

IMPROVED CHARACTERIZATION OF THE REAL-WORLD CONTRIBUTIONS OF NON-TAILPIPE PARTICULATE MATTER EMISSIONS

Greg Evans, Cheol H. Jeong, Christi Jose, Nicole Trieu, Xing Wang, Yee-Ka Wong

Southern Ontario Centre for Atmospheric Aerosol Research,
University of Toronto, Toronto, Ontario, Canada

SOCAAR

southern ontario centre for atmospheric aerosol research



UNIVERSITY OF
TORONTO

Overarching Approach and Aims

Develop, evaluate and combine methods to assess exposure to non-tailpipe particulate matter

1. Characterize temporal patterns of non-tailpipe particulate matter
2. Disentangle spatial patterns using complementary approaches
3. Improve methods to differentiate between tailpipe and non-tailpipe particulate matter
4. Identify non-tailpipe in microenvironments to guide future health studies.

Methodology

Data Collection

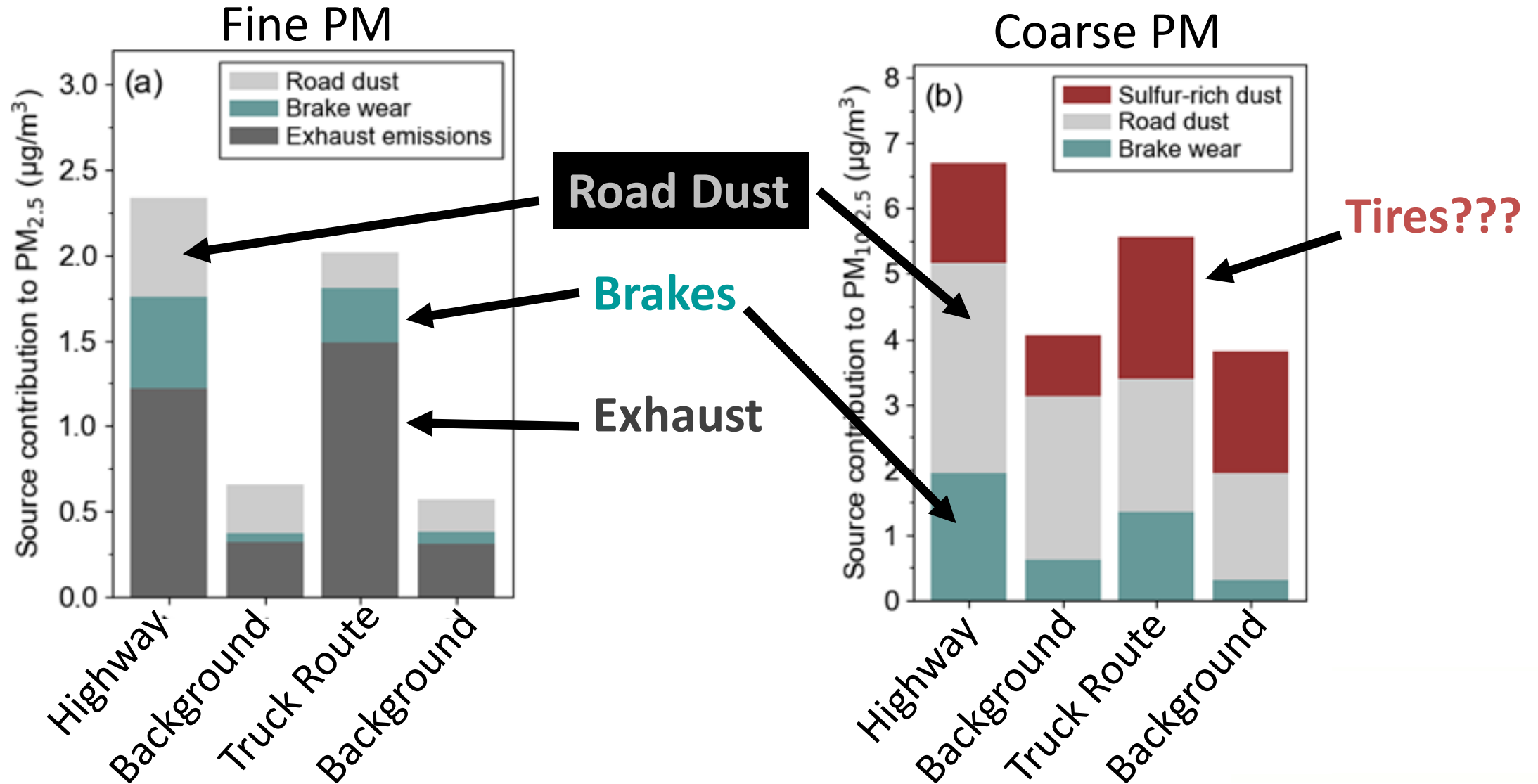
- Fixed site sampling (40 sites, 3 seasons)
 - 24h filter samples
 - High time-resolution instruments
- Mobile sampling (11,000+ km of driving)
- Hotspot sampling

Data Analysis

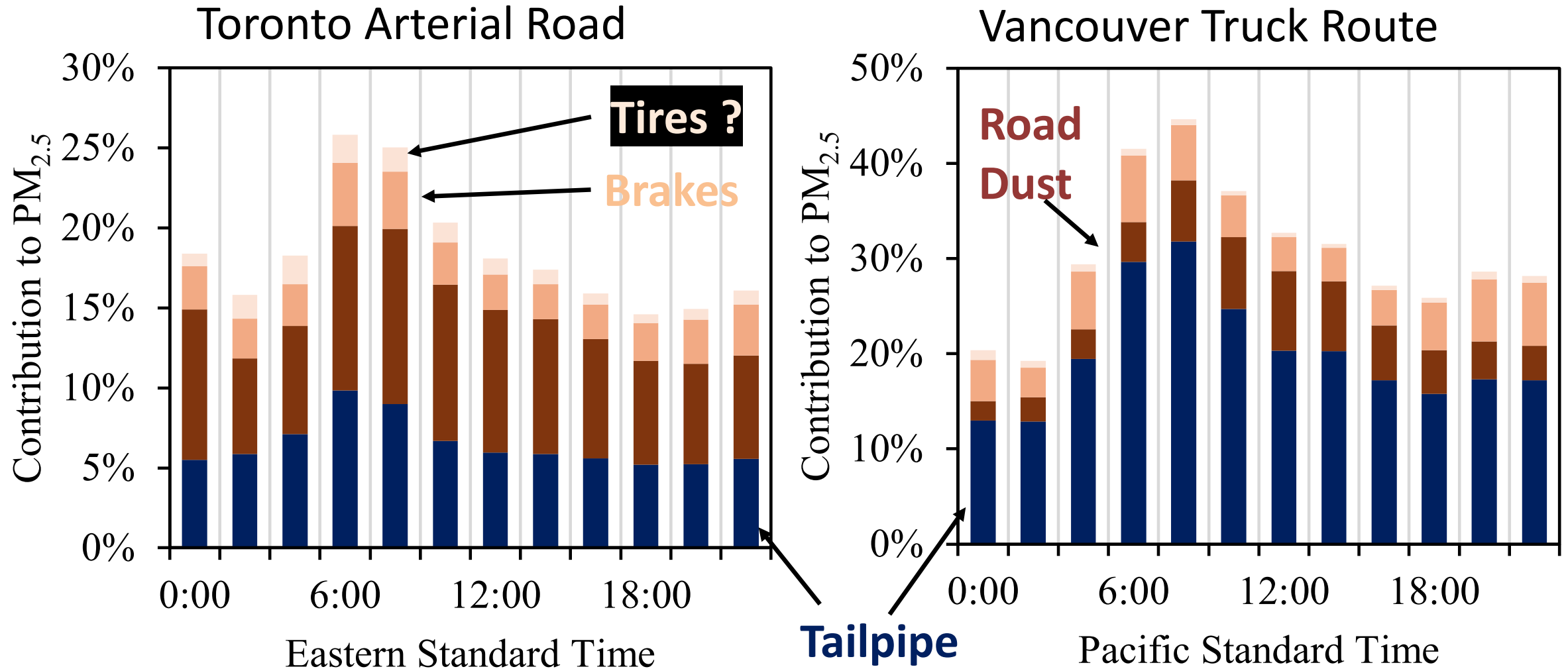
- Source Apportionment
- Land Use Regression
- Combinations



What is the contribution of non tailpipe emissions?



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City	Toronto		Vancouver	
Location	Highway	Downtown	Truck Route	Truck Route
Method	Filter	Instrument	Filter	Instrument
Exhaust	14%	7%	25%	20%
Brake Wear	6%	3%	5%	5%
Road Dust	7%	6%	3%	5%
Tires	<1.3%	<1%	< 1%	<1%

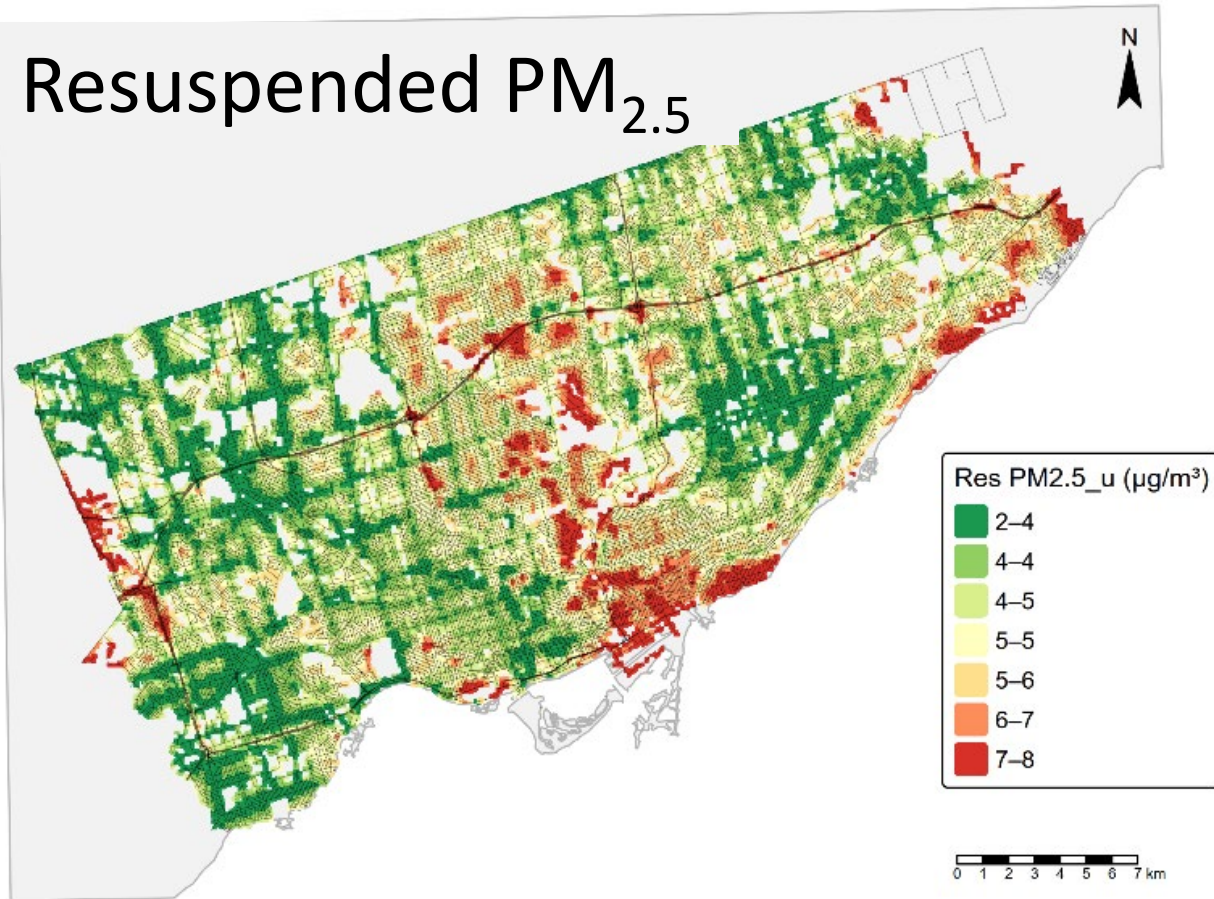
Percent of particulate matter mass (PM2.5)

How Much do Tires Contribute?

- **< 1 to 2%** in fine particles based on zinc rich source resolved by receptor modeling (similar at background site)
- **< 5%** in fine or coarse particles beside roads based on measurement of rubber
 - Multiplied by 4 to estimate tire and road wear contribution
 - Tire and road wear concentration in fine particles was similar ($\approx 0.2 \mu\text{g}/\text{m}^3$) independent of traffic volume.
- **<20 to 30%** in coarse PM, based on sulfur rich source
 - Higher at near road than background sites
 - May be due to SO_2 depositing on road dust

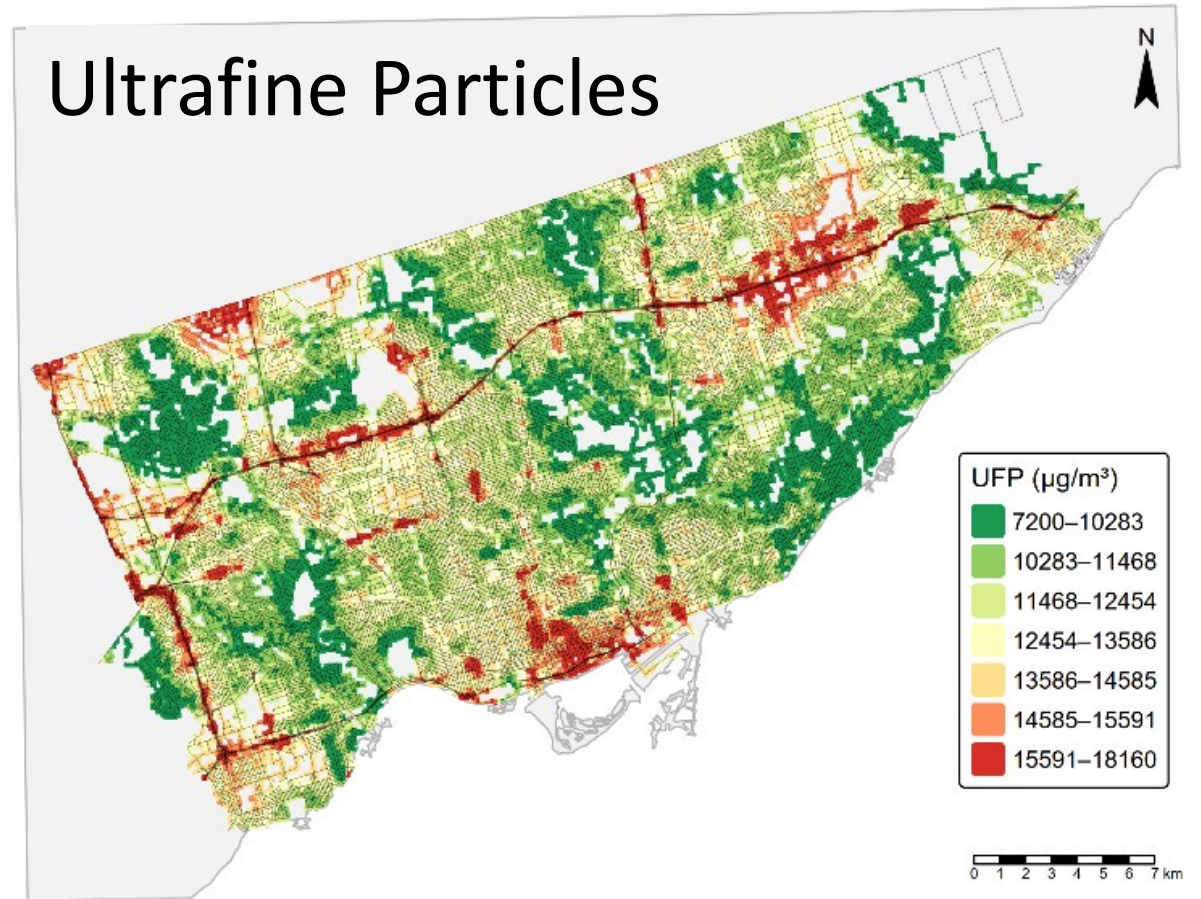
Do non-tailpipe and tailpipe emissions vary in distinguishable ways?

Resuspended $PM_{2.5}$



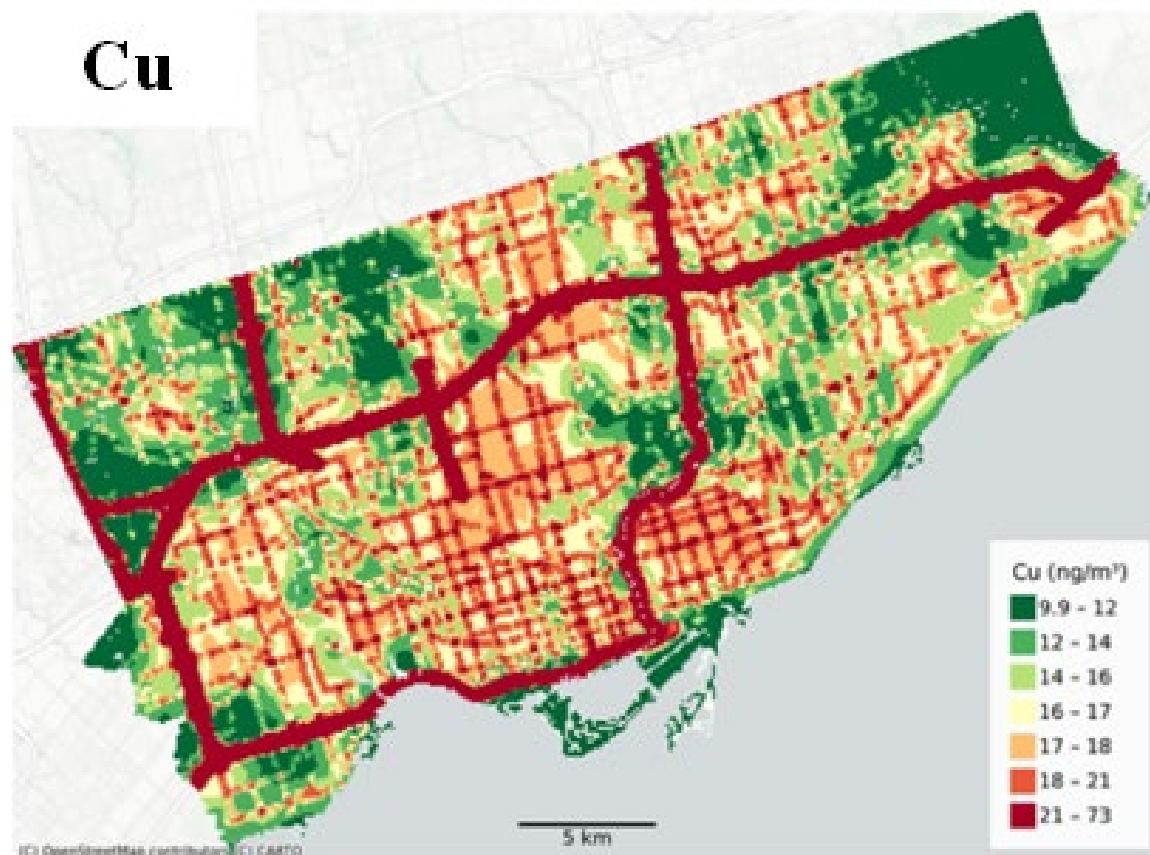
Non-Tailpipe: Road Dust

Ultrafine Particles

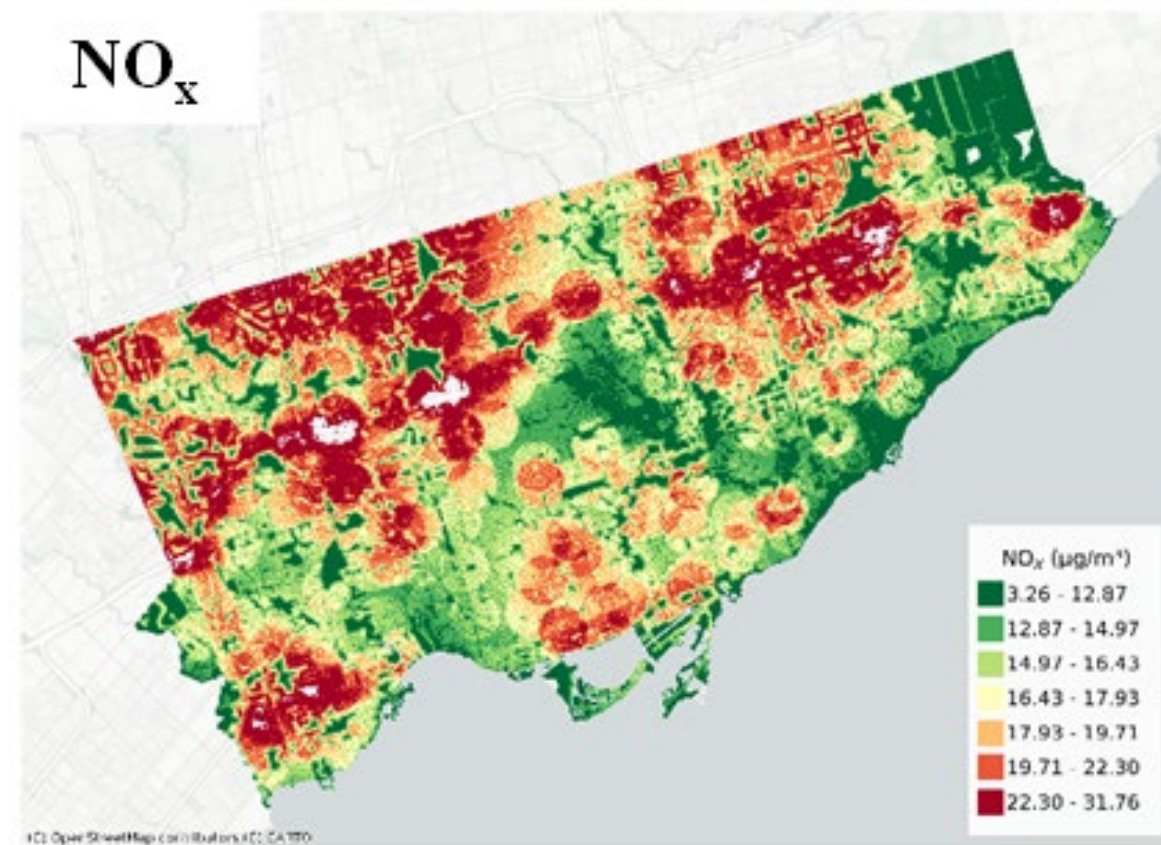


Tailpipe: Cars and Trucks

Do non-tailpipe and tailpipe emissions vary in distinguishable ways?



Non-Tailpipe: Brakes



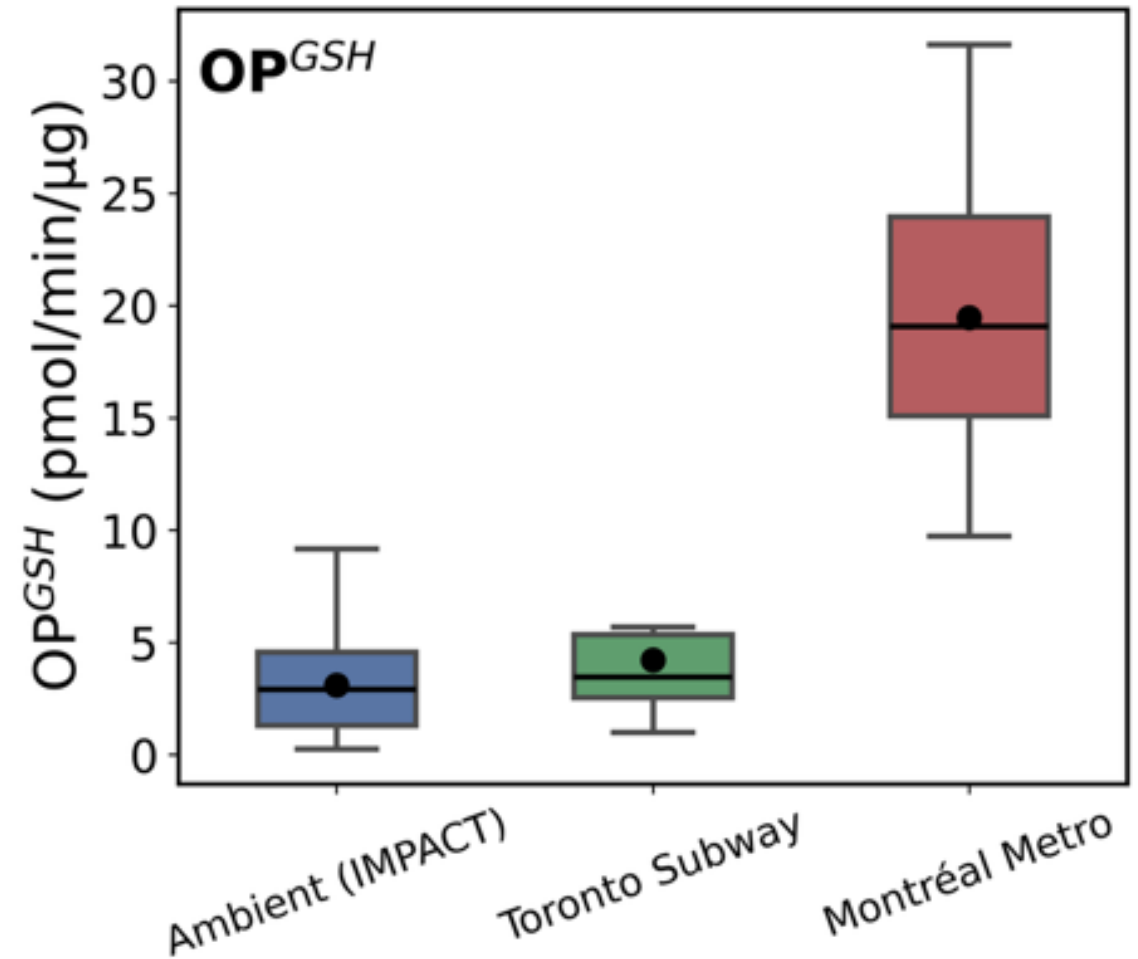
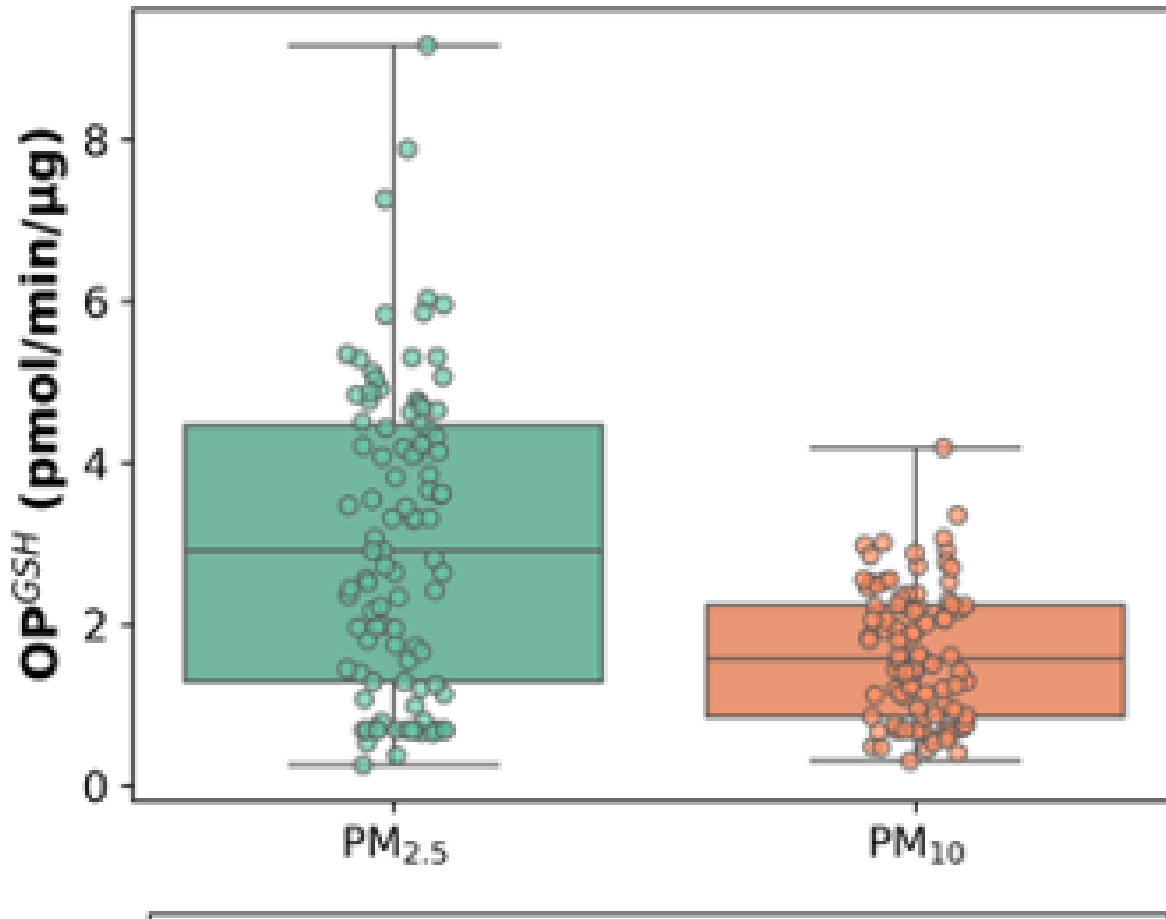
Tailpipe: Trucks

Can similarities and differences support future health studies?

	Cu (%)	Ba (%)	Fe (%)	Ca (%)
Brake wear	1.1	2.4	45	4.9
Subway	0.16	0.28	38	0.54
Road dust	0.03	0.03	13	24
ambient air	0.03	0.02	1.1	1.1

Some similarities in the composition of fine particulate matter

Can similarities and difference support future health studies?



Oxidative Potential based on glutathione depletion

Take away messages

- The contributions and spatiotemporal patterns of brakes and road dust can be resolved but this requires demanding methods
- The contributions of non-tailpipe and tailpipe emissions are equivalent at some sites (e.g. highway) but not others (truck route)
- Tires make a small contribution to ambient fine particles but contribution to coarse particles is uncertain.
- Maps of tailpipe vs non-tailpipe show useful differences
- Non-tailpipe emissions can, but do not necessarily, increase the oxidative potential of fine PM.
- Exposure subways may provide a pathway to evaluate health impacts associated with exposure to non-tailpipe particulate matter

The way forward

- Develop methods that can be easily deployed across cities
- Better constrain the contribution of tire particles to ambient particulate matter
- Explore the feasibility of using higher time resolution methods like aerosol mass spectrometry to measure rubber in ambient air.
- Apply wheel-well sampling in other cities to evaluate inter-city differences and translate to emission rates of resuspended road dust.