Sensor Description

Manufacturer/Model: Kaiterra/Laser Egg 2+
Pollutants: PM$_{2.5}$ and PM$_{10}$ mass concentration

Time Resolution: 1 minute

Type: Optical

Field Evaluation Highlights

- Overall, the Kaiterra Laser Egg 2+ sensors showed fairly constant accuracy (47% to 65%) over the PM$_{2.5}$ conc. range tested and overestimated PM$_{2.5}$ mass conc. from FEM GRIMM in the laboratory experiments at 20 °C and 40% RH.
- The Laser Egg 2+ sensors exhibited high precision for all T/RH combinations and all PM concentrations.
- The Laser Egg 2+ sensors (IDs: CED6, D0C3 and D20E) showed low intra-model variability.
- Data recovery was ~76% and 97% from all units in the field and in the laboratory, respectively.
- For PM$_{2.5}$, the Laser Egg 2+ sensors showed moderate to strong correlations with the FEM BAM, FEM GRIMM and FEM T640 from the field (PM$_{2.5}$ 0.59 < R$^2$ < 0.88) and showed very weak correlations with GRIMM, FEM BAM and T640 for PM$_{10}$ (R$^2$ < 0.31). The Laser Egg 2+ sensors showed very strong correlations with the FEM GRIMM in the laboratory studies (R$^2$ > 0.99 for PM$_{2.5}$).
- The same three Laser Egg 2+ units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

Deployment period 02/19/2019 - 04/09/2019: the three Kaiterra Laser Egg 2+ sensors showed moderate to strong correlations with PM$_{2.5}$ mass concentration as monitored by FEM BAM, FEM GRIMM and FEM T640. PM$_{10}$ mass conc. showed very weak correlations with the corresponding GRIMM, FEM BAM and T640 data.

- The units showed low intra-model variability and data recovery for PM$_{2.5}$ and PM$_{10}$ was ~76% and 77%, respectively.

Field Evaluation report:
http://www.aqmd.gov/aq-spec/evaluations/field

Lab evaluation report:
http://www.aqmd.gov/aq-spec/evaluations/laboratory

AQ-SPEC website:
http://www.aqmd.gov/aq-spec

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.
Laboratory Evaluation Highlights

Accuracy (PM$_{2.5}$)

<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>9.4</td>
<td>6.5</td>
<td>54.5</td>
</tr>
<tr>
<td>2</td>
<td>17.4</td>
<td>11.4</td>
<td>47.2</td>
</tr>
<tr>
<td>3</td>
<td>47.0</td>
<td>34.8</td>
<td>64.9</td>
</tr>
<tr>
<td>4</td>
<td>163.3</td>
<td>108.8</td>
<td>49.9</td>
</tr>
<tr>
<td>5</td>
<td>287.1</td>
<td>193.5</td>
<td>51.6</td>
</tr>
<tr>
<td>6</td>
<td>451.0</td>
<td>302.7</td>
<td>51.0</td>
</tr>
</tbody>
</table>

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.

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%).

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the Kaiterra Laser Egg 2+ sensor; at the set-points of RH change, the sensors showed some small spiked conc. Changes.

Coefficient of Determination

The Kaiterra Laser Egg 2+sensors showed very strong correlations with the corresponding FEM PM$_{2.5}$ data ($R^2 > 0.99$) at 20 °C and 40% RH.

Observed Interferents

N/A