

Real-world particle number emission factors of heavy-duty vehicles: Contribution of sub-10 nm particles

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What & Why: UFPs

Ultrafine particles (UFPs) = particles with a diameter below 100 nm

Human exposure to UFPs ↔ Harmful brain impacts

- For instance, BC particles were found in memory-related brain regions of individuals with Alzheimer's disease, including the olfactory bulb¹
→ environmental BC particles can enter the brain via the olfactory pathway?

WHO Air quality guideline (2021) - good practice statement:
Quantify ambient UFPs in terms of particle number concentration (PNC) with a lower limit of ≤ 10 nm

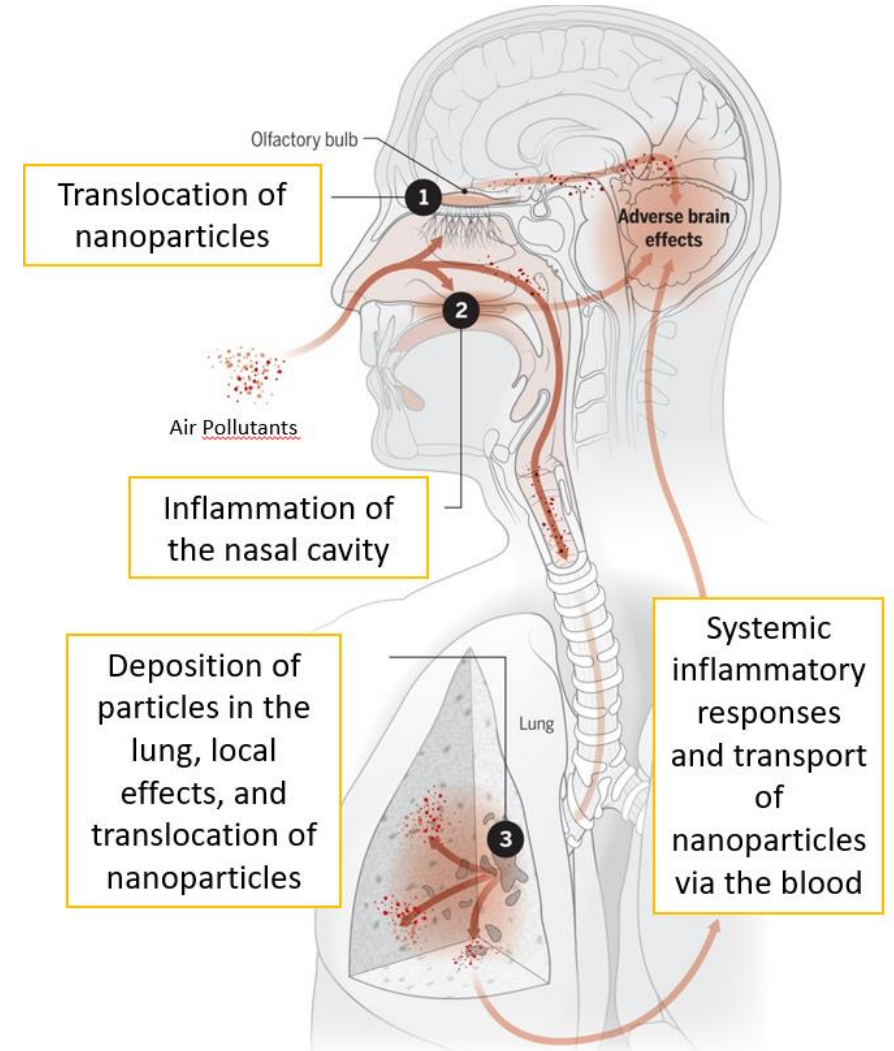
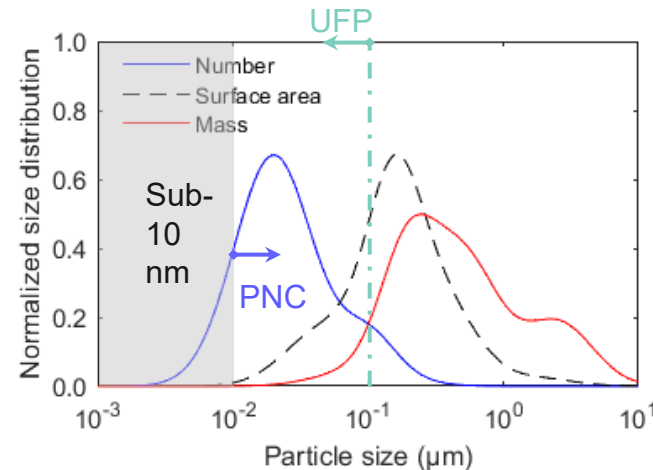


Illustration: IAC2022 Plenary Talk by Annette Peters, originally modified from Underwood (Science 2017)

¹Vanbrabant, K. et al. (2024). *JAMA Network Open*

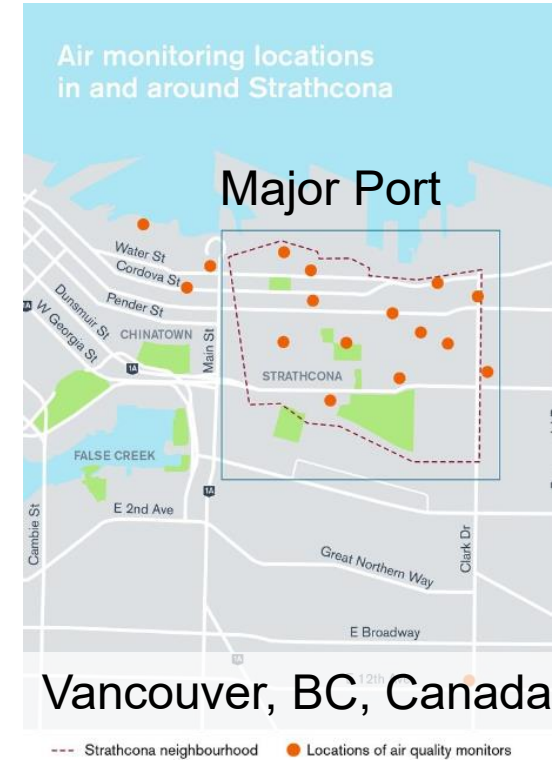
What & Why: Heavy Duty EFs



- Emission factors (EFs): emissions per unit activity
- Real-world EF needed for emission modeling



- Presence of super-emitters
 - ← x7 times higher PN peaks, 70 % sub-10 nm, predominantly diesel trucks²
- Goods movement vehicles can have a major influence on air quality
 - Urban areas like Strathcona
 - Equality questions



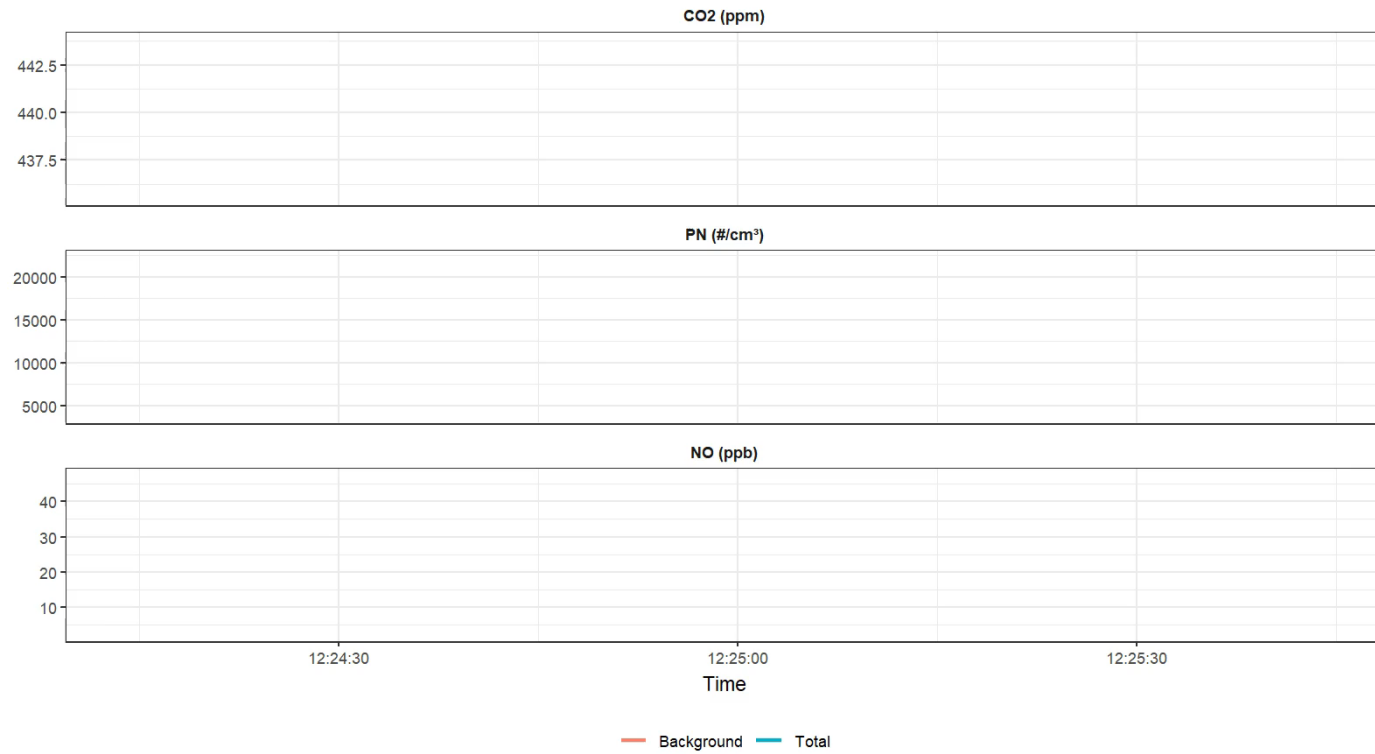
Roadside measurements on causeway to GCT Deltaport

7 sampling days in October – November 2025 (data in this presentation from 2 days)

7.2–19.8 °C 58–91 %



What this looks like coming in



Corrected for ~ 7 second lag between vehicle and pollutant detection

Roadside measurements on causeway to GCT Deltaport

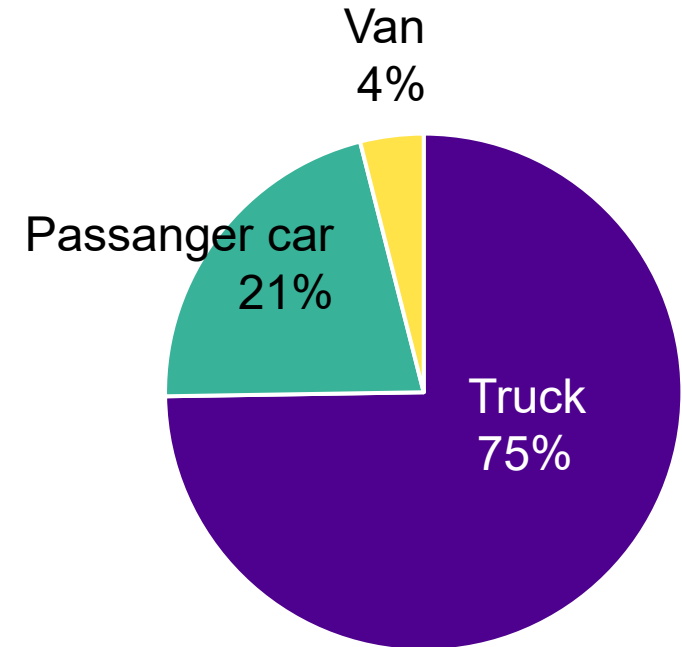
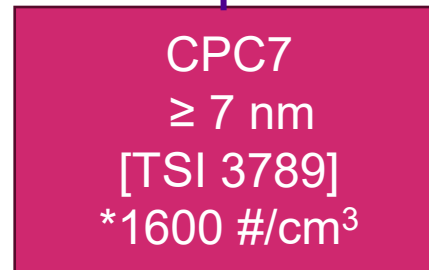
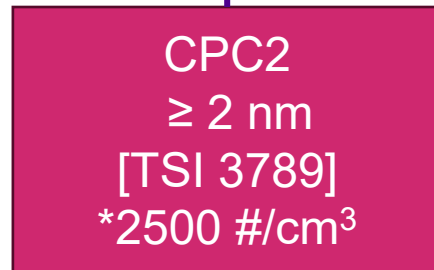
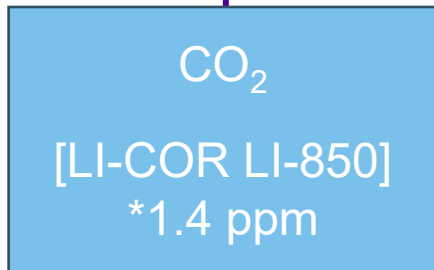


UBC PLUME Van

- Ultrafine Particles (size and number)
- CO₂, NO, NO₂
- Wind speed & direction
- Organic aerosol (Aerosol mass spec)

Also

Non-exhaust emissions (road-level sampling)



Sample traffic count (1h)
404 vehicles in total

- CO₂ + PNC for particles > 2 nm, > 7 nm, and 2–7 nm
- Emission factor calculation using the carbon balance method

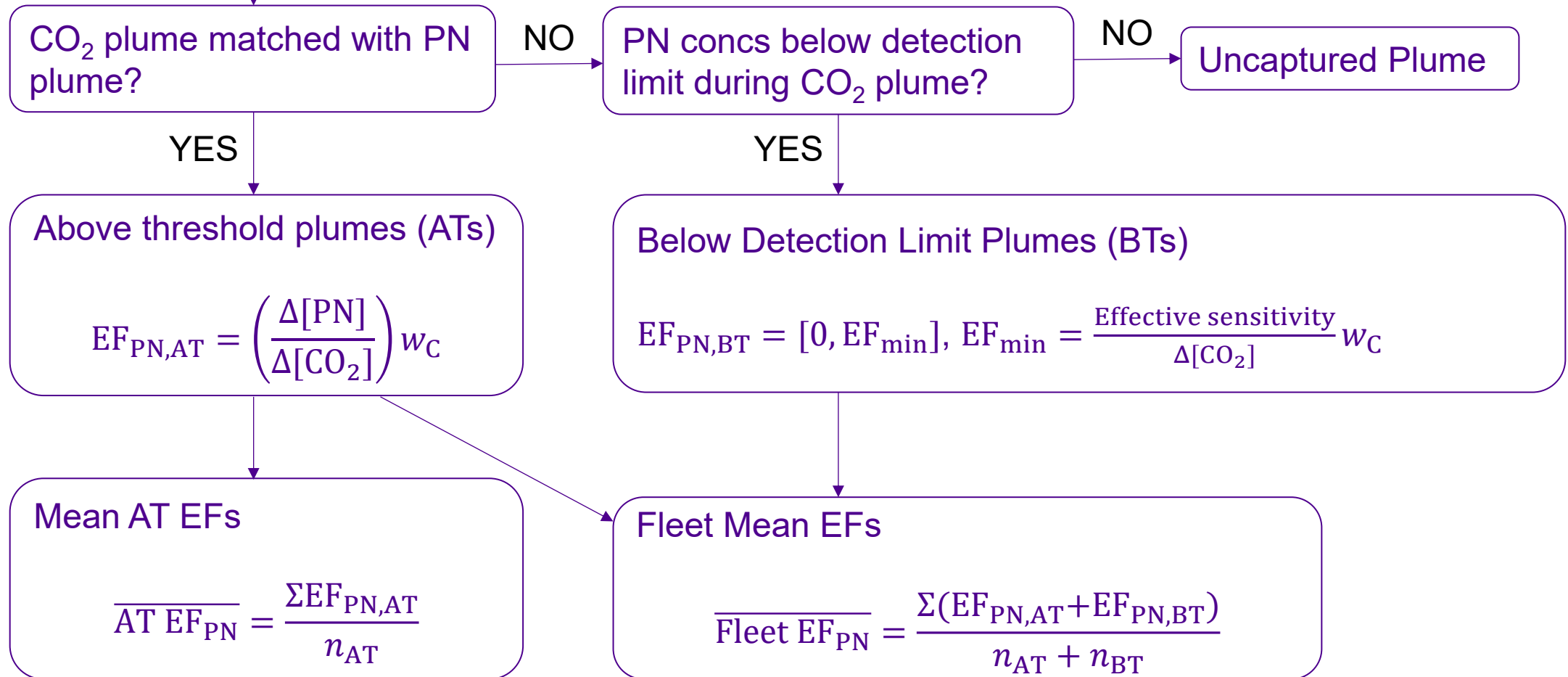
$$\text{*Effective sensitivity (ES)} = \frac{1}{(P_{\max} - P_{\min}) \text{no vehicle period}}$$

Note: Thorough sensitivity analysis of the approach not yet performed

Assumptions: carbon emitted as CO₂, ideal gas law, std conditions, mass fraction of carbon in fuel (diesel) $w_C = 0.86$

For individual pollutants:

- 1) Background subtraction
- 2) Plume identification
 - detection limit: effective sensitivity value



[Results unpublished]

Thank you!

- High variability in heavy-duty PN emission factors ($10^{13} - 10^{17}$)
- 50 % of the PN emission is in sub-10 nm size range
- High PN emitters remain among truck fleet

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