Laboratory Evaluation:

TSI BlueSky
Three **TSI BlueSky** sensors (units IDs: 8031, 8027, 8037) were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (04/08/2020 to 06/15/2020) 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 TSI BlueSky units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

**TSI BlueSky (3 units tested):**
- Particle sensor: optical; non-FEM (SPS30, Sensirion)
- Each unit reports: PM$_{2.5}$ and PM$_{10}$ (μg/m$^3$), Temperature and Relative Humidity
- Unit cost: $400
- Time resolution: 1-min
- Units IDs: Unit 8031, Unit 8027 and Unit 8037

**GRIMM (reference method):**
- Optical particle counter
- FEM PM$_{2.5}$
- Uses proprietary algorithms to calculate PM$_{1.0}$, PM$_{2.5}$, and PM$_{10}$ mass conc. from particle number measurements
- Cost: ~$25,000
- Time resolution: 1-min
The TSI BlueSky sensors tracked well with the concentration variation as recorded by the FEM GRIMM in the concentration range of 0 - ~250 $\mu$g/m$^3$.

The TSI BlueSky sensors showed very strong correlations with the FEM GRIMM PM$_{2.5}$ mass conc. ($R^2 > 0.99$).
TSI BlueSky 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>9.0</td>
<td>8.7</td>
<td>96.4</td>
</tr>
<tr>
<td>2</td>
<td>16.1</td>
<td>14.8</td>
<td>91.1</td>
</tr>
<tr>
<td>3</td>
<td>48.6</td>
<td>48.1</td>
<td>98.9</td>
</tr>
<tr>
<td>4</td>
<td>148.8</td>
<td>149.4</td>
<td>99.6</td>
</tr>
<tr>
<td>5</td>
<td>260.2</td>
<td>250.3</td>
<td>96.0</td>
</tr>
</tbody>
</table>

• The TSI BlueSky sensors overestimated FEM GRIMM PM$_{2.5}$ mass concentration at 20 °C and 40% RH. The accuracy of the TSI BlueSky sensors was fairly constant (~ 91% to 99%) over the PM$_{2.5}$ mass concentration range tested.

TSI BlueSky: Data Recovery and Intra-model Variability

• Data recovery for PM$_{2.5}$ mass concentration from all units was 100%
• Moderate PM$_{2.5}$ measurement variations were observed between the TSI BlueSky sensors
TSI BlueSky vs FEM GRIMM
(PM$_{2.5}$; 1-min mean)

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

- Overall, the TSI BlueSky sensors showed high precision for all combinations of low, medium and high PM$_{2.5}$ conc., T, and RH.
- Precision was relatively higher at higher PM$_{2.5}$ mass concentrations.
TSI BlueSky PM$_{2.5}$: Climate Susceptibility

Low Temp – RH ramping (medium conc.)

High Temp – RH ramping (medium conc.)
Discussion

➢ **Accuracy:** Overall, the accuracy of the TSI BlueSky sensors was fairly constant (~ 91% to 99%) over the PM\(_{2.5}\) mass concentration range tested. The TSI BlueSky sensors overestimated PM\(_{2.5}\) measurements from FEM GRIMM in the laboratory experiments at 20 °C and 40% RH.

➢ **Precision:** The TSI BlueSky sensors showed high precision for all test combinations (PM concentrations, T and RH) for PM\(_{2.5}\) mass concentrations.

➢ **Intra-model variability:** Moderate intra-model variability was observed among the TSI BlueSky sensors.

➢ **Data Recovery:** Data recovery for PM\(_{2.5}\) mass concentration was 100% from all TSI BlueSky units.

➢ **Coefficient of Determination:** The TSI BlueSky 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 climate condition had minimal effect on the TSI BlueSky sensors’ precision; the sensors showed spiked conc. change at the RH change points at 5 °C and showed significant concentration variation at 5 °C/65% RH.