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Integrated Climate forcing and Air pollution Reduction in Urban Systems

Uncertainty associated with assessing personal exposure to particulate matter with high temporal resolution using low-cost portable sensors

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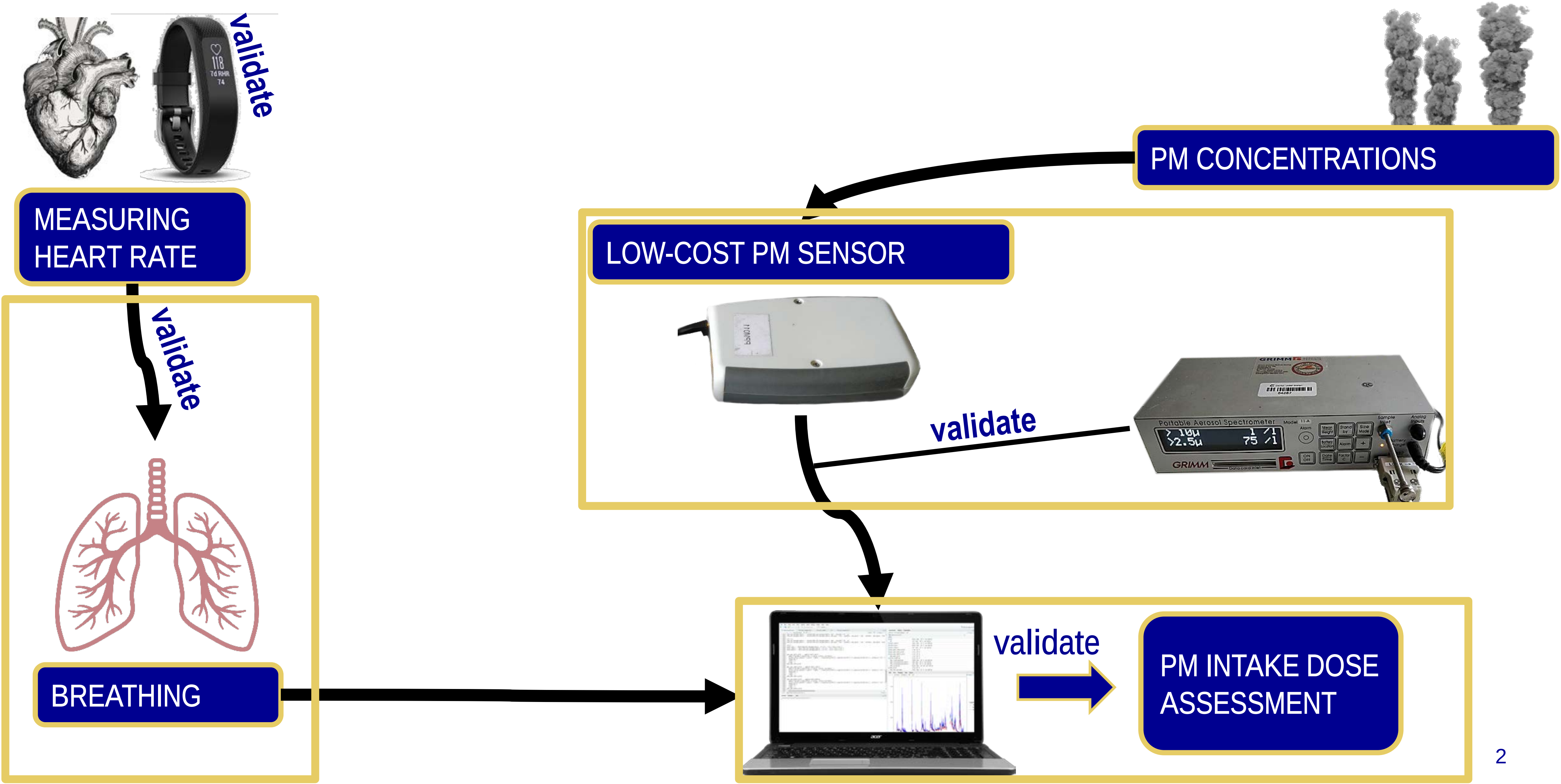
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MEASURING HEART RATE
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BREATHING
PM CONCENTRATIONS
LOW-COST PM SENSOR
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Portable Aerosol Spectrometer
GRIMM
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PM INTAKE DOSE ASSESSMENT

sensors MDPI

Article

Comparing Airborne Particulate Matter Intake Dose Assessment Models Using Low-Cost Portable Sensor Data

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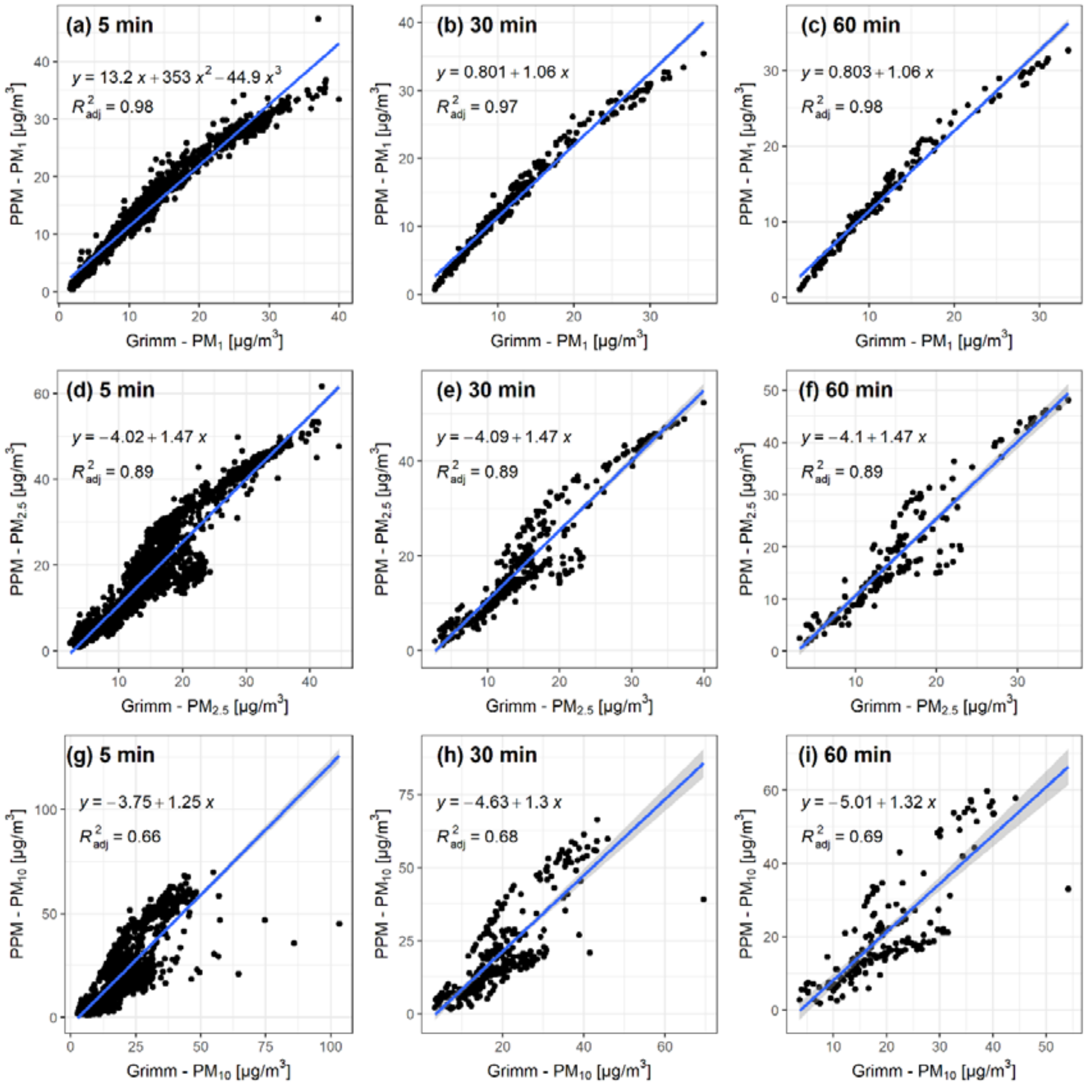
Measuring PM & calculating intake dose



$$intake\ dose = \dot{V}_E * PM_1$$

minute ventilation [l/min]

PM_1 concentration [µg/m³]

model 1 model 2

model 3 model 4

Intake dose models

model 1

$$intake\ dose = \dot{V}_E^1 * PM_1$$

- Most complex estimate for $\dot{V}_E$
- Based on Greenwald et al.

$$\dot{V}_E^1 = e^{-9.59} HR^{2.39} age^{0.274} sex^{-0.204} FVC^{0.520}$$

- HR: Heart rate in beats per minute
- age: Age in years
- sex: "1" for male, "2" for female
- FVC: Forced vital capacity From GLFI methodology (3.32 l for P1, 5.37 l for P2)

model 3

$$intake\ dose = \dot{V}_E^3 * PM_1$$

- $\dot{V}_E$ not based on HR; activity patterns, inhalation rates, and body weight, with a specific type of microenvironment
- Based on Sarigiannis et al., Madureira et al. and EPA Exposure Factors Handbook
- Average $\dot{V}_E$ provided for 4 levels of activity
- $\dot{V}_E$ determined for each hourly interval

model 2

$$intake\ dose = \dot{V}_E^2 * PM_1$$

- Less complex $\dot{V}_E$ calculation, using only HR and sex
- Based on Zuurbier et al.

$$\dot{V}_E^2 = (a * HR + b)^e$$

- HR: Heart rate in beats per minute
- a, b: "a" and "b" based on sex: a is 0.023 and 0.021, b is 0.57 and 1.03, for females and males, respectively

model 4

$$intake\ dose = \dot{V}_E^4 * PM_1$$

- Most basic approach for $\dot{V}_E$, using only age, sex and weight
- Using EPA Handbook with generalized $\dot{V}_E$ data for time spent in micro-locations, doing specific activities for each (age and sex) group

$$\dot{V}_E^4 = (sP * aV_P + sLi * aV_{Li} + sMi * aV_{Mi} + sHi * aV_{Hi}) * BW$$

Determining uncertainty

- PPM sensor ► compare with GRIMM
- SAT tracker ► Oniani et al.
- FVC ► Interval from lower to higher
- EPA $\dot{V}_E$ ► Upper and lower interval
- EPA activity► Upper and lower interval
- Propagation of uncertainty!

Quantifying Uncertainty

~16%

Oniani et al.

~9.82%

FVC

~22%

Propagation of uncertainty

model 1	model 2	model 3	model 4
41% ± 9 %	45% ± 10%	38% ± 7 %	49% ± 17 %

Choosing the “right” option

Which model is “the best”?

Which is “the most accurate”?

Which one should we use?

IT DEPENDS!

- Only have some basic data (weight, age)
- Need a general assessment with more uncertainty
- Short on time and resources

↓

M3 & M4

- Have data with high spatiotemporal resolution
- Participants heavily involved in research
- A lot of processing power
- Need more accurate data

↓

M1 & M2

Three things to remember

1. Low-cost sensors ► intake dose estimate?
It is possible!

2. Most of the uncertainty comes from the $\dot{V}_E$ **MODELS**, not the sensors

3. Which approach is the best for your research? **It depends!**

Thank you for your attention!

QUESTIONS, COMMENTS

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