-time nephelometry). Some updates will be necessary (such as those for the carbonyls) after this time frame.
- XRF and other later arriving datasets to be integrated as available during 2009-2010

Data Analysis Phases

The DEARS data analysis plan has a four tiered analysis structure. These are:

1. Performing descriptive statistics, validating individual datasets, and establishing the relationships between various spatial measurements
2. Use of various modeling approaches to integrate factors and ancillary data influencing the relationships established above
3. Data from 1 and 2 above will be integrated into PM and air toxics human exposure modeling development.
4. Data from 1 and 2 above, along with original data will be used to perform source apportionment modeling

Detroit Study – Progress

- Mobile Source Characterization-near road emphasis-Ambassador Bridge and SouthField Freeway
- Detroit Children's Health Study, including MICA (Mechanistic Indicators of Childhood Asthma)
- Detroit Healthy Heart (Detroit Cardiovascular Health Study-University of Michigan)
- Detroit Tox Study (Hi Vol Trailer)
- Evaluation of biogenic markers for PM (carbon -14)
- Secondary Organics data collections
- Health Canada and Environment Canada collaborations (like the CRUISER)

Initial Articles

- EC Impacts near Ambassador Bridge
- Study Design and implementation
- Effective distances
- Recruiting and retention
- Monitoring compliance
- Personal clouds, infiltration, spatiality
- Coarse PM
- VOC relationships

NO_2 Findings

- Poor relationship with ambient measures
- High degree of inter-personal variability
- Seasonal effects
- Household and environmental effects

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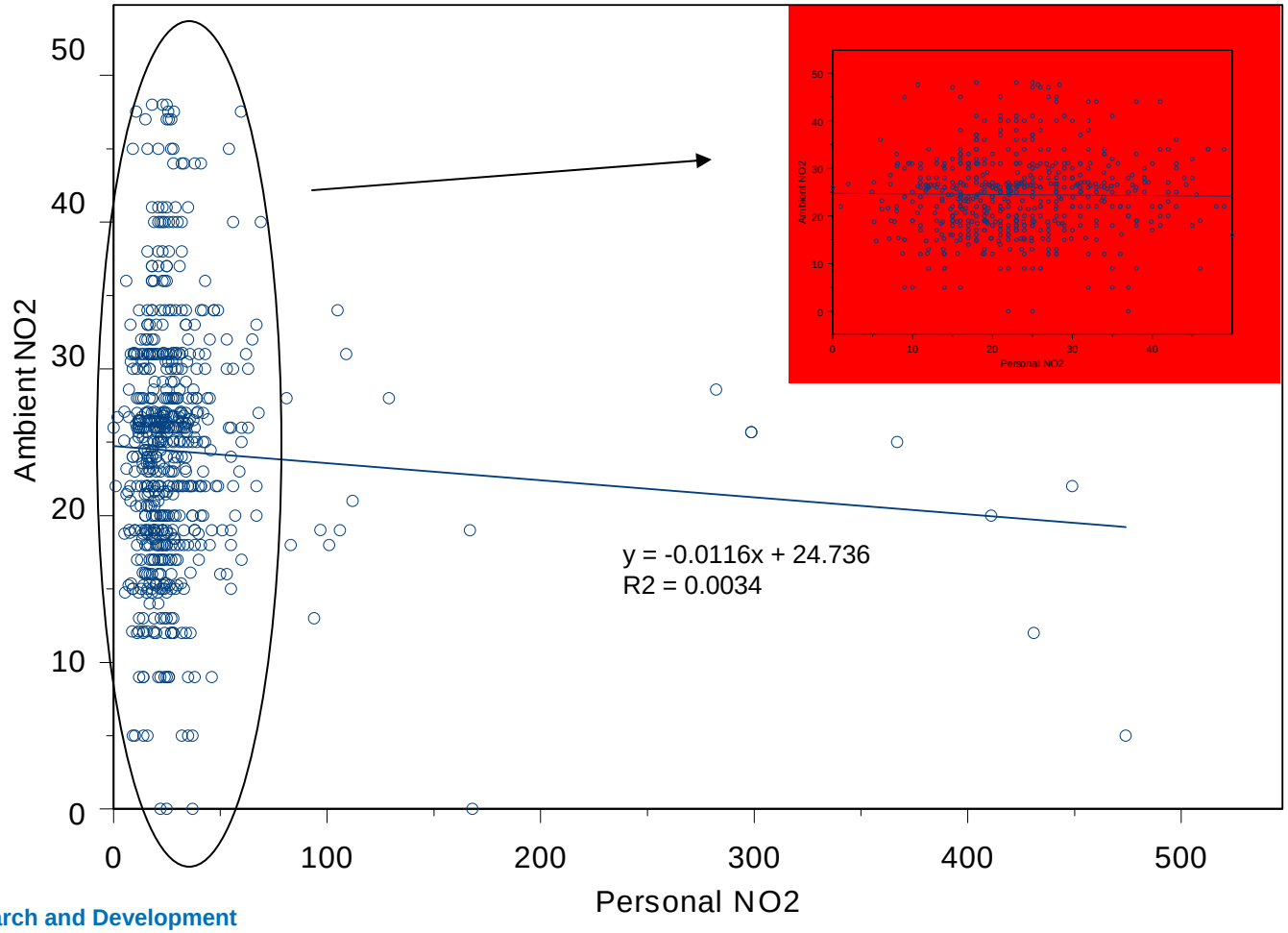
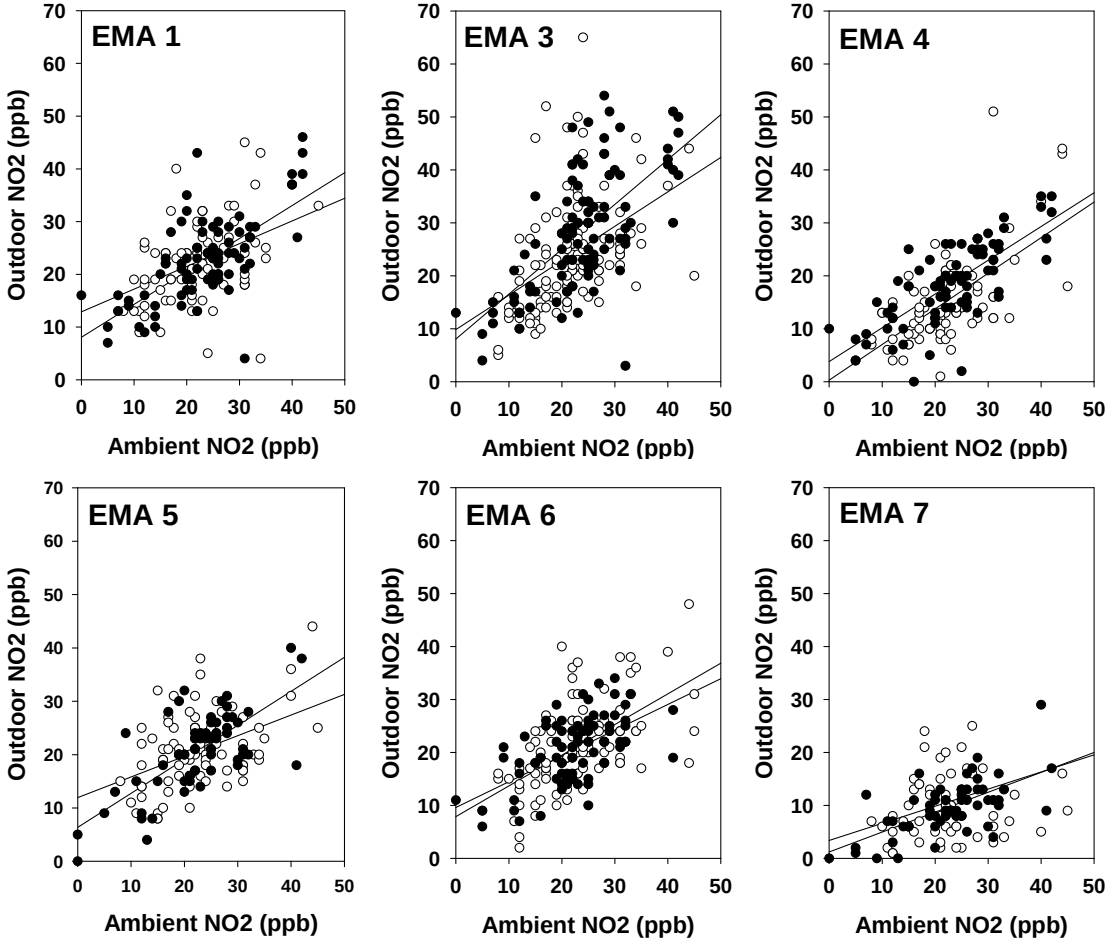
Personal and Ambient NO_2 Mass Concentration Relationships (ppb)



Seasonal Differences in Temporal-Spatial Variation



Regression Slopes

EMA	Summer	Winter
1	0.43	0.62
3	0.65	0.85
4	0.67	0.64
5	0.39	0.64
6	0.58	0.49
7	0.32	0.38

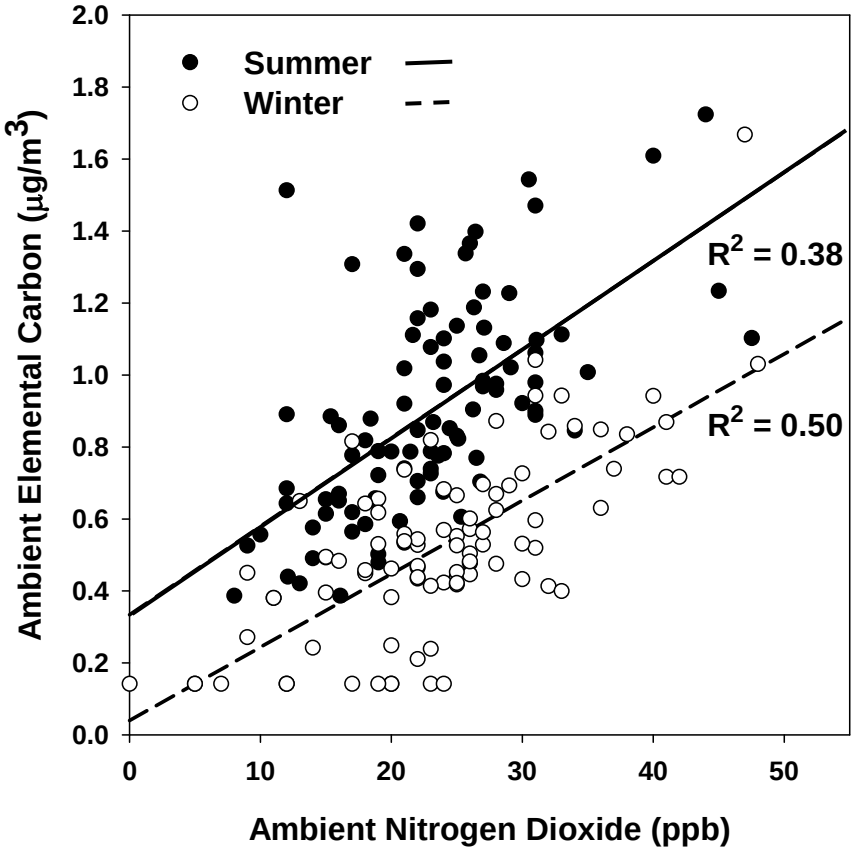
Coefficient of Determination (R^2)

EMA	Summer	Winter
1	0.17	0.46
3	0.20	0.42
4	0.39	0.56
5	0.17	0.50
6	0.30	0.35
7	0.05	0.40

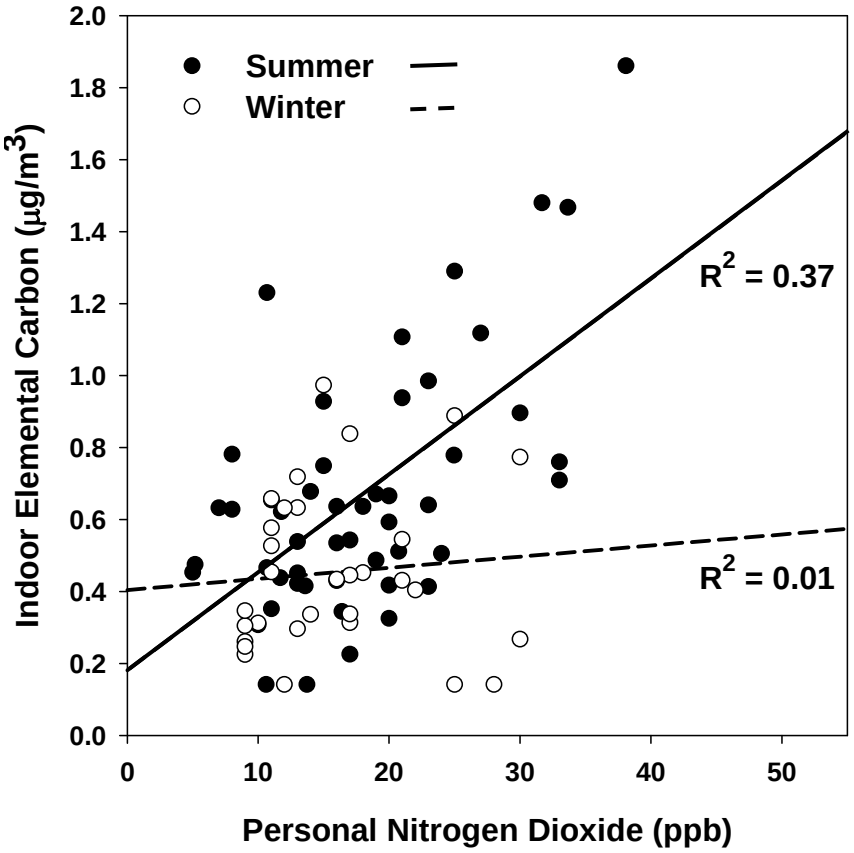
What Impacts NO_2 Exposures?

- Use of air cleaners
- Candles
- Central Air
- Cooking events
- Opening doors
- Use of dryer pilot light
- ETS exposures
- Fuel choice
- Use of kitchen fans
- Furnace pilot light
- Water heater pilot lights
- Fireplaces
- Gas heat
- Use of heat
- Gas space heater
- Use of window AC units
- Opening windows

NO_2 Relationships



97 Summer measurements
89 Winter measurements

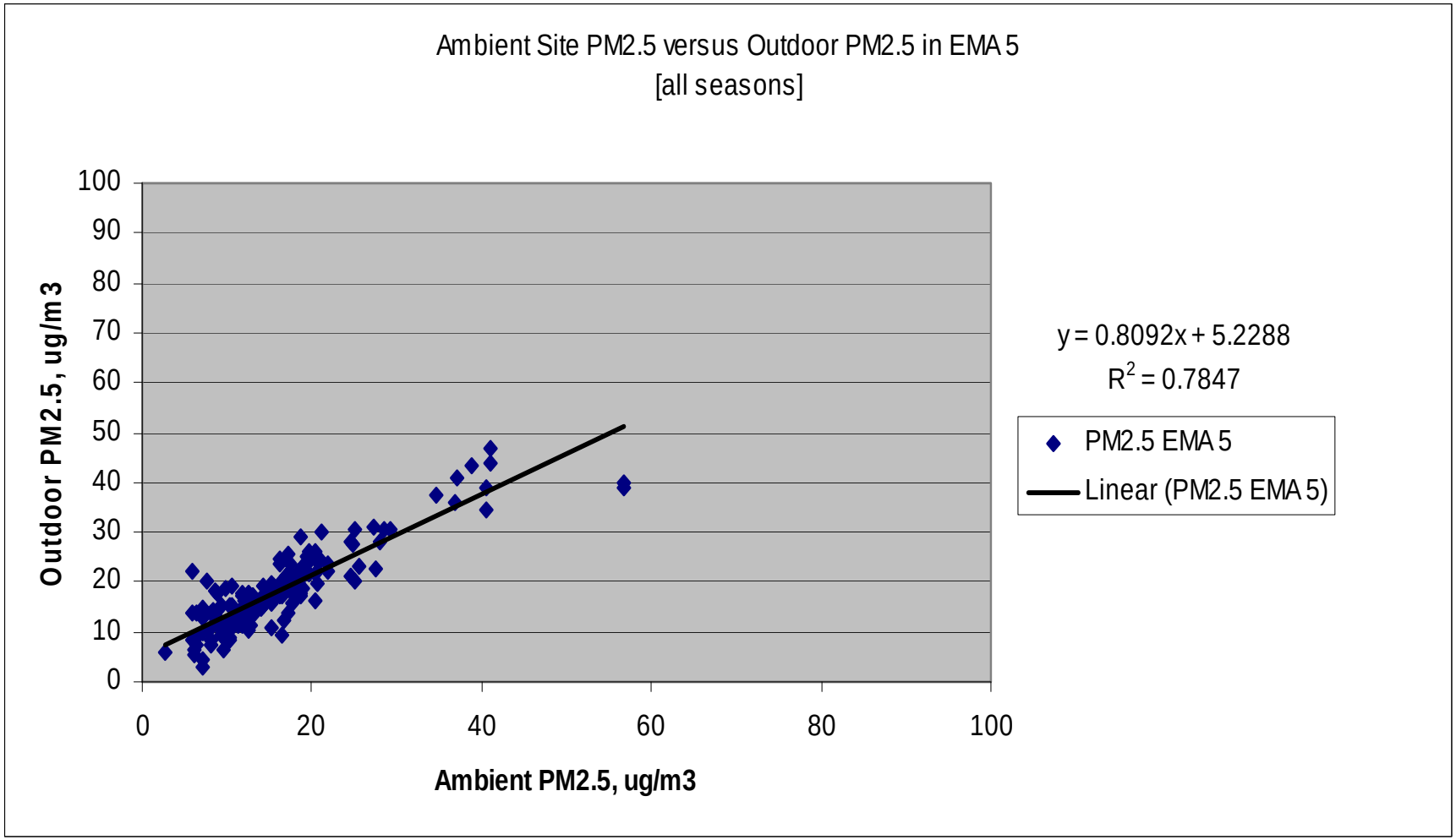


50 Summer measurements
31 Winter measurements

PM Mass Findings

DEARS Season #	Season	Arithmetic PM mass means (standard deviations), all participants, all EMA's					
		$PM_{2.5}$					$PM_{10-2.5}$
		Personal	Indoor	Outdoor	Central	Dichot	Dichot
1	summer	18.4 (15.3)	17.6 (15.5)	15.8 (10.1)	16.7 (11.2)	13.3 (7.1)	6.5 (3.1)
2	winter	13.3 (15.7)	10.5 (9.4)	17.5 (15.5)	17.8 (14.8)	18.1 (14.4)	9.0 (4.2)
3	summer	24.2 (22.3)	20.5 (12.0)	19.0 (9.9)	20.4 (11.3)	18.5 (9.5)	10.4 (4.0)
4	winter	23.6 (31.9)	22.9 (32.8)	14.1 (6.8)	13.1 (6.1)	13.0 (6.5)	7.7 (3.5)
5	summer	22.2 (17.5)	21.2 (20.5)	17.0 (8.3)	16.8 (7.9)	15.5 (7.6)	8.2 (2.4)
6	winter	25.6 (30.1)	17.7 (16.7)	14.7 (7.9)	15.2 (7.4)	15.4 (7.4)	11.9 (6.6)
	summer mean	21.6 (n=192)	19.8 (n=197)	17.3 (n=201)	18.0 (n=205)	15.7 (n=199)	8.3 (n=201)
	winter mean	20.8 (n=144)	17.0 (n=93)	15.4 (n=181)	15.4 (n=183)	15.5 (n=182)	9.5 (n=182)

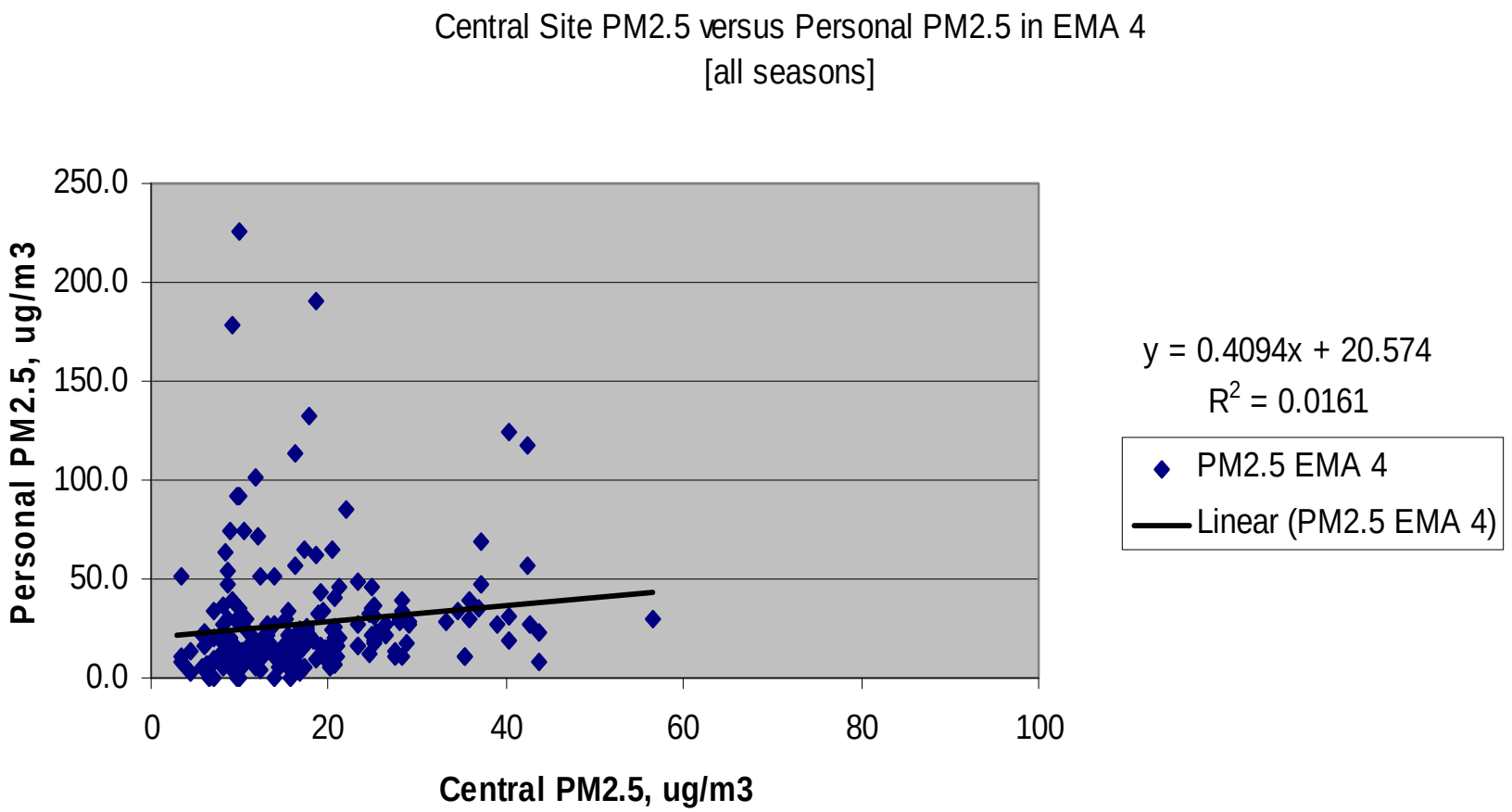
PM2.5 Central Site Mass Versus EMA 5



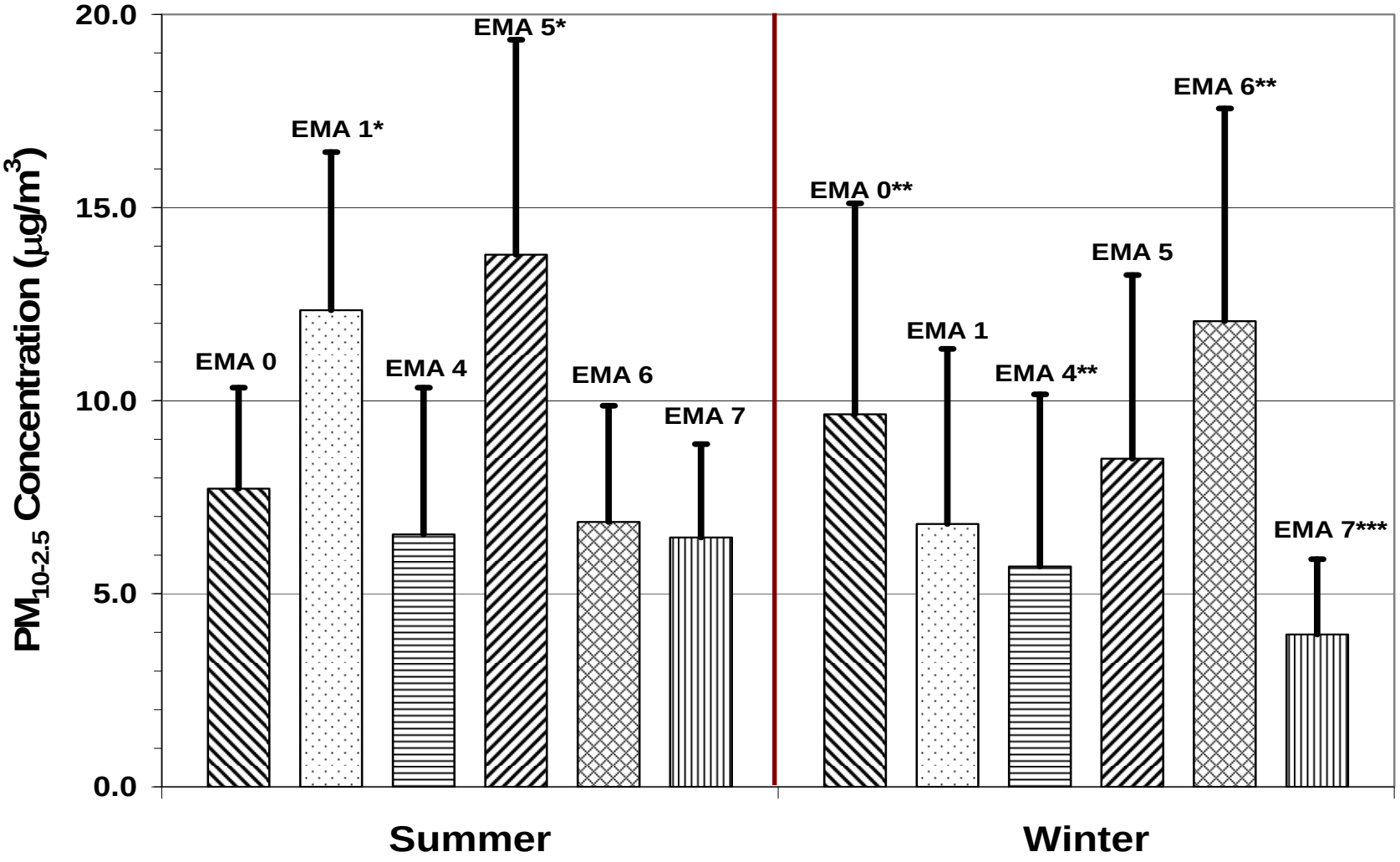
$PM_{2.5}$ Infiltration and Personal Exposure

Season	F_{inf}	F_{pex}
Summers	0.81	0.78
Winters	0.59	0.59

Central Site Versus Personal Exposures



Seasonal and Spatial PMcoarse Variability



Ambassador Bridge Impacts

- EC impacting the local neighborhood

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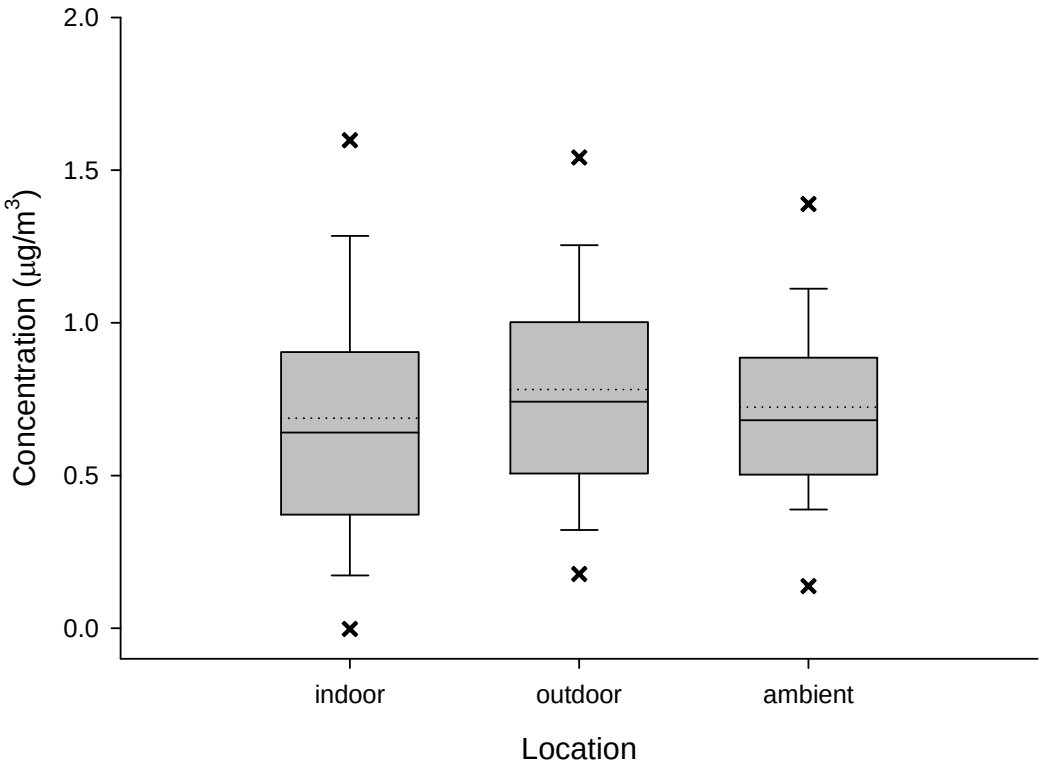
Results: Distributions of indoor, outdoor, and ambient concentrations of EC



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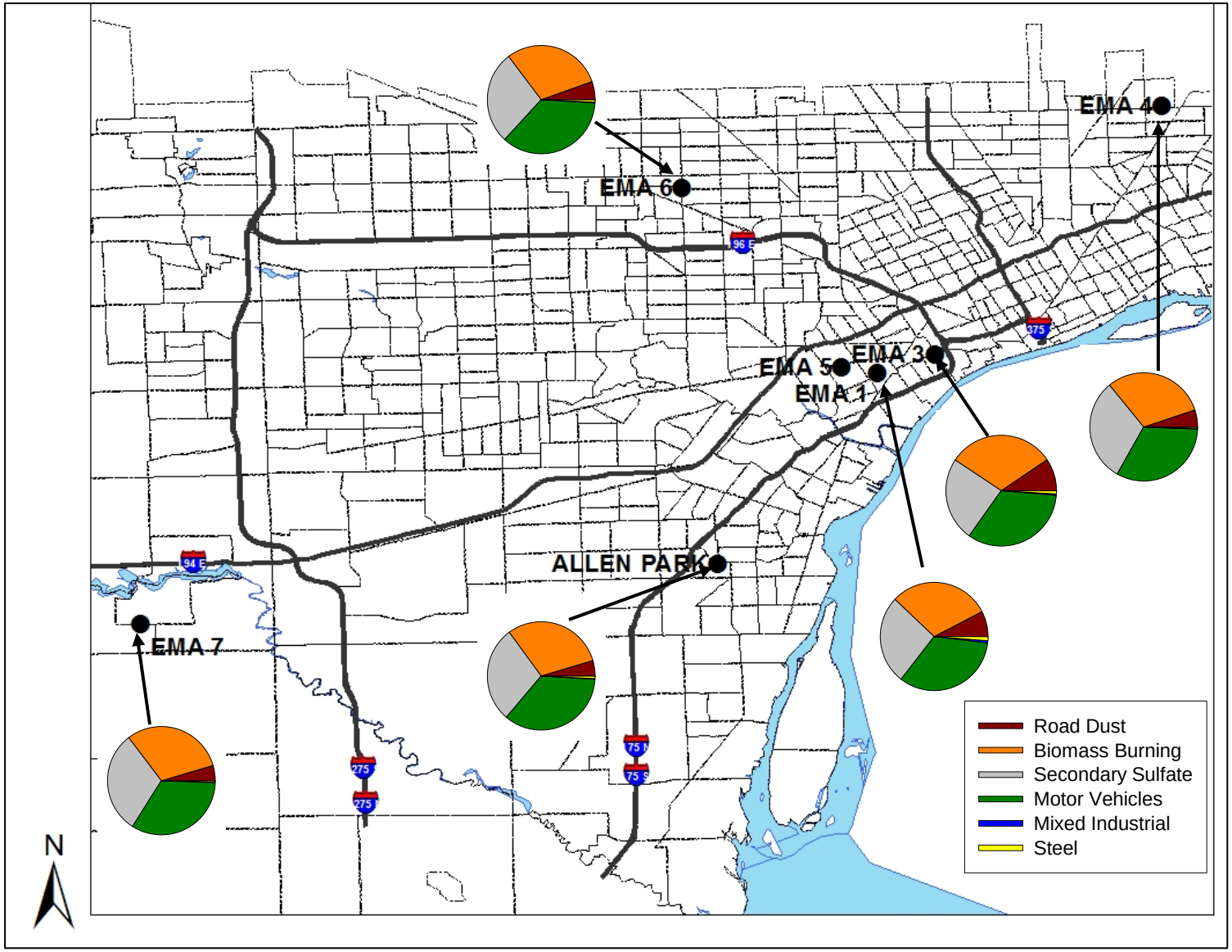
Results: Indoor-outdoor, indoor-ambient, and outdoor-ambient EC associations

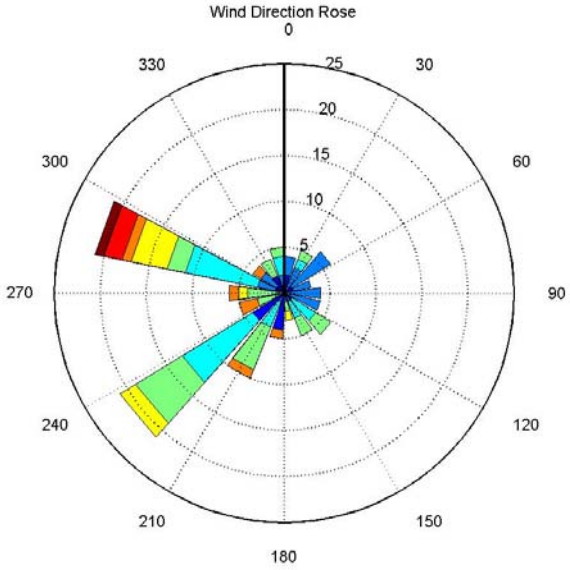
Model	R^2
log(Indoor) = log (Outdoor)	0.66
log(Indoor) = log (Ambient)	0.49
log(Outdoor) = log (Ambient)	0.53

*R^2 was calculated using a method developed by (Xu 2003) for random intercept mixed models

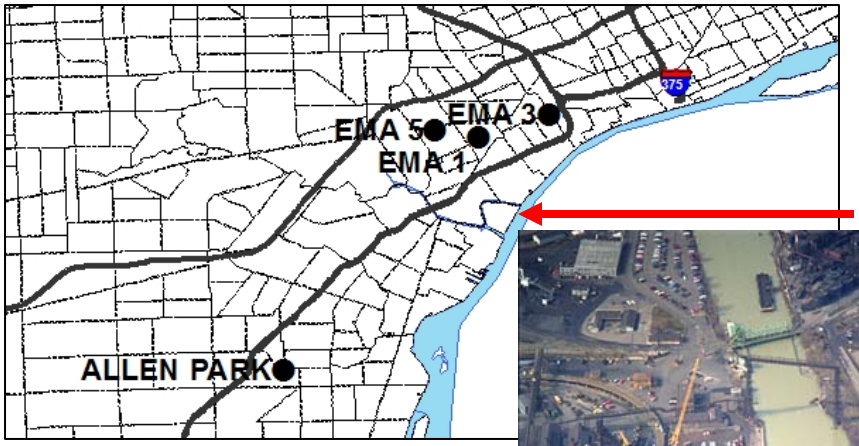
Figure: Average Source Contributions (in %) for DEARS Season 1 to 4

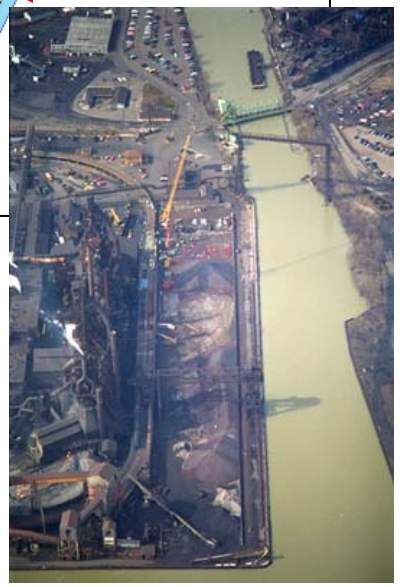


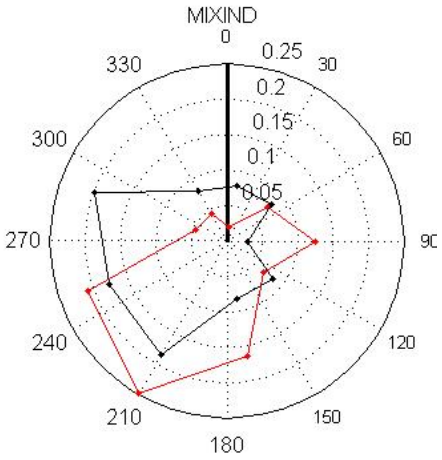
Local Transport of Sources – DEARS EMA 1

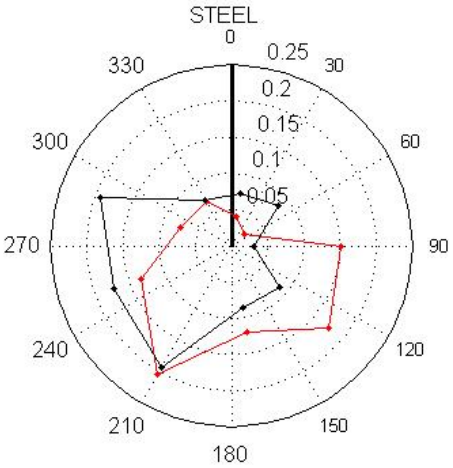


Plots represent average of mixed industrial and steel sources for Seasons 1 to 4. EMA 1 is impacted by industrial sources located southwest/west of the site.









EPA Air Pollution Transport to Receptor (APTR) wind rose plot for SEAS Particulate Matter Iron showing impact of Detroit (northwest) and Canadian sources (east). Crimson and red concentration percentile blocks indicate high concentrations. The receptor site is situated at Micmac Park, Windsor, Canada.

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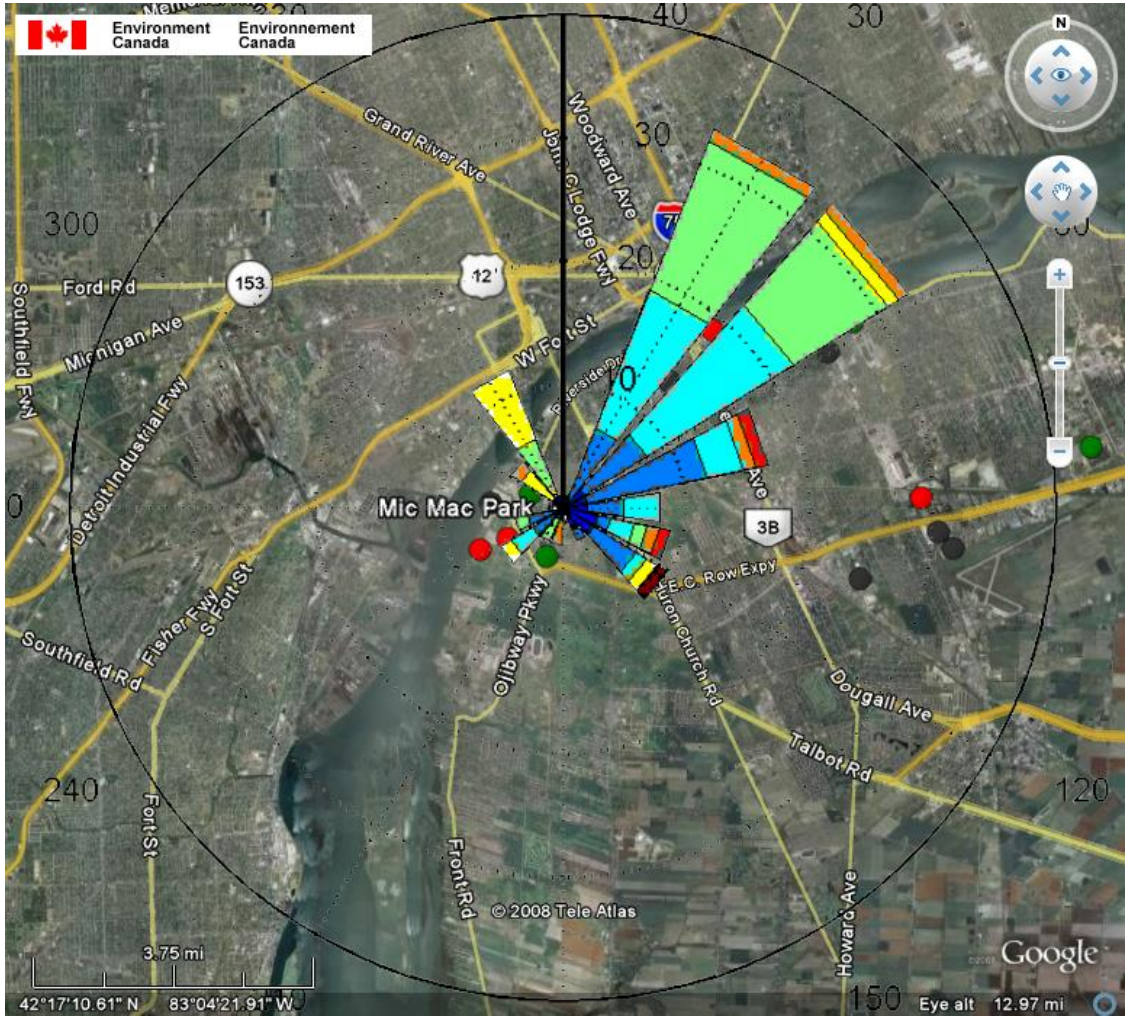
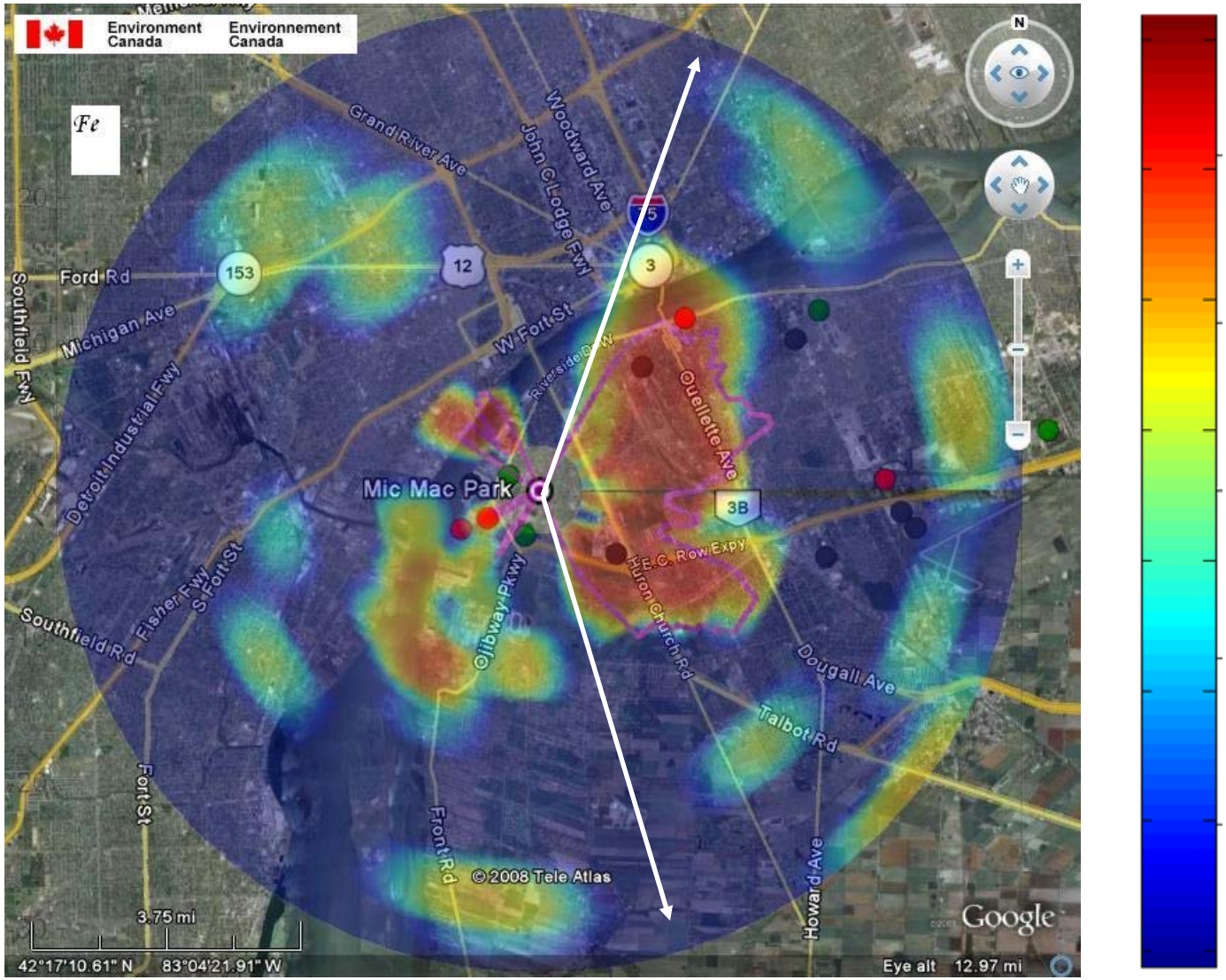


EPA APTR plot of **source region density function** for SEAS Particulate Matter Iron showing impact of Detroit (north & northwest) and Canadian sources (south-west and east).

All impacts below the median value are blue while colors higher than blue on the color bar indicate an increasing impact from the source region.

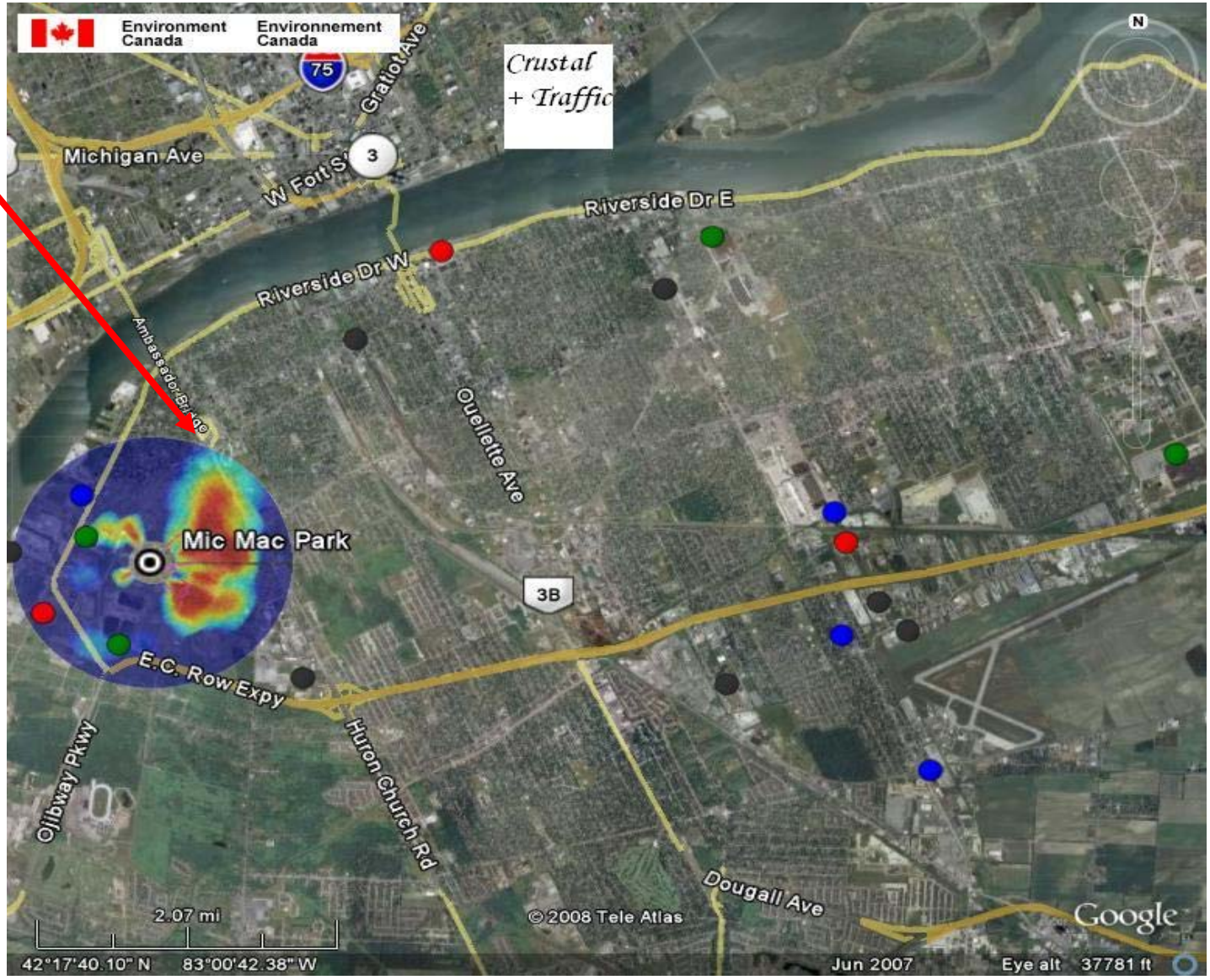
Caution: The presence of hot spot reflects on the entire sector, all sources near and far and is not limited to the region where the hot spot appears.

In this image, the large area of significance in the east includes even the farthest green spot in the east.



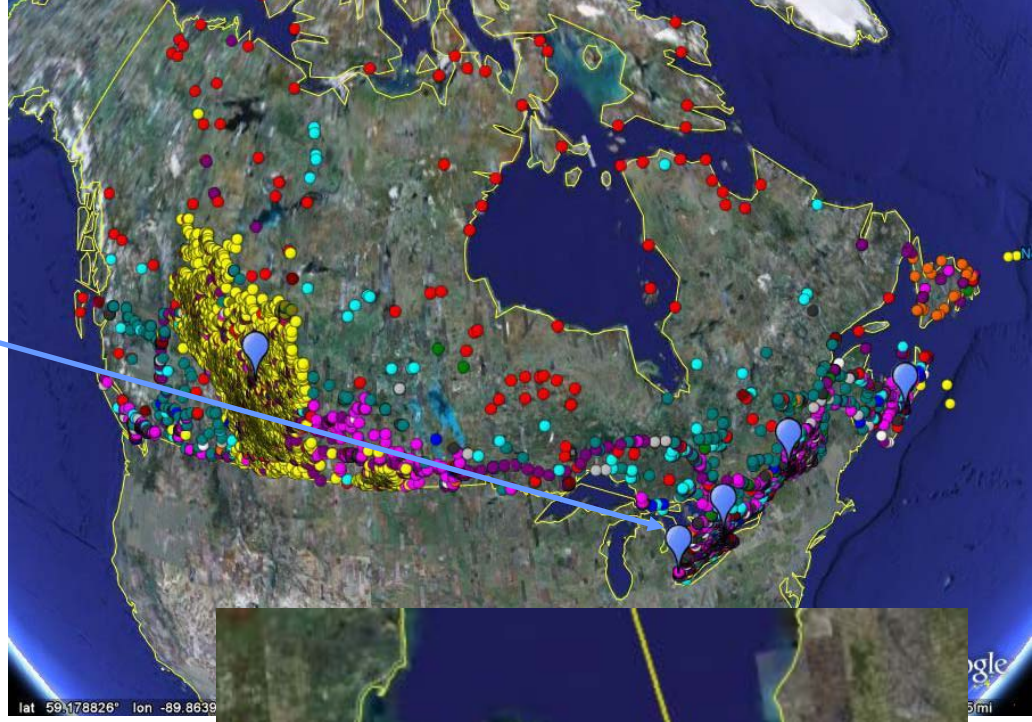
EPA APTR Plot for Crustal & Traffic Sources showing the impact of **Ambassador Bridge Traffic** (Source Contribution output from EPA PMF 3.0)

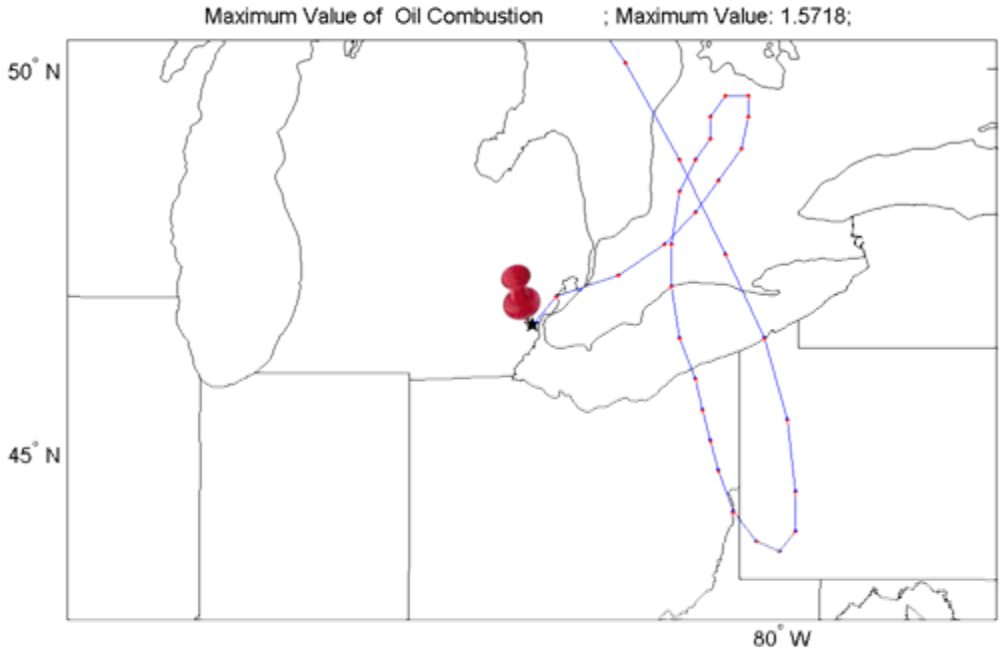
PMF Data
SEAS (samples analyzed by EPA HR ICP-MS), AMS, Aethalometer, PM2.5 (Grimm)

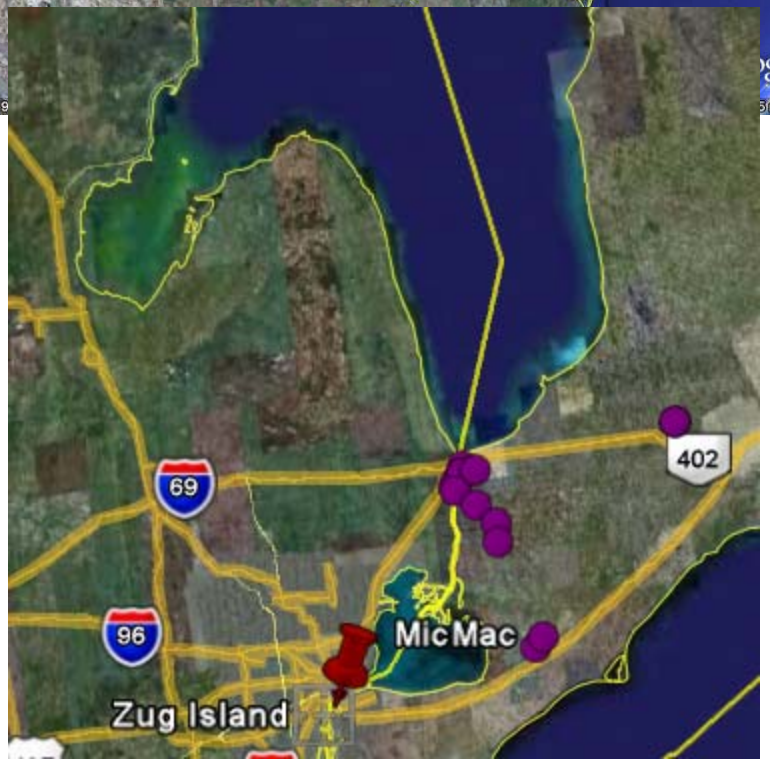


EPA will be adding Canadian Back Trajectory Data for 5 sites (blue balloon markers) to EPA APTR (2000 to 2007).

The figure below shows the trajectory associated with the highest EPA PMF oil combustion impact. The air mass passes over a number of oil refineries (purple).







Acknowledgements

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