Field Evaluation
Liveable Cities – SLX-NO$_2$
From 11/19/2021 to 01/19/2022, three Liveable Cities – SLX-NO₂ multi-sensor pods were deployed at the South Coast AQMD stationary ambient monitoring site in Rubidoux and were run side-by-side with the Federal Reference Method (FRM) instrument measuring the same pollutants.

**Liveable Cities - SLX-NO₂**
- **3 units tested**:
  - Sensors: NO₂ – Electrochemical (Alphasense B43F, non-FEM)
  - Each unit measures: NO₂ (ppb)
  - Unit cost: $569 + $309/year for software, reporting and cellular data
  - Time resolution: 1-min
  - Units IDs: 0124, 0130 (three sensors were deployed and one of the sensors reported invalid values and was excluded from the data analysis)

**South Coast AQMD Reference instruments**:
- NOₓ instrument (Teledyne T200U; FRM NO₂)
  - Cost: ~$13,000
  - Time resolution: 1-min
Data validation & recovery

- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for NO\textsubscript{2} from Unit 0124 and Unit 0130 was ~ 90% and 97%, respectively

Liveable Cities - SLX-NO\textsubscript{2}; Intra-model variability

- Absolute intra-model variability was ~ 0.33 ppb for the NO\textsubscript{2} measurements (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 36.2% for the NO\textsubscript{2} measurements (calculated as the absolute intra-model variability relative to the mean of the three sensor means)
The Liveable Cities - SLX-NO₂ sensors showed weak to moderate correlations with the corresponding FRM NO₂ data (0.42 < R² < 0.55).

Overall, the Liveable Cities - SLX-NO₂ sensors underestimated the NO₂ concentrations as measured by the FRM instrument.

The Liveable Cities - SLX-NO₂ sensors seemed to track the diurnal NO₂ variations as recorded by the FRM instrument.
The Liveable Cities - SLX-NO₂ sensors showed weak to moderate correlations with the corresponding FRM NO₂ data (0.47 < $R^2$ < 0.59).

Overall, the Liveable Cities - SLX-NO₂ sensors underestimated the NO₂ concentrations as measured by the FRM instrument.

The Liveable Cities - SLX-NO₂ sensors seemed to track the diurnal NO₂ variations as recorded by the FRM instrument.
• The Liveable Cities - SLX-NO₂ sensors showed moderate correlations with the corresponding FRM NO₂ data (0.66 < R² < 0.70)

• Overall, the Liveable Cities - SLX-NO₂ sensors underestimated the NO₂ concentrations as measured by the FRM instrument

• The Liveable Cities - SLX-NO₂ sensors seemed to track the diurnal NO₂ variations as recorded by the FRM instrument
### Summary: NO₂

<table>
<thead>
<tr>
<th>Average of 3 Sensors, NO₂</th>
<th>Liveable Cities - SLX-NO₂ vs FRM NO₂</th>
<th>FRM NO₂ (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (ppb)</td>
<td>SD (ppb)</td>
<td>R²</td>
</tr>
<tr>
<td>5-min</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>1-hr</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>24-hr</td>
<td>1.3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

¹ Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).
² Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.
³ Root Mean Square Error (RMSE): another metric to calculate measurement errors.
Discussion

• Data recovery for NO$_2$ from Unit 0124 and Unit 0130 was ~ 90% and 97%, respectively
• The absolute intra-model variability for NO$_2$ was ~ 0.33 ppb.
• During the entire field deployment testing period:
  ➢ NO$_2$ sensors showed weak to moderate relations with the FRM instrument (0.42 < $R^2$ < 0.55, 5-min mean) and underestimated the corresponding FRM data
• No sensor calibration was performed by AQ-SPEC staff for this evaluation.
• Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under controlled T and RH conditions and known target and interferent pollutants concentrations.
• These results are still preliminary