Monitoring Indoor Air Quality Using Low Cost Sensors at a Community Scale

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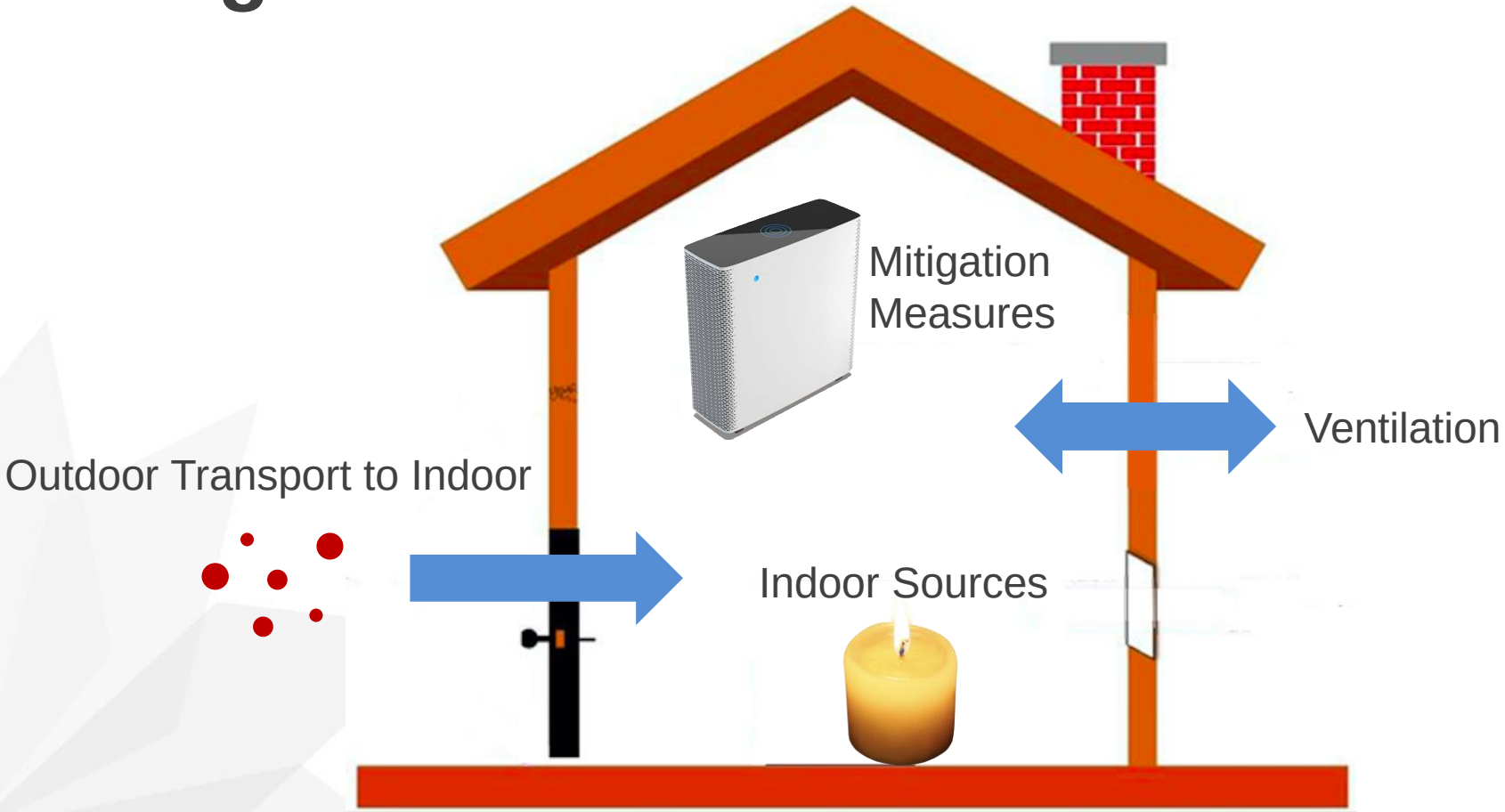
Background


Mitigation Measures
Ventilation
Outdoor Transport to Indoor
Indoor Sources

Background

- Cooking is a major indoor emission source for PM (Wallace, 2004).
- Burning candles can increase PM levels by multiple times (He et al., 2004).
- Vacuuming was found to increase $PM_{2.5}$ level (He et al., 2004).

Indoor Sources

Outdoor to Indoor Transport

Significant fraction of outdoor PM can penetrate into indoor environments (Jones et al., 2000).

Ventilation

Ventilated indoor environments have higher I/O ratios for PM (Cyrys et al., 2004).

Mitigation

Air purification could result in more than 50% reduction of $PM_{2.5}$ within hours of operation (Chen et al., 2015).

Objective

To determine to what extent low-cost air sensors can be used to detect and evaluate the impacts of the following on indoor air quality.

- Indoor Sources
- Outdoor to Indoor Transport
- Ventilation
- Mitigation

Study Design

30 Sensors

12 Outdoor Sensors

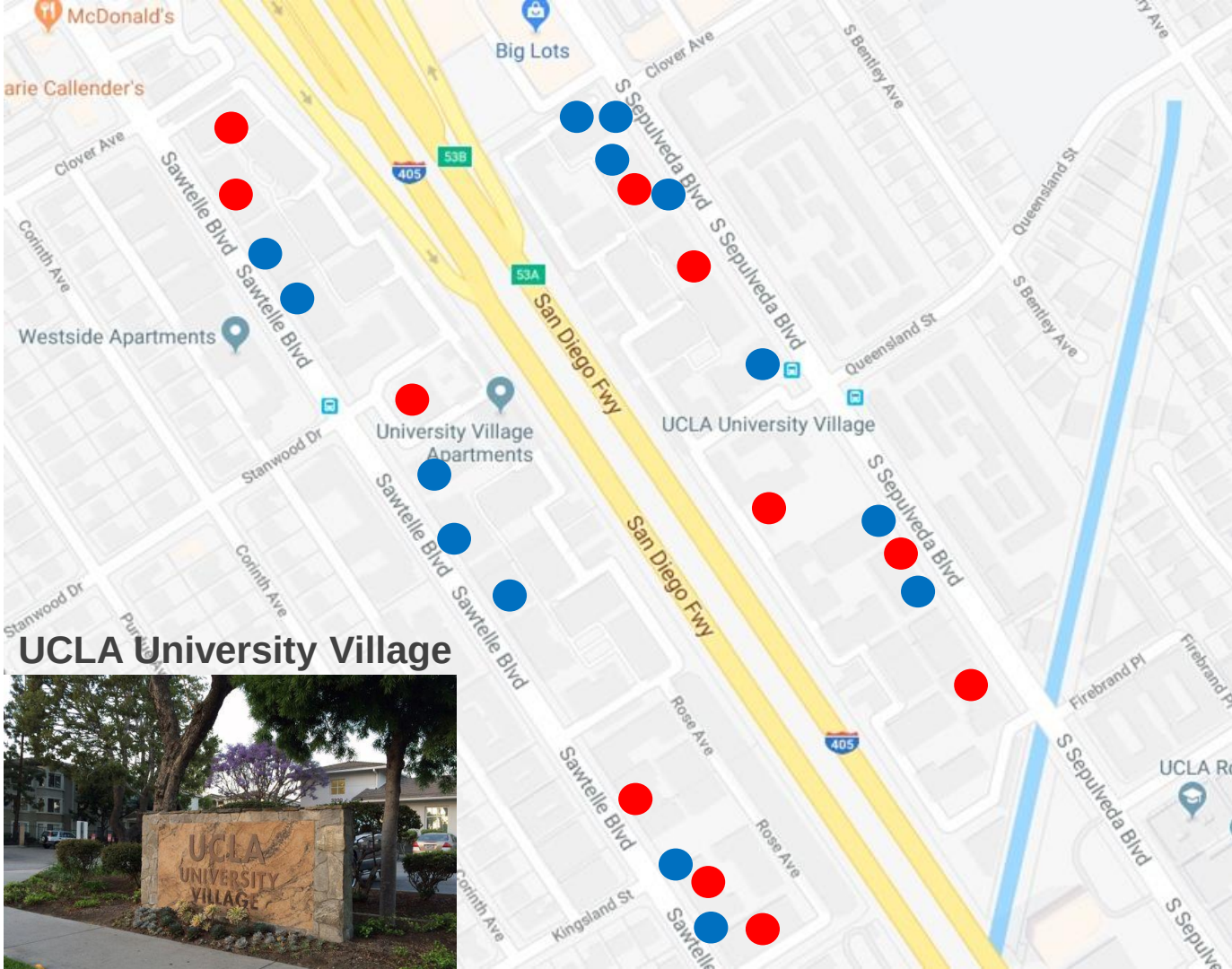
6 in Sawtelle

6 in Sepulveda

18 Indoor Sensors

8 in Sawtelle

10 in Sepulveda



UCLA University Village

Sensor Selection

TSI (AirAssure)

Air Quality Egg (Version ||)

Dylos (DC1100)

Foobot

Hanvon (Hanvon N1)

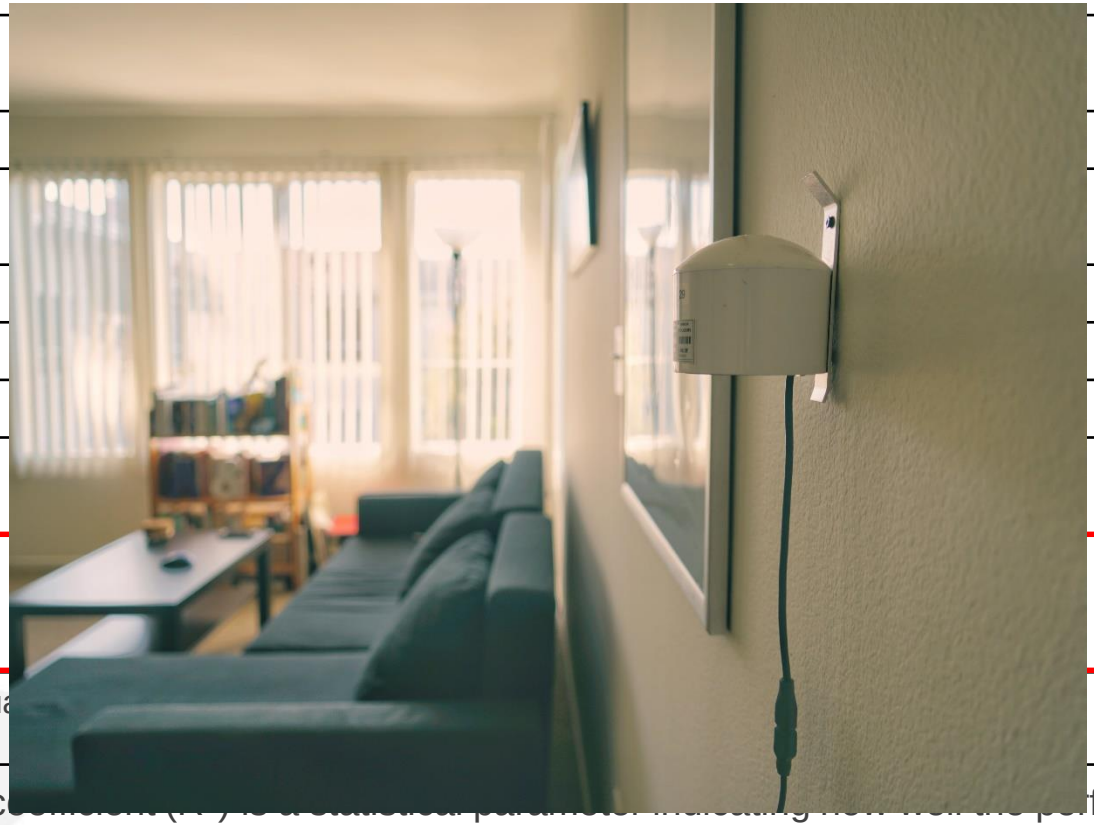
Origins (Laser Egg)

PurpleAir (PA ||)

Shinyei (PM Evaluation Kit)

Sensor Selection

Manufacturer (Model)	**Lab** R^2
TSI (AirAssure)	R^2 ~ 0.99
Air Quality Egg (Version ||)	
DC1100 PRO	R^2 ~ 0.89
Foobot	
Hanvon N1	
Laser Egg	
PurpleAir (PA ||)	$PM_{1.0}$: R^2 ~ 0.99 $PM_{2.5}$: R^2 ~ 0.99 PM_{10}: R^2 ~ 0.95
Shinyei (PM Evalua	R^2 ~ 0.93

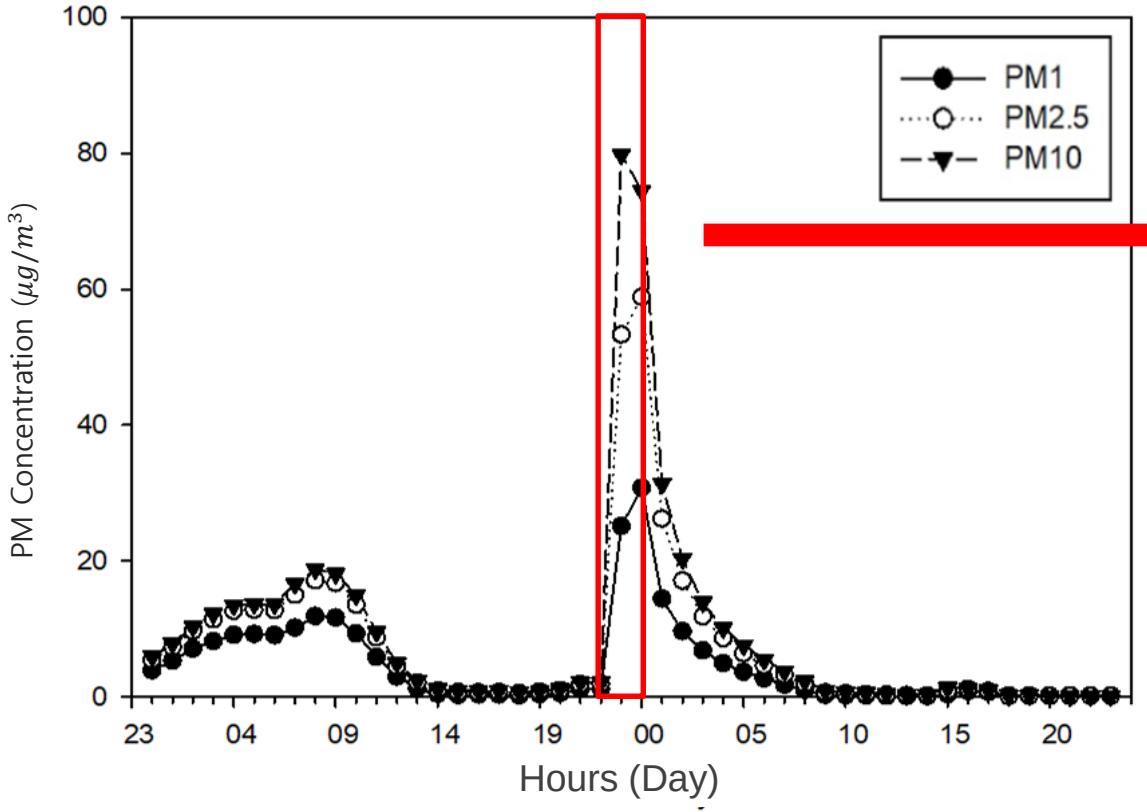


*The correlation c[illegible] (R^2) is a statistical parameter indicating how well the performance of each sensor compares to that of a Federal Reference Method (FRM), Federal Equivalent Method (FEM), o r Best Available Technology (BAT) instrument.

http://www.aqmd.gov/aq-spec/evaluations/summary

Indoor Sources: Candles

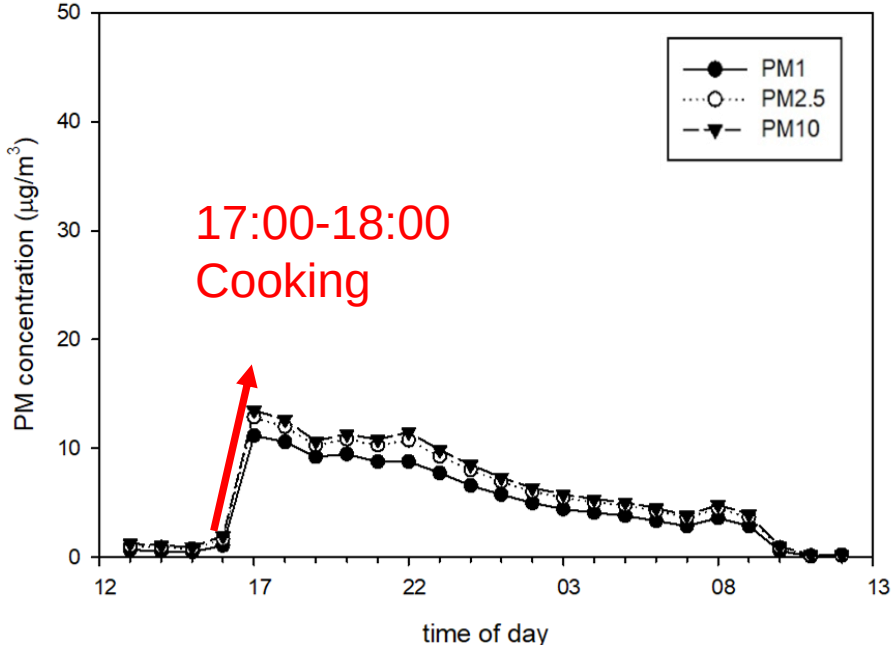
Hourly PM Concentration of an Apartment over 48 Hours

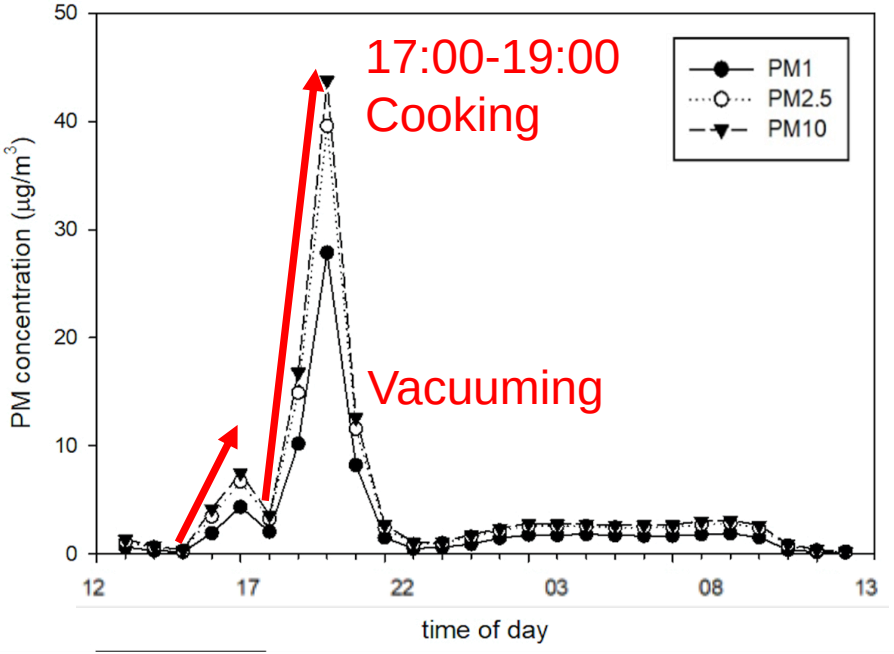


23:00 – 24:00
Candle Burning

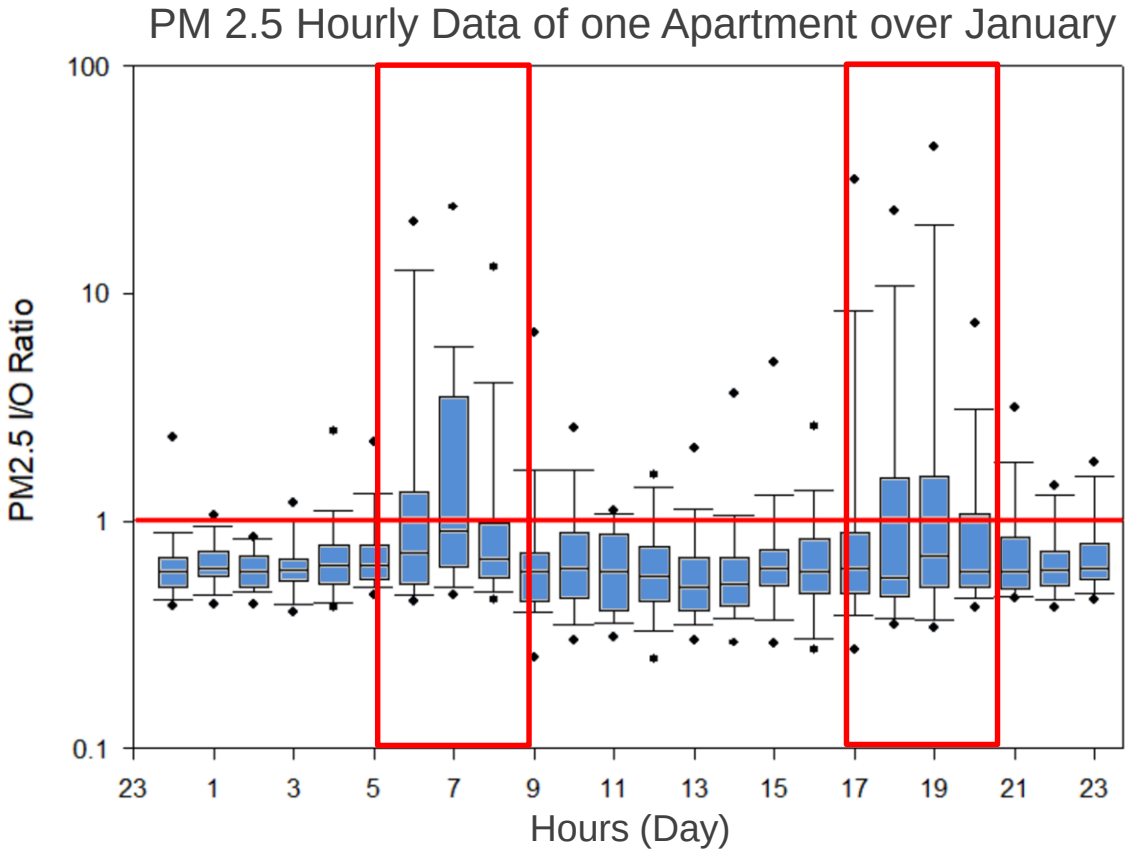
Indoor Sources: Vacuuming and Cooking

Hourly PM Concentration of one apartment in two separate days

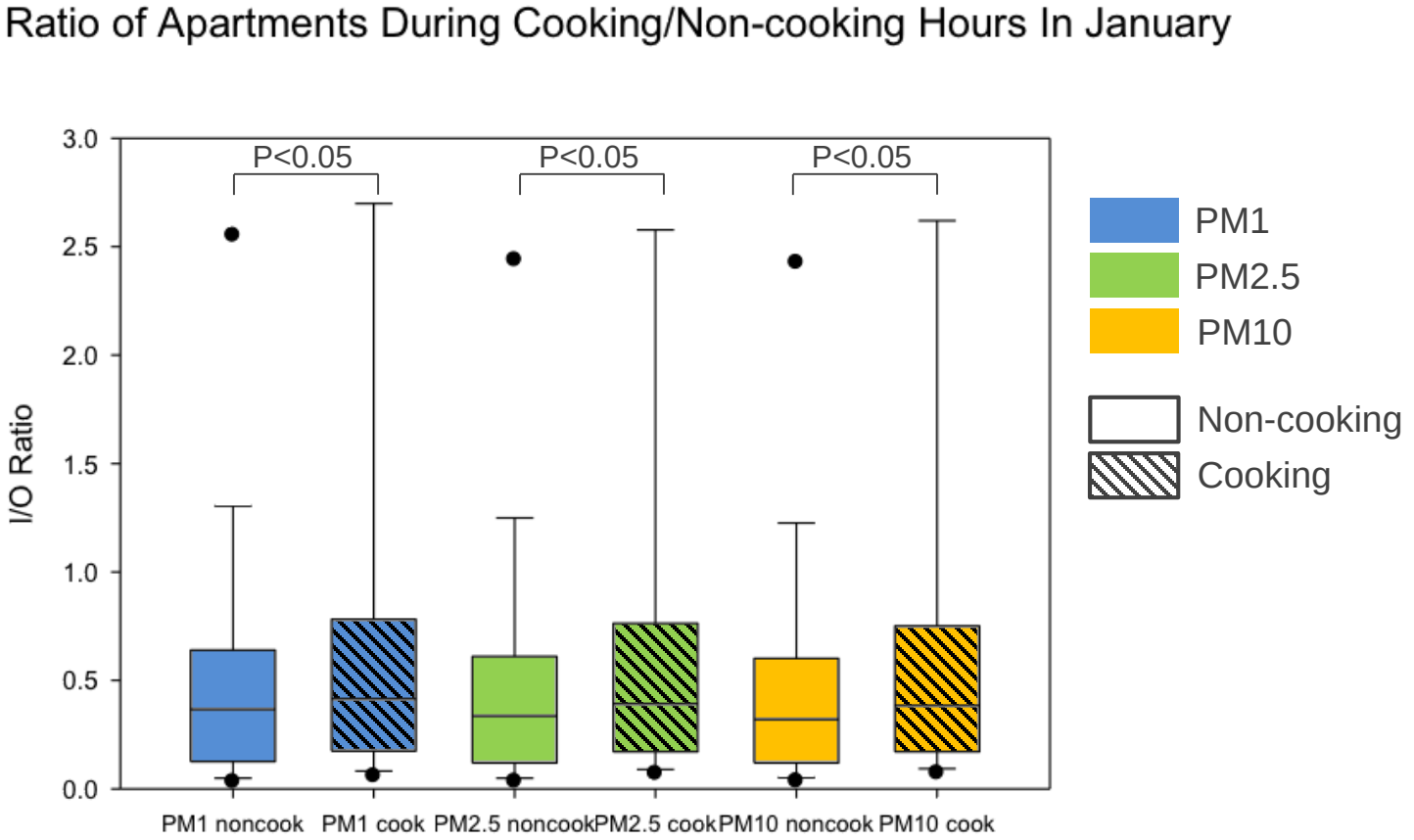




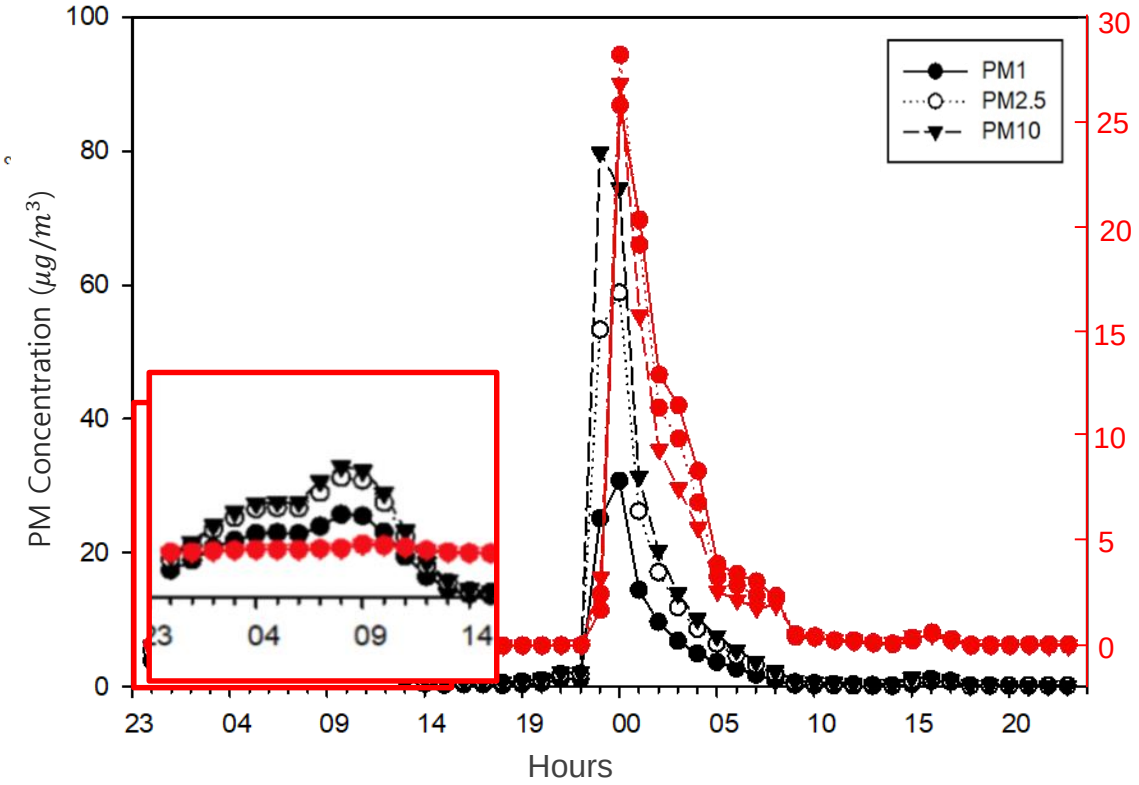
Indoor Sources: Cooking

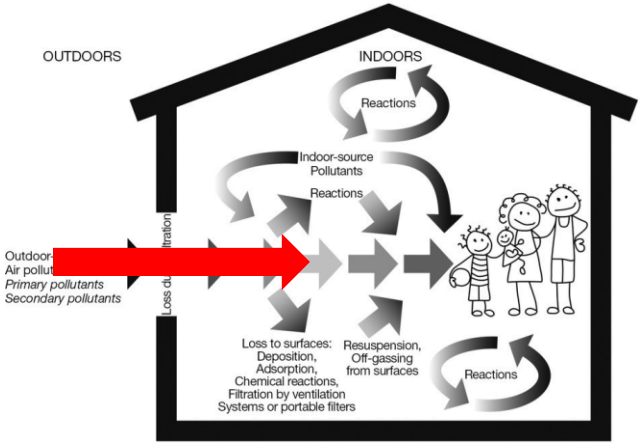


Indoor Sources: Cooking

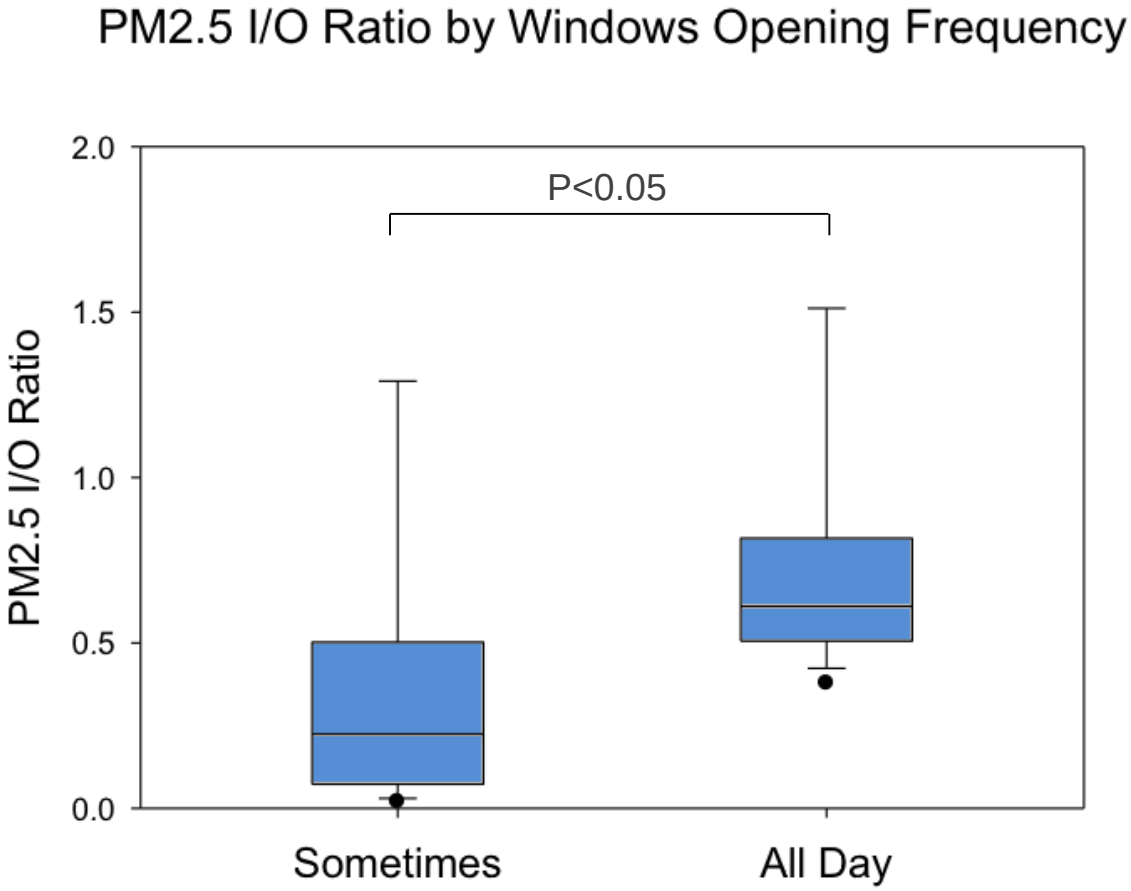


Outdoor to Indoor Transport



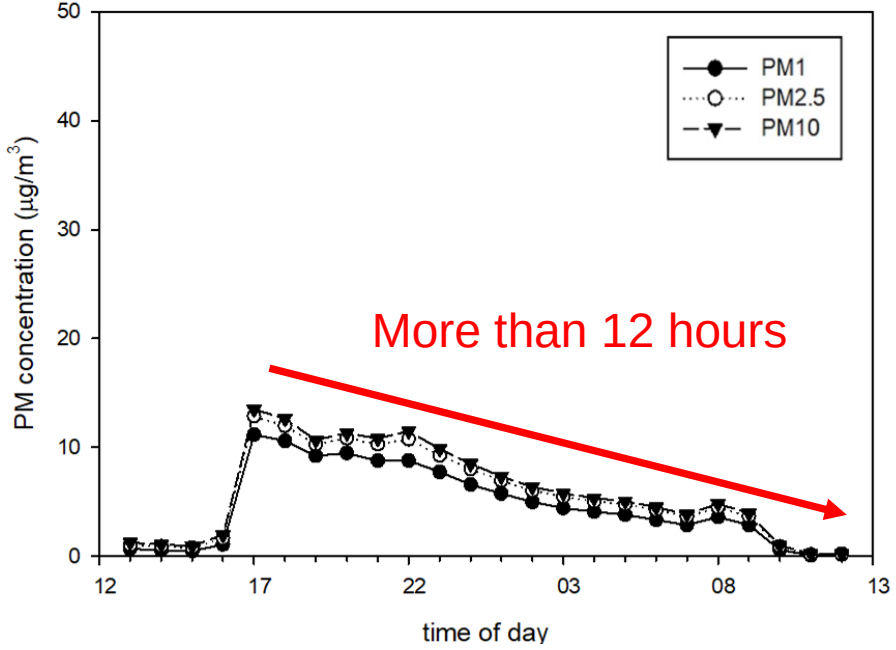


Ventilation

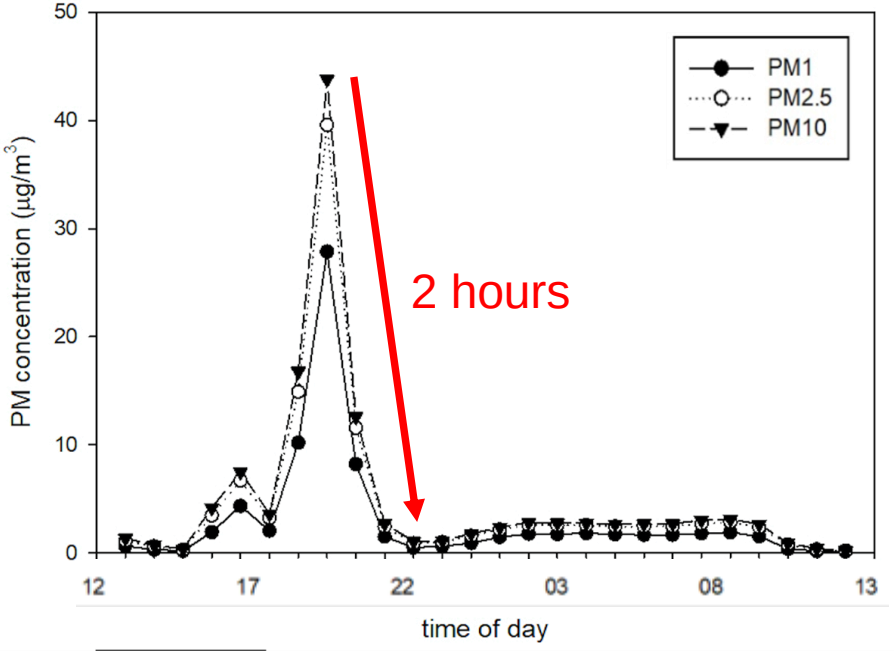


Mitigation: Fan over Stove

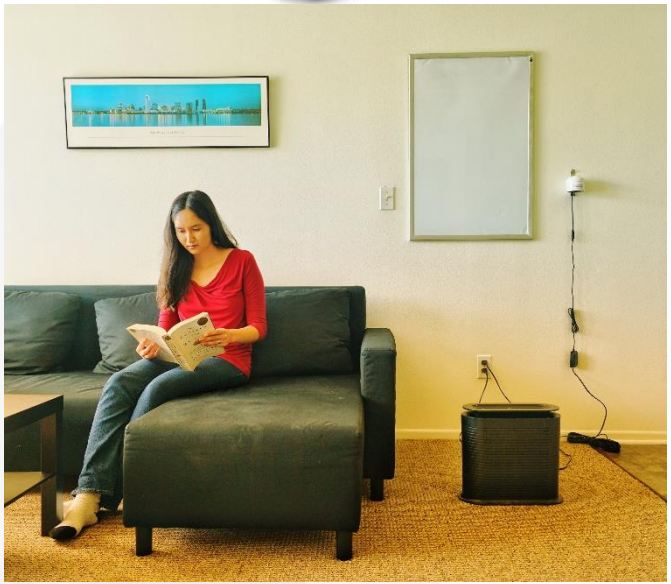
Fan over stove off

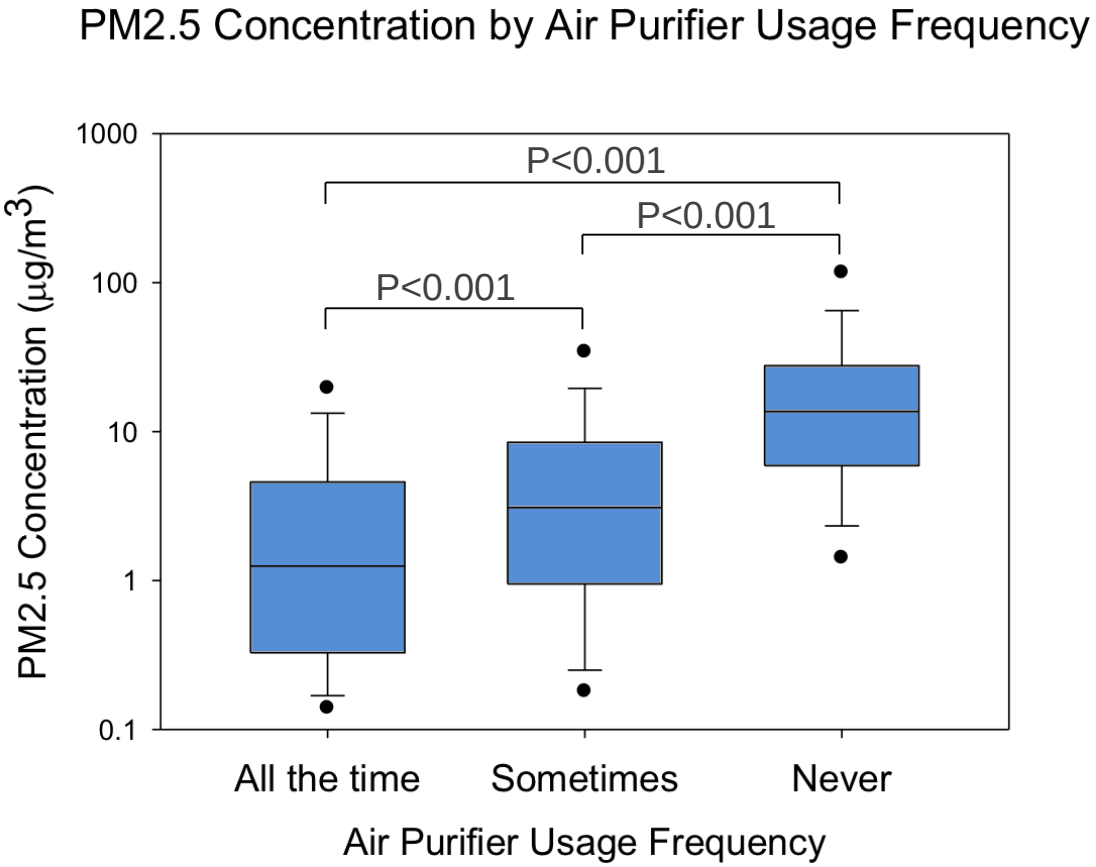


Fan over stove on



Mitigation: Air Purifier





Conclusions

- ✓ Low-cost sensors are effective to monitor indoor air quality.
- ✓ Low-cost sensors can capture indoor PM sources and outdoor to indoor transport.
- ✓ Low-cost sensors can be used to evaluate indoor PM mitigation measures.
- ✓ Low-cost sensors are effective and reliable to be used in the indoor environments.

Acknowledgement

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Engage, Educate, and Empower California Communities on the Use and Applications of “Low-cost” Air Monitoring Sensors

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