

Comparison of air quality in Canadian subway systems: Toronto, Ontario and Montreal, Quebec



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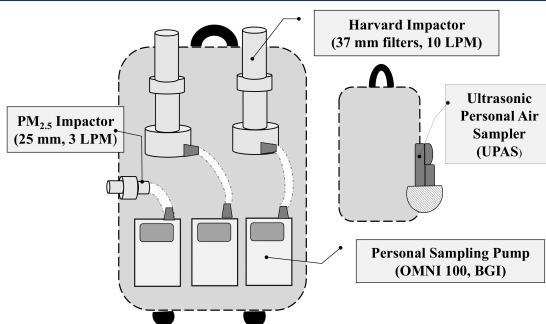
Introduction

- Commuters are exposed to **varying levels of fine particulate matter (PM_{2.5})** depending on their mode of transportation.¹
- PM_{2.5} concentrations are **higher in subway environments** and are **enriched in several metals** compared to outdoor PM_{2.5} demonstrating a need for **improving air quality underground**.¹⁻⁴
- In the subway, PM_{2.5} is mainly emitted from **mechanical friction and wear processes between rails, wheels and brakes**.²⁻³

Objectives

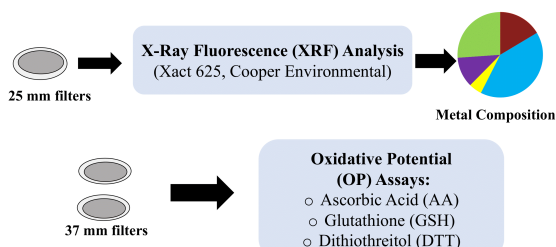
- Monitor the PM_{2.5} levels **both interior of trains and platforms**.
- Characterize and compare the **elemental composition** of the subway PM_{2.5} in both cities.
- Investigate relationships between **oxidative potential (OP)**, **PM composition and sources**.

Sampling Equipments

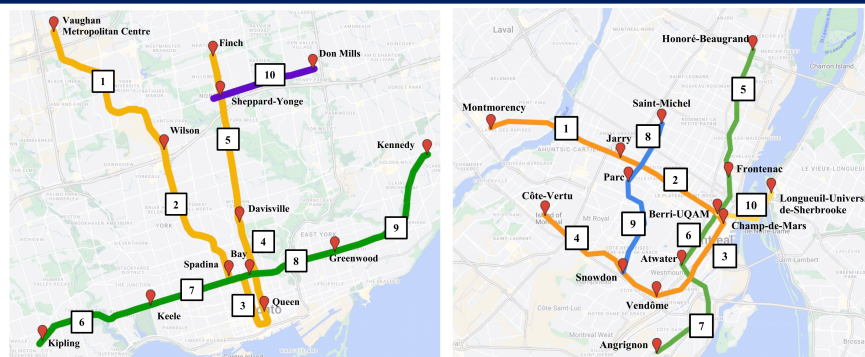


- Sampled for 20 weekday **mornings (7-10 AM)** and **evenings (3-6 PM)**.

Sample Analysis



Sampling Locations

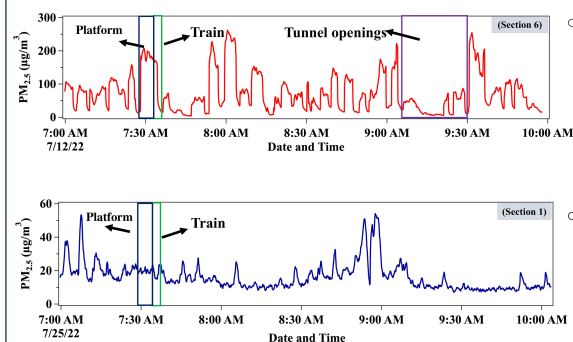


Toronto Transit Commission (TTC) Subway Map

Société de transport de Montréal (STM) Metro Map

- Both cities' **entire subway systems** were divided into **ten sections** to capture variability in PM_{2.5} chemical composition.
- Measurements were done in the **middle of each platform** and **in-train** with **disembarking and boarding patterns**.

PM_{2.5} Levels on Platforms vs. Inside Trains

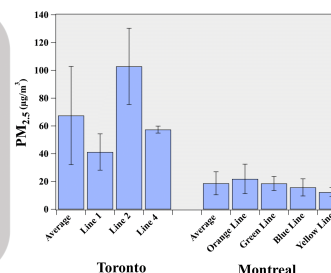


- In the **Toronto subway**:
 - Lower PM_{2.5} levels inside trains** than on the platform.
 - Mainly attributed to the **air conditioning system operating inside the trains**.
- In the **Montreal Metro**:
 - Similar levels** are found inside trains and on platforms.
 - No air conditioning system** in the train and open vents allow air to exchange with tunnel air continually.

PM_{2.5} in Each City Subway System

Why are PM_{2.5} levels higher in the TTC Subway⁴⁻⁵?

- The TTC Subway use of the conventional steel wheels rolling on steel track is known to produce steel dust, whereas the features of rubber wheels on concrete rollways in the STM Metro produce less metallic particles.
- TTC Subway relies on the piston effect, as well as the different openings in their tunnel for ventilation.
- STM Metro relies heavily on mechanical and natural shafts throughout their system for ventilation.



Relationship Between PM_{2.5} Elemental Composition

	Toronto						Montreal				
Ca	1	0.94	0.85	0.75	0.8	Ca	1	0.52	0.3	0.38	0.36
Ti	0.94	1	0.91	0.8	0.82	Ti	0.52	1	0.38	0.49	0.15
Fe	0.85	0.91	1	0.93	0.95	Fe	0.3	0.38	1	0.96	0.27
Cu	0.75	0.8	0.93	1	0.97	Cu	0.38	0.49	0.96	1	0.34
Zn	0.8	0.82	0.95	0.97	1	Zn	0.36	0.15	0.27	0.34	1

Pearson correlation matrix between PM_{2.5} elemental composition in each city subway system

- Fe is a major component** in all subway systems.
- In Toronto, **Ca, Ti, Fe, Cu and Zn** were highly correlated.
- In Montreal, **Cu and Fe** were highly correlated.
- All elements **characteristic of the subway environment** (composition of steel rail tracks, wheels, brake pads and power supply).

Future Work

- Determine **PM_{2.5} health impacts** with samples collected in both subway systems using **oxidative potential assays**.
- Investigate **correlation between oxidative potential and PM elemental composition**
- Study the **seasonal variation** of PM_{2.5} in the subway (Winter vs. Summer)

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References

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