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Measured LDSA concentrations indoors and outdoors at four schools/daycares in Finland

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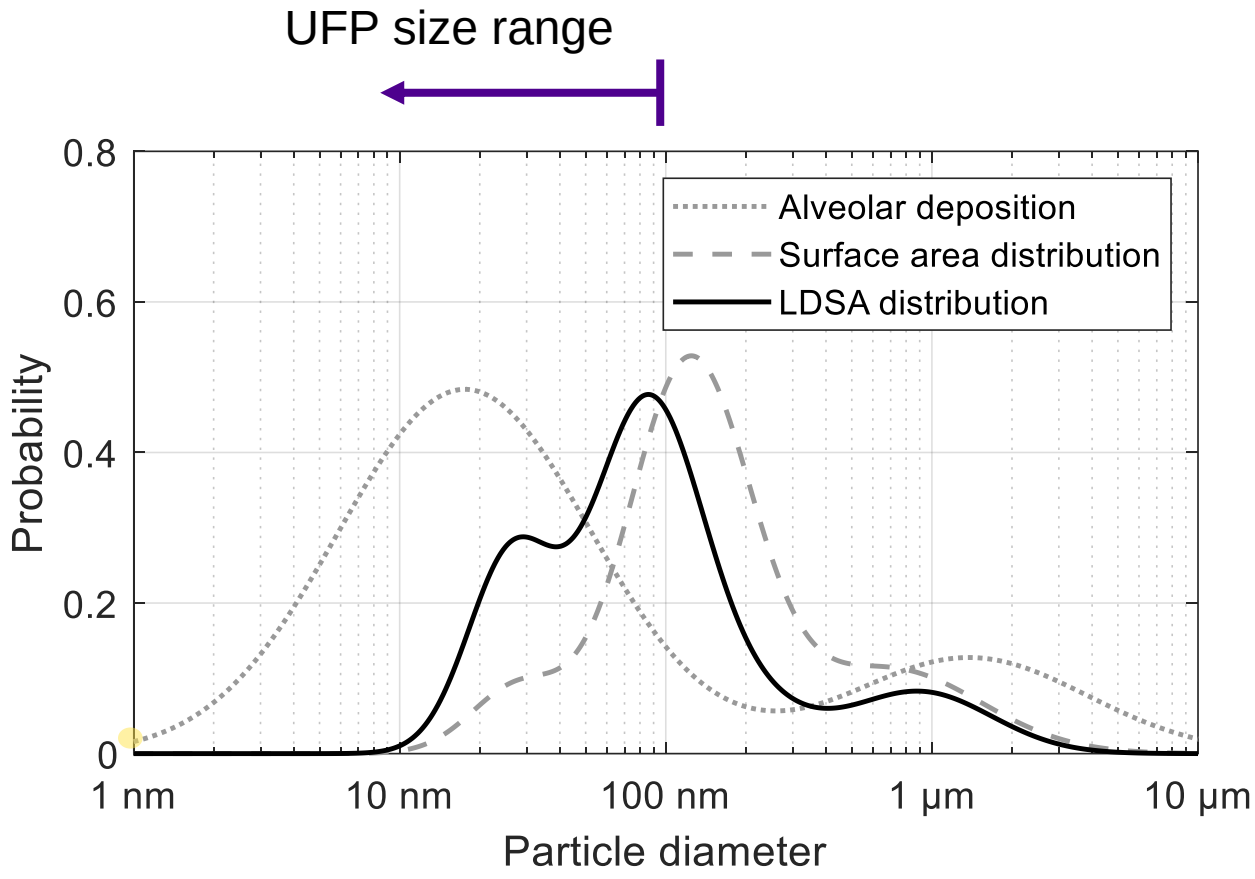
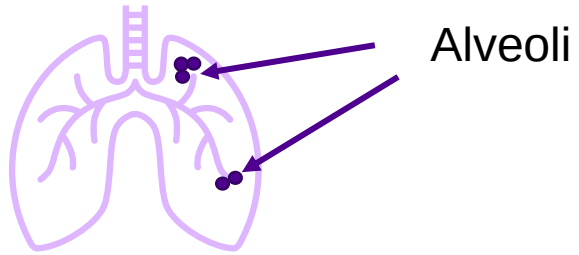
Motivation

- Air pollution causes 8.8[1] million deaths annually worldwide
- Children are especially susceptible to air pollution[2]
- WHO has specified ultrafine particles (sub 100 nm particles, UFP) as a health concern and added particle number “best practice statements”[3],
  - Particle number for above 10 nm particles
    - 24 h low concentration < 1000 particles/cm^3
    - 24 h high concentration > 10 000 particles/cm^3
    - 1 h high concentration > 20 000 particles/cm^3
- **Very few studies on fine and ultrafine particle concentration in Finnish schools and daycares**

What is LDSA?

- Lung-deposited surface area (of particles)
- LDSA = alveolar deposition probability × particle surface area concentration
- Units: μm^2 of particle surface per cm^3 of air
- Health-relevant metric for particle concentration, good metric for UFP size range
- No guideline values exist for LDSA, but calculating from particle number and assuming 100 nm spherical particles
  - Low LDSA: 24h mean < 5 $\mu m^2/cm^3$
  - High LDSA: 24h mean > 40 $\mu m^2/cm^3$
  - High LDSA: 1 h mean > 90 $\mu m^2/cm^3$
- Many commercially available options for total LDSA measurement





Methodology

- Four schools, two in suburban locations and two city locations in Finland
- Simultaneous LDSA measurement indoors and outdoors with two Partectors (handheld electrical particle measurement devices, manufacturer Naneos)
- Two-week measurement at each location (late summer and early autumn in 2021)
- Data was processed from 1 Hz resolution to minutely and hourly means, weekend data was excluded

Name	Building renovations	Original building year
Suburban school 1	-	2013
Suburban school 2	2015, 2010	1952
City school 1	-	2018
City school 2	2013	1904

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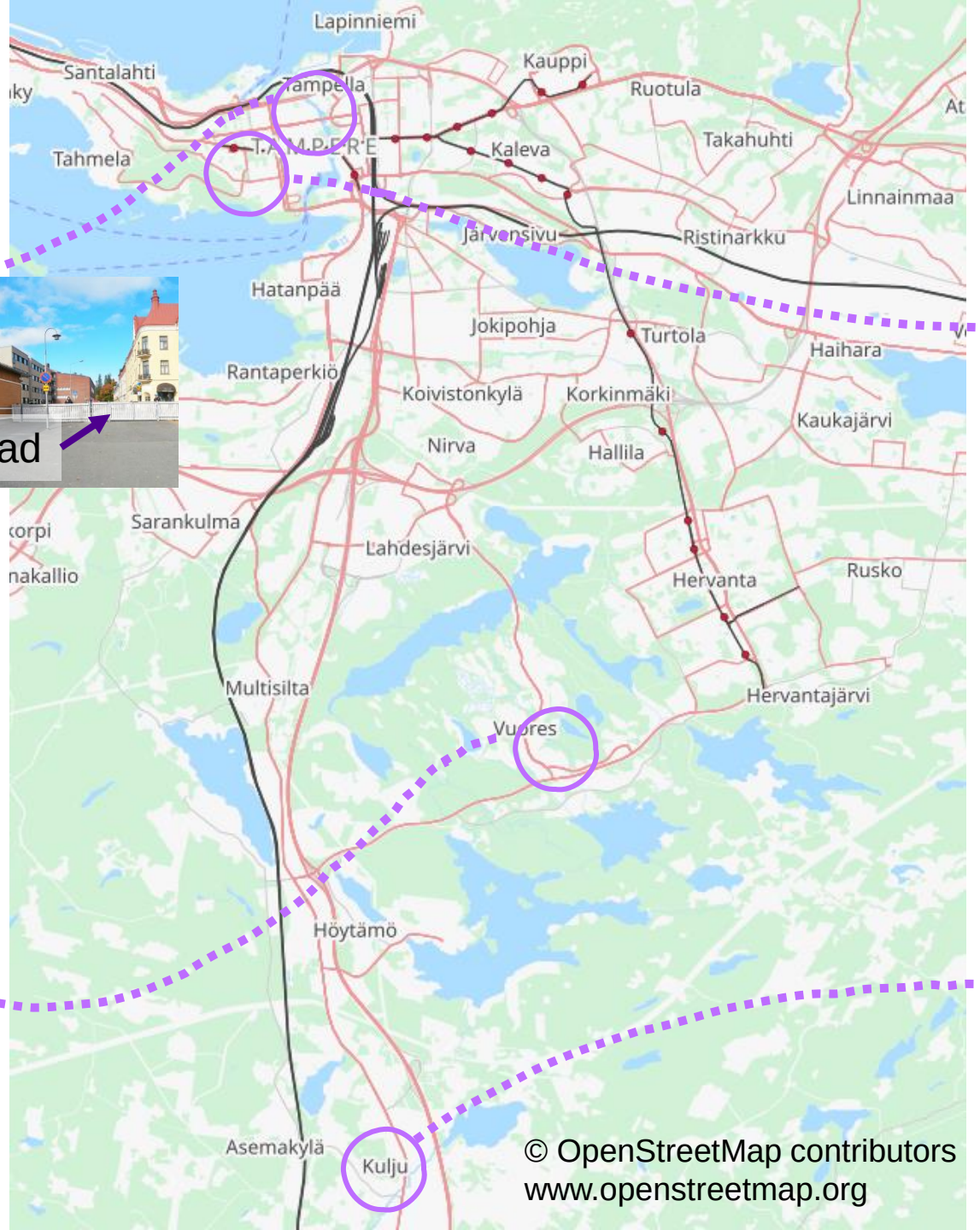
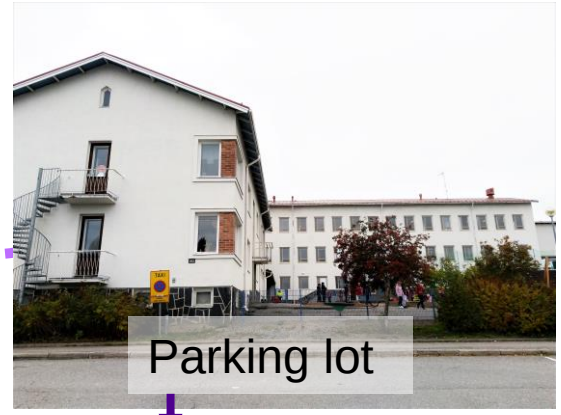
City school 1

City school 2



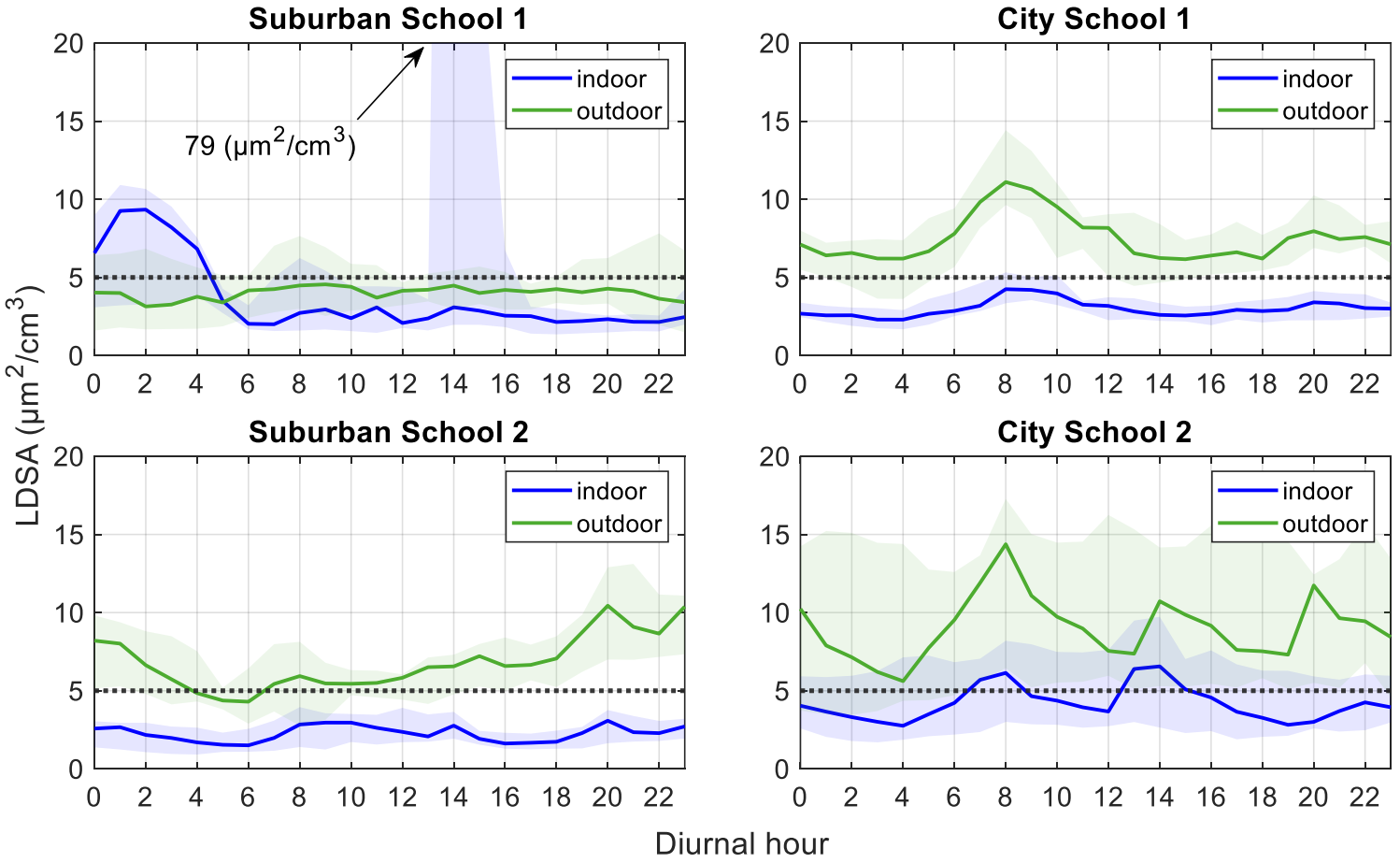
Suburban school 1

Suburban school 2



Diurnal plots

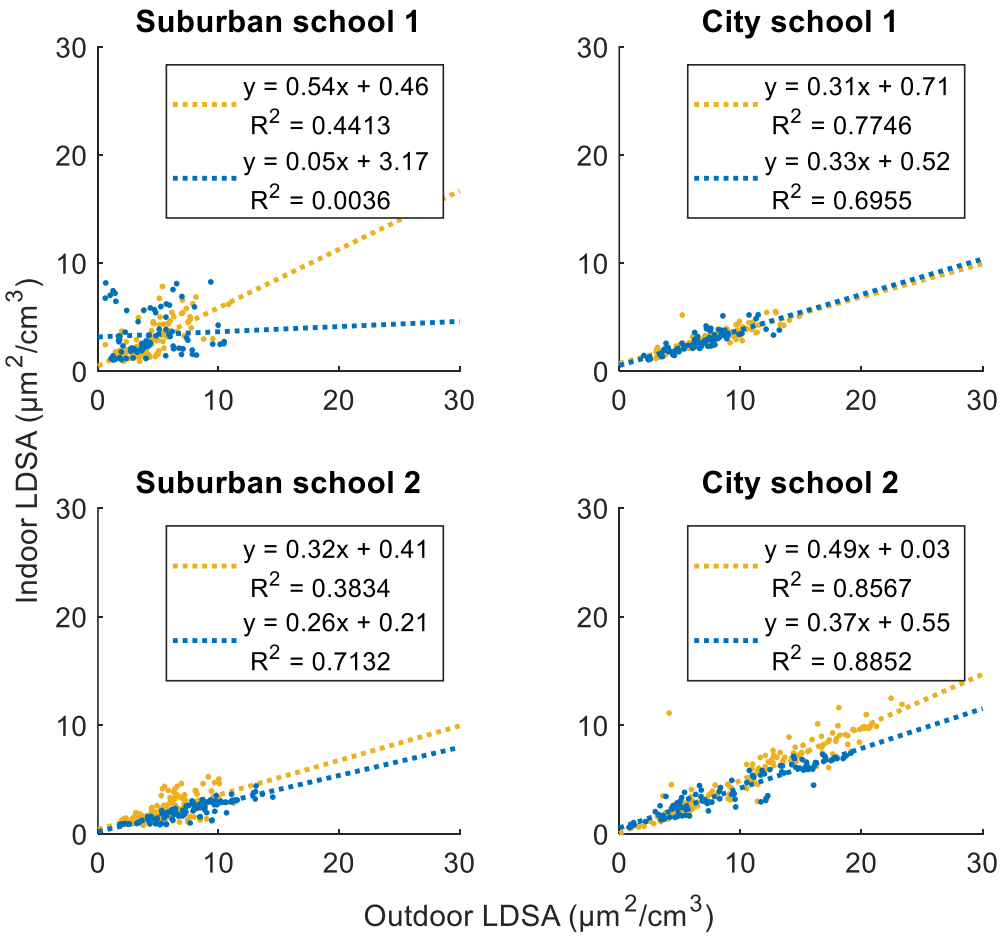
- Minutely data grouped by hour of day and averaged
- **Suburban school 1** has an I/O above 1 at night, related to changes in ventilation settings
- **City Schools 1** & **2** show increased concentrations at morning rush hour
- Median indoor LDSA (in $\mu m^2/cm^3$) overall was
  - 2.8 **Suburban school 1**
  - 2.1 **Suburban school 2**
  - 2.9 **City school 1**
  - 4.0 **City school 2**



Particle infiltration

$$LDSA_{indoor} = F_{inf} LDSA_{outdoor} + LDSA_{indoor\ sources}$$

- Daytime hours (6-18) and nighttime hours (19-5)
- Ventilation was operated with lower air volumes during the night
- Outliers have been removed from this data
- Infiltration is higher during the day in all cases except **City School 1**
- The **City School 2 and Suburban School 1** have the highest particle infiltration factors, F_{inf}
- The infiltration factor also gives the IO-value if there are no indoor particle sources



Summary of Results

- Measurements were successful
- Concentrations were low on (below 5 $\mu m^2/cm^3$)
  - 70 % of measurement days at **Suburban School 1**
  - 100 % of measurement days at **Suburban School 2**
  - 80 % of measurement days at **City School 1**
- The daily mean value was above 5 $\mu m^2/cm^3$ on half of the measurement days at **City School 2**
  - The high daily mean values were due to particle infiltration
  - Infiltration could most likely be reduced by upgrading filters

References

[1]Lelieveld, J., Klingmüller, K., Pozzer, A., Pöschl, U., Fnais, M., Daiber, A., & Münzel, T. (2019). Cardiovascular disease burden from ambient air pollution in Europe reassessed using novel hazard ratio functions. European Heart Journal, 40(20), 1590–1596. doi: 10.1093/eurheartj/ehz135

[2]World Health Organization. (2018). Air pollution and child health: prescribing clean air. Summary. Geneva. Retrieved from https://www.who.int/publications/i/item/air-pollution-and-child-health

[3]World Health Organization. (2021). WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Retrieved from https://apps.who.int/iris/handle/10665/345329

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Thanks for listening!

- Any questions or comments?
- You can contact me later at laura.salo@tuni.fi

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