Enabling Affordable and Accurate Indoor Air Monitoring

Air quality sensors can measure indoor $PM_{2.5}$ (tiny particles generated by cooking, smoking and burning) in real time. However, their readings can be unreliable. To address this, we developed a machine-learning calibration approach that improves sensor performance.

The challenge: indoor air is different to outdoor air

Uncalibrated sensors often show poor agreement with research-grade instruments (Figure 1). Indoor activities such as cooking, smoking and burning incense can produce $PM_{2.5}$ concentrations far higher than those typically measured outdoors where levels are typically ≤25 μgm^{-3}, (Figure 2).

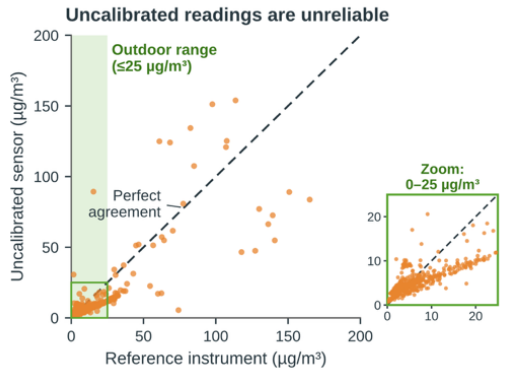


Figure 1 | Uncalibrated sensor readings compared with a research-grade instrument; the zoom shows the ≤25 μg/m^3 outdoor range.

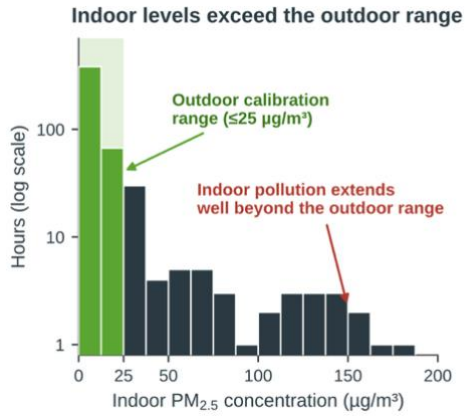


Figure 2 | Hours spent at each indoor $PM_{2.5}$ level. Axes stop at 200 μg/m^3; readings above this level (35 of 547 hours by the reference instrument) are not shown.

Indoor humidity and temperature can change rapidly, affecting sensor performance. As a result, calibration methods developed for outdoor environments are not reliable for sensors to be used in indoor settings.

Our approach

We co-located 40 air quality sensors with a research-grade monitor under realistic indoor conditions. Using machine learning techniques, we calibrated each sensor's measurement while accounting for variations in temperature and humidity, substantially improving accuracy across a range of indoor air quality conditions.

What did we learn?

- Uncalibrated air quality sensors can have substantial measurement errors.
- For reliable results indoor air quality sensors must be calibrated under indoor conditions.
- Our machine learning method reduces sensor errors by about half, enabling calibrated sensors to closely match measurements from a research-grade monitor.
- This approach can be scaled across large sensor networks.

Full article

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