Laboratory Evaluation

IQAir AirVisual Pro v1.1683
Three IQAir AirVisual Pro FW 1.1683 (hereafter IQAir AirVisual Pro) sensors (units IDs: TP7S, YCYL, MXC7) were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (08/15/2018 to 10/11/2018) under ambient environmental conditions and have been evaluated in the South Coast AQMD Chemistry Laboratory under controlled artificial aerosol concentration/size range, temperature, and relative humidity. The same three IQAir AirVisual Pro units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

**IQAir AirVisual Pro (3 units tested):**
- Particle sensors (optical; non-FEM)
- Each unit measures: PM$_{2.5}$ mass concentration ($\mu$g/m$^3$), Temperature (F/°C), Relative Humidity (%)
- Unit cost: ~$270
- Time resolution: 1-min
- Units IDs: TP7S, YCYL, MXC7
- Difference from 1st generation: Improved PM$_{2.5}$ sensor with a further enhanced calibration process

**GRIMM (reference method):**
- Optical particle counter
- FEM PM$_{2.5}$
- Uses proprietary algorithms to calculate total PM, PM$_{2.5}$, and PM$_1$ mass conc. from particle number measurements
- Cost: ~$25,000
- Time resolution: 1-min

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GRIMM (reference method): Optical particle counter, FEM PM$_{2.5}$, proprietary algorithms for PM calculation, cost: ~$25,000, time resolution: 1-min.

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FEM GRIMM
The IQAir AirVisual Pro sensors tracked well with the concentration variation as recorded by the FEM GRIMM in the concentration range of 0 - ~300 μg/m³. The coefficient of determination (R² = 0.99) shows very strong correlations with the FEM GRIMM PM₂.₅ mass conc. (5-min; μg/m³).
IQAir AirVisual Pro vs FEM GRIMM PM$_{2.5}$ Accuracy

- Accuracy (20°C and 40% RH)

<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>11.2</td>
<td>10.18</td>
<td>89.7</td>
</tr>
<tr>
<td>2</td>
<td>17.5</td>
<td>15.20</td>
<td>84.9</td>
</tr>
<tr>
<td>3</td>
<td>64.6</td>
<td>59.62</td>
<td>91.7</td>
</tr>
<tr>
<td>4</td>
<td>172.4</td>
<td>153.11</td>
<td>87.4</td>
</tr>
<tr>
<td>5</td>
<td>338.2</td>
<td>270.07</td>
<td>74.8</td>
</tr>
</tbody>
</table>

- The IQAir AirVisual Pro sensors overestimated FEM GRIMM PM$_{2.5}$ mass concentration at 20°C and 40% RH. The IQAir AirVisual Pro sensors showed good accuracy for all PM$_{2.5}$ levels except for ~300 µg/m$^3$.

IQAir AirVisual Pro: Data Recovery and intra-model variability

- Data recovery for PM$_{2.5}$ mass concentration from all units was 100% except for Unit YCYL in several experiments.

- PM$_{2.5}$ measurement variations were observed between the three units: 36.4%, 23.6% and 24.6% for low, medium and high PM$_{2.5}$ mass concentrations, respectively.
IQAir AirVisual Pro: Precision

- Precision (Effect of PM$_{2.5}$ conc., Temperature and Relative Humidity)

Overall, the IQAir AirVisual Pro sensors showed high precision for all of the combinations of low, medium and high PM$_{2.5}$ conc., T, and RH.

- No results presented for the Medium PM$_{2.5}$ RH ramping at 5°C due to low data recovery from all units.
IQAir AirVisual Pro: Climate Susceptibility

IQAir AirVisual Pro vs FEM GRIMM
(20 °C RH ramping, Med PM$_{2.5}$ mass conc.)

High Temp – RH ramping
(medium conc.)

Med Temp – RH ramping
(medium conc.)
Discussion

➢ **Accuracy**: Overall, the IQAir AirVisual Pro sensors showed good accuracy for all PM$_{2.5}$ levels except for ~300 μg/m$^3$. The IQAir AirVisual Pro sensors overestimated PM$_{2.5}$ measurements from FEM GRIMM in the laboratory experiments at 20°C and 40% RH.

➢ **Precision**: The IQAir AirVisual Pro sensors have high precision for all test combinations (PM concentrations, T and RH) for PM$_{2.5}$ mass concentrations.

➢ **Intra-model variability**: Intra-model variability was observed among the IQAir AirVisual Pro sensors was 36.4%, 23.6% and 24.6% for low, medium and high PM$_{2.5}$ mass concentrations, respectively.

➢ **Data Recovery**: Data recovery for PM$_{2.5}$ mass concentration from all units was ~100% except for Unit YCYL not able to report data in several experiments.

➢ **Coefficient of Determination**: The IQAir AirVisual Pro sensors showed very strong correlation/linear response with the corresponding FEM GRIMM PM$_{2.5}$ measurement data ($R^2 = 0.99$).

➢ **Climate susceptibility**: For most of the temperature and relative humidity combination, the IQAir AirVisual Pro sensors showed variations in PM$_{2.5}$ concentrations at 65% RH, especially at low temperature.