Field Evaluation of AirThinx IAQ
From 5/11/2018 to 7/10/2018, three AirThinx IAQ sensor units were deployed at our (SCAQMD) Rubidoux station and ran side-by-side with Federal Equivalent Method (FEM) instruments measuring the same pollutants.

**AirThinx IAQ (3 units tested):**
- Particle sensor (optical; non-FEM) (model Plantower PMS5003)
- Each sensor reports: PM\(_{1.0}\), PM\(_{2.5}\) and PM\(_{10}\) mass concentration (μg/m\(^3\))
- Unit also carries CO\(_2\) (ppm), CH\(_2\)O (mg/m\(^3\)), VOC (ppm), pressure (hPa), temperature (degree F), and relative humidity (%) sensors
- Unit cost: $1000
- Time resolution: 1-min
- Units IDs:
  - Unit 5797
  - Unit 6258
  - Unit 6772

**MetOne BAM (reference method):**
- Beta-attenuation monitor (FEM PM\(_{2.5}\), FEM PM\(_{10}\))
- Unit cost: ~$20,000
- Time resolution: 1-hr

**GRIMM (reference method):**
- Optical Particle Counter (FEM PM\(_{2.5}\))
- Uses proprietary algorithms to calculate total PM\(_{1.0}\), PM\(_{2.5}\), and PM\(_{10}\) from particle number measurements
- Unit cost: ~$25,000 and up
- Time resolution: 1-min

**SCAQMD Meteorological Station:**
- Measures temperature and relative humidity
- Unit cost: ~$5,000
- 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 was near 100% for all three units tested.

AirThinx; intra-model variability

• Low intra-model variability was observed for the mass concentrations of $PM_{1.0}$, $PM_{2.5}$, and $PM_{10}$ from the three tested AirThinx units.
Equivalent methods: BAM vs GRIMM

- Good correlation between the two equivalent methods for PM\textsubscript{2.5} and PM\textsubscript{10} measurements
• PM$_{1.0}$ measurements from the three AirThinx sensors correlate well with the corresponding GRIMM data ($0.68 < R^2 < 0.71$).
• The three sensor units tested seem to track well the diurnal PM$_{1.0}$ variations recorded by the GRIMM instrument.
AirThinx vs FEM GRIMM (PM$_{2.5}$; 5-min mean)

- AirThinx PM$_{2.5}$ measurements show moderate correlations with the corresponding FEM GRIMM PM$_{2.5}$ mass concentrations ($0.54 < R^2 < 0.57$).
- AirThinx measurements seem to track the PM$_{2.5}$ diurnal variations recorded by the FEM instrument.
AirThinx vs GRIMM (PM$_{10}$; 5-min mean)

- PM$_{10}$ measurements form the three AirThinx sensors do not correlate with the corresponding GRIMM data.
- The three sensor units tested seem to track the diurnal PM$_{10}$ variations recorded by the GRIMM instrument well.
- The sensors PM$_{10}$ measurements largely underestimate the corresponding GRIMM data.
AirThinx vs GRIMM (PM$_{1.0}$; 1-hr mean)

- AirThinx PM$_{1.0}$ measurements correlate well with the corresponding GRIMM PM$_{1.0}$ mass concentrations ($0.71 < R^2 < 0.74$).
- The three sensor units tested track well the diurnal PM$_{1.0}$ variations recorded by the GRIMM instrument.
• PM$_{2.5}$ measurements from AirThinx sensors correlate moderately with the corresponding FEM GRIMM data ($0.58 < R^2 < 0.61$)
• The three sensor units tested seem to track well the diurnal PM$_{2.5}$ variations recorded by the FEM GRIMM instrument.
AirThinx vs GRiMM (PM$_{10}$; 1-hr mean)

- AirThinx PM$_{10}$ measurements do not correlate with the corresponding GRiMM PM$_{10}$ mass concentrations.
- The three sensor units tested seem to track well the diurnal PM$_{10}$ variations recorded by the GRiMM instrument.
- The sensors PM$_{10}$ measurements largely underestimate the corresponding GRiMM data.
• AirThinx PM$_{1.0}$ measurements correlate well with the corresponding 24-hr mean GRIMM PM$_{1.0}$ mass concentrations ($0.87 < R^2 < 0.91$).

• The three sensor units tested seem to track well the daily PM$_{1.0}$ variations recorded by the GRIMM instrument.
• AirThinx PM$_{2.5}$ measurements correlate well with the corresponding FEM GRIMM PM$_{2.5}$ mass concentrations ($0.74 < R^2 < 0.78$).
• The three sensor units tested seem to track well the daily PM$_{2.5}$ variations recorded by the FEM GRIMM instrument.
AirThinx vs GRIMM (PM$_{10}$; 24-hr mean)

- AirThinx PM$_{10}$ measurements do not correlate with the corresponding GRIMM PM$_{10}$ mass concentrations ($R^2 < 0.1$).
- The sensors PM$_{10}$ measurements largely underestimate the corresponding GRIMM data.
AirThinx vs FEM BAM (PM$_{2.5}$; 1-hr mean)

- AirThinx PM$_{2.5}$ measurements correlate moderately with the corresponding FEM BAM PM$_{2.5}$ mass concentrations ($0.51 < R^2 < 0.55$).
- The three sensor units tested seem to track well the diurnal PM$_{2.5}$ variations recorded by the FEM BAM instrument.
PM\textsubscript{10} measurements from AirThinx sensors do not correlate with the corresponding FEM BAM PM\textsubscript{10} data ($0.04 < R^2 < 0.07$).

The tested sensors seem to track the diurnal PM\textsubscript{10} variations recorded by the FEM BAM instrument.

All AirThinx sensors largely underestimate the corresponding FEM PM\textsubscript{10} measurements.
AirThinx vs FEM BAM (PM$_{2.5}$; 24-hr mean)

- AirThinx PM$_{2.5}$ measurements correlate moderately with the corresponding FEM BAM PM$_{2.5}$ mass concentrations data ($0.52 < R^2 < 0.58$).
- The three sensor units track well the daily PM$_{2.5}$ variations recorded by the FEM BAM instrument.
AirThinx vs FEM BAM (PM$_{10}$; 24-hr mean)

- PM$_{10}$ measurements by AirThinx sensors do not correlate with the corresponding FEM BAM PM$_{10}$ data (0.08 < $R^2$ < 0.11).
- AirThinx sensors seem to track the daily PM$_{10}$ variations recorded by the FEM BAM instrument.
Temperature measurements from all three AirThinx sensors correlate well with the corresponding reference data ($R^2 > 0.96$), but they slightly overestimate the ambient temperature as measured by SCAQMD met station.

The three sensor units track well the diurnal variations of ambient temperature as measured by the SCAQMD met station.
AirThinx vs SCAQMD Met Station (Relative Humidity; 1-hr mean)

- AirThinx sensors Relative Humidity (RH) measurements correlate well with the corresponding SCAQMD met station data ($R^2 > 0.94$)
- AirThinx sensors track well the diurnal variations of ambient RH as measured by the SCAQMD met station.
AirThinx vs SCAQMD Met Station (Temperature; 24-hr mean)

- Temperature measurements from all three AirThinx sensors correlate well with the corresponding reference data ($R^2 > 0.91$), but they slightly overestimate the SCAQMD’s met station measured temperature.
- The three sensor units track well the daily variations of ambient temperature as measured by the SCAQMD met station.
AirThinx vs SCAQMD Met Station (Relative Humidity; 24-hr mean)

- AirThinx sensors Relative Humidity (RH) measurements correlate well with the corresponding SCAQMD met station data ($R^2 > 0.97$).
- AirThinx sensor units seem to slightly underestimate the SCAQMD met station data.
- AirThinx sensors track well the daily variations of ambient RH as measured by the SCAQMD met station.
Discussion

- Overall, the **AirThinx** sensor units were reliable with high data recovery (~100%)
- The three units tested showed low intra-model variability for the mass concentrations of PM$_{1.0}$, PM$_{2.5}$, and PM$_{10}$
- AirThinx PM$_{1.0}$ data correlated well (0.68 < $R^2$ < 0.71) with the corresponding 5-min values collected using substantially more expensive particle instrument (GRIMM)
- AirThinx PM$_{2.5}$ mass concentrations showed moderate correlations (0.54 < $R^2$ < 0.57) with 5-min FEM GRIMM PM$_{2.5}$ mass measurements
- AirThinx PM$_{10}$ mass concentrations did not correlate ($R^2$ < 0.06) with the GRIMM PM$_{10}$ mass measurements
- Comparison of AirThinx to FEM BAM showed moderate correlation for PM$_{2.5}$ (0.51 < $R^2$ < 0.55) but did not correlate for PM$_{10}$ (0.04 < $R^2$ < 0.07)
- AirThinx PM$_{2.5}$ data was usually overestimated, while PM$_{10}$ data were largely underestimated compared to the corresponding FEM BAM and GRIMM values
- Temperature and relative humidity measured by AirThinx sensors correlated very well ($R^2$ > 0.94) with the corresponding values collected using a substantially more expensive meteorological instrument
- It should be noted that no sensor calibration had been performed by SCAQMD Staff prior to the beginning of this field testing
- Laboratory chamber testing may be necessary to fully evaluate the performance of these sensors over different / more extreme environmental conditions

- **All results are still preliminary**