Evaluation of low-cost PM monitors for residential sources

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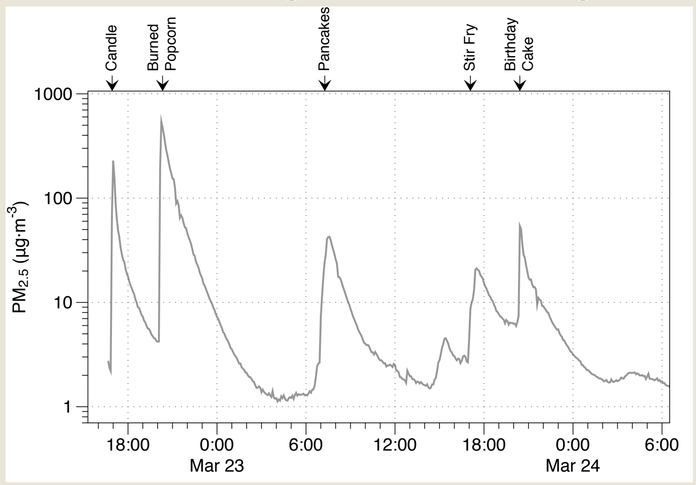
Q: Can a low cost PM monitor be useful for understanding and controlling IAQ?



There has been considerable work on understanding how low-cost sensors and sensor-based monitors perform for outdoor PM. Indoor concentrations can be significantly higher than outdoors, with distinct sources often dominated by ultrafine particles. Do available devices "see" the variety of relevant indoor sources? How well do they quantify events?

Low-cost monitors cost <$300

Research grade cost several $K

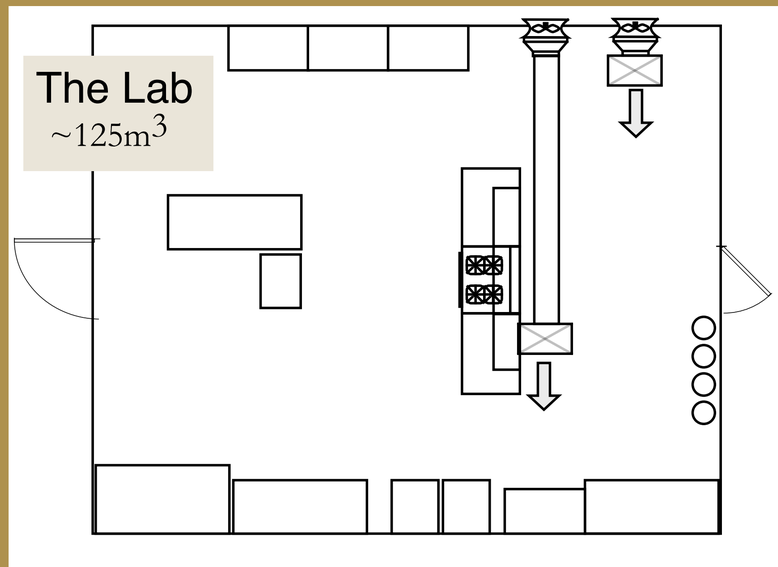
Reference grade cost 10x's $K

TEOM/FDMS

GRIMM miniWRAS

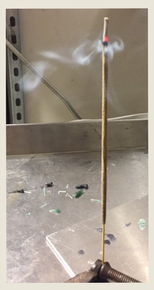
Approach

We performed a series of scripted events in a lab space the size of a large residential room. The events covered a range of possible indoor sources. Each test involved a pre-release period, the actual event, a 1-hr decay followed by a room flush. Low cost, reference, and research monitors were centrally placed in the well mixed room.



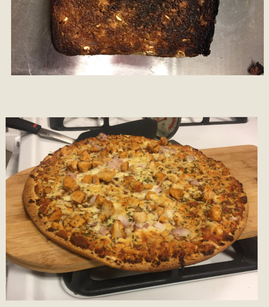
The sources

General



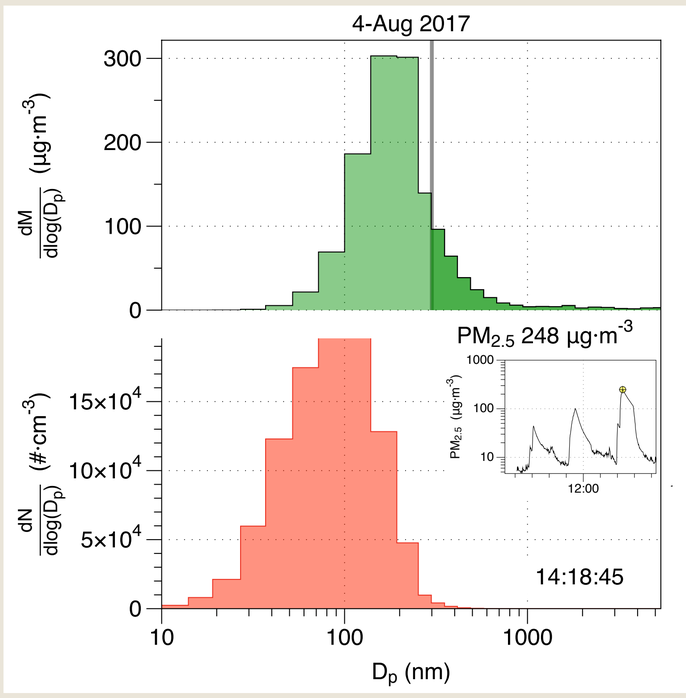
Burning / Heated

Cooking

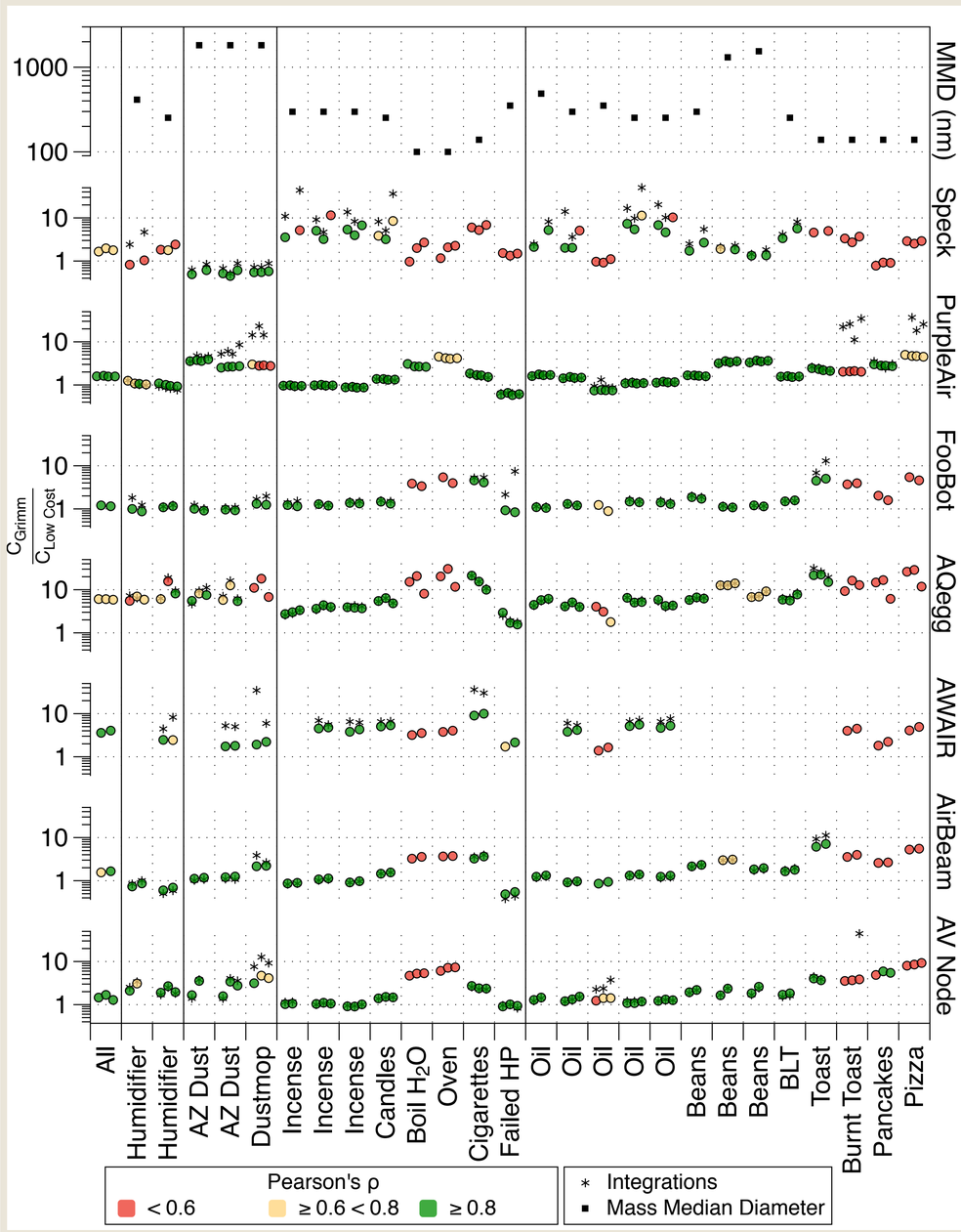


Results

Example: Particle size distributions for the cigarette event. Optical instruments will have troubles measuring mass in the light green shaded region.



Comparisons of low cost devices to the GRIMM monitor using a linear regression with 5 minute average values. The y - axis values are the linear scaling factors determined by the regression. The integrated values are shown where available. The top panel shows the event mass median diameter.



A: They may be very useful, but it depends on the sensor and the source

All of the low cost devices use optical detection sensors that have limited sensitivity below about 300nm (and some below about 500 nm). As a result they miss a large fraction of the particle distributions for many indoor sources. The sensors also have varied response by size and chemical composition; and use different aerosols for calibration. This results in varying scaling factors (correction factors relating device response to reference PM) across particle sources.

While there were sources that the devices missed, most events had a broad enough particle size distribution to at least create a bump in the signal. For IAQ control (e.g., ventilation or filtration) knowing the absolute value is not critical. While care must be taken when quantifying exposure, several of the devices appear promising for controls.

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