**Sensor Description**

Manufacturer/Model: PurpleAir/ PA-I Indoor

Pollutants: PM$_{1.0}$, PM$_{2.5}$ and PM$_{10}$ mass concentration

Time Resolution: 2-minute

Type: Optical

- Overall, the accuracy of the PA-I Indoor sensors increased with increasing PM$_{1.0}$ mass conc. The accuracy was negative at low PM$_{2.5}$ mass conc. and fairly constant for PM$_{2.5}$ mass conc. > 50 μg/m$^3$; and the accuracy decreased as the PM$_{10}$ mass conc. increased. The PA-I Indoor sensors underestimated PM$_{1.0}$ at PM$_{1.0}$ mass conc. > 50 μg/m$^3$ and all PM$_{10}$ levels; the sensors overestimated PM$_{2.5}$ measurements from the reference instruments in the laboratory experiments.

- The PA-I Indoor sensors exhibited high precision for all PM conc., T and RH combinations for PM$_{1.0}$ and PM$_{2.5}$ mass conc. The precision for PM$_{10}$ mass conc. cannot be determined due to the inherent variability of the test dust used.

- The PA-I Indoor sensors (IDs: 29D1, A3CA and BB9F) showed low to moderate intra-model variability.

- Data recovery was ~ 100% from all units in the field and in the laboratory.

- For PM$_{2.5}$, the PA-I Indoor sensors showed strong correlations with FEM BAM from the field (PM$_{2.5}$ R$^2$ ~ 0.75) and very strong correlations with GRIMM in the laboratory studies (R$^2$ > 0.99 for PM$_{1.0}$ and PM$_{2.5}$). For PM$_{10}$, the PA-I Indoor sensors showed weak correlations with FEM BAM from the field (PM$_{10}$ R$^2$ < 0.47) and very strong correlations with GRIMM and APS in the laboratory studies (R$^2$ ~ 0.97 and 0.968, respectively).

- The same three PA-I Indoor units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

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**Field Evaluation Highlights**

- Deployment period 02/15/2018 - 04/25/2018: the three PA-I Indoor sensors showed strong correlations with the PM$_{2.5}$ mass concentration as measured by FEM BAM and showed weak correlations with the corresponding FEM BAM PM$_{10}$ data.

- The units showed low intra-model variability and data recovery > 99.5%.

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Coefficient of Determination (R$^2$) quantifies how the three sensors followed the PM$_{2.5}$ concentration change by the reference instruments.

An R$^2$ approaching the value of 1 reflects a near perfect agreement, whereas a value of 0 indicates a complete lack of correlation.
Accuracy (PM$_{2.5}$)

Accuracy was evaluated by a concentration ramping experiment at 20 °C and 40%. The sensor’s readings at each ramping steady state are compared to the reference instrument.

A negative % means sensors’ overestimation by more than two fold. The higher the positive value (close to 100%), the higher the sensor’s accuracy.

<table>
<thead>
<tr>
<th>Steady state #</th>
<th>Sensor Mean (µg/m$^3$)</th>
<th>FEM GRIMM (µg/m$^3$)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.4</td>
<td>10.3</td>
<td>-37.1</td>
</tr>
<tr>
<td>2</td>
<td>33.9</td>
<td>15.3</td>
<td>-21.5</td>
</tr>
<tr>
<td>3</td>
<td>86.3</td>
<td>60.2</td>
<td>56.6</td>
</tr>
<tr>
<td>4</td>
<td>216.1</td>
<td>152.6</td>
<td>58.3</td>
</tr>
<tr>
<td>5</td>
<td>387.4</td>
<td>255.2</td>
<td>48.2</td>
</tr>
</tbody>
</table>

Precision (PM$_{2.5}$)

Sensor’s ability to generate precise measurements of PM$_{2.5}$ concentration at low, medium, and high pollutant levels were evaluated under 9 combinations of T and RH, including extreme weather conditions like cold and dry (5 °C and 15%) cold and humid (5 °C and 65%), hot and humid (35 °C and 65%), or hot and dry (35 °C and 15%).

Coefficient of Determination

The PA-I Indoor sensors showed very strong correlations with the corresponding FEM PM$_{2.5}$ data ($R^2 > 0.99$) at 20 °C and 40% RH. For conc. ramping experiments of PM$_{1.0}$ and PM$_{10}$, please see the lab report.

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the PA-I Indoor sensors except that the sensors showed spiked concentration changes at the 65% RH Set-point at 5 °C.

Observed Interferents

N/A