AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Sensor Description

Manufacturer/Model:
TSI AirAssure
Model IPM2.5

Pollutants:
PM2.5

Measurement Range:
5 - 300 µg/m³

Type: Optical

Additional Information

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

Evaluation Summary

- Overall, the three AirAssure sensors showed low accuracy. They overestimated the FEM GRIMM $PM_{2.5}$ measurements for a concentration range between 0 to 150 µg/m³. When the $PM_{2.5}$ concentration was higher than 150 µg/m³ (measured by GRIMM), the AirAssure plateaued at 300 µg/m³.

- The three AirAssure sensors exhibited high precision for most of the tested T/RH combinations in the environmental chamber.

- AirAssure sensors (units IDs: 004, 005, 010) showed low intra-model variability in the field deployment. However, in the laboratory testing, units IDs 5036, 7003, and 7004 showed moderate to high intra-model variability.

- AirAssure sensors had good data recovery (>99% for 5-min average in the field, and >97% for 1-min average in the laboratory).

- For $PM_{2.5}$, the AirAssure sensors showed strong correlations with the reference instrument from the field ($R^2 > 0.81$) and very strong correlations from the laboratory studies ($R^2 > 0.99$).

Field Evaluation Highlights

- Deployment period 12/18/2015- 02/15/2016: the three AirAssure sensors (units IDs: 004, 005, 010) showed strong correlations with $PM_{2.5}$ concentration change as monitored by GRIMM and BAM.

- The units showed > 99% data recovery as well as low intra-model variability.

$R^2 > 0.81$
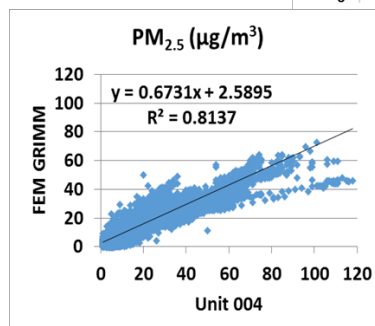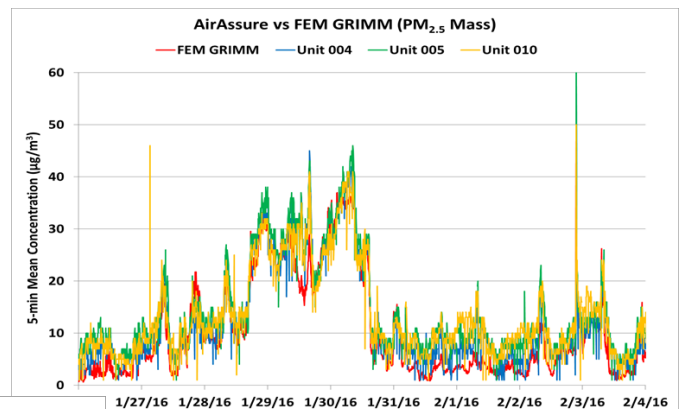
Coefficient of Determination (R^2) quantifies how the three sensors followed the PM concentration change by GRIMM.

An R^2 approaching the value of 1 reflects a near perfect agreement, whereas a value of 0 indicates a complete lack of correlation.
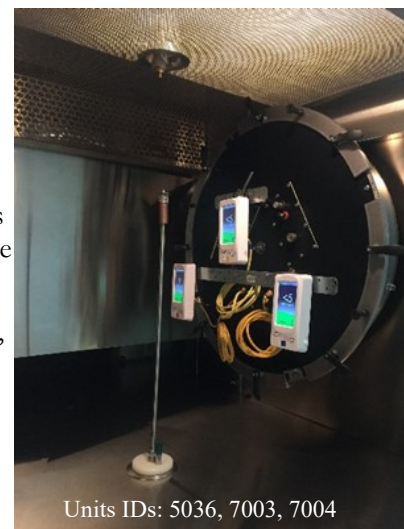
Laboratory Evaluation Highlights
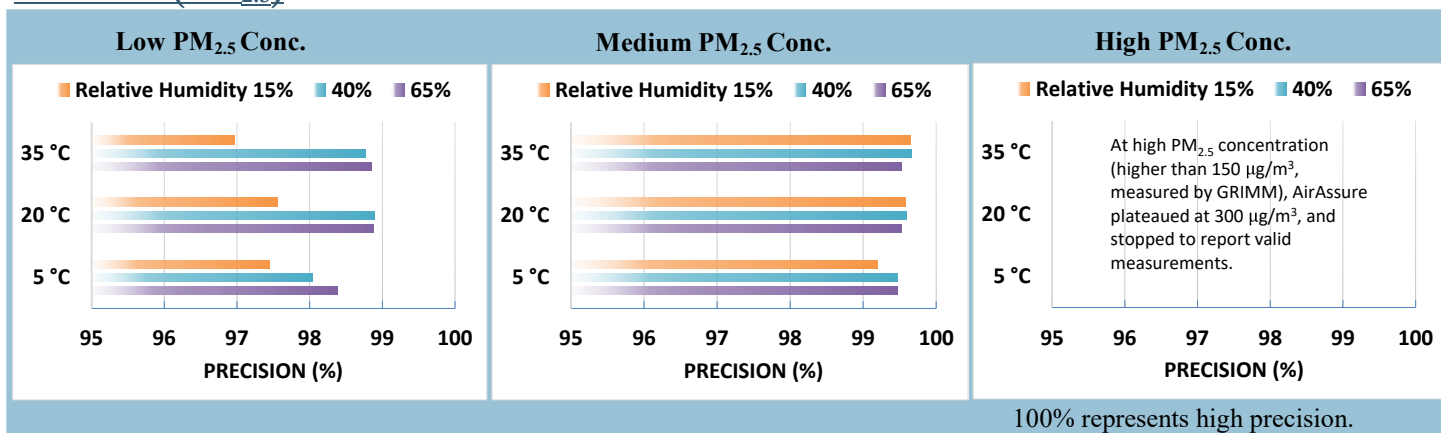
Accuracy

$$A\,(\%) = 100 - \frac{|\bar{X}-\bar{R}|}{\bar{R}} * 100$$

Steady State (#)	Sensor mean (µg/m³)	GRIMM (µg/m³)	Accuracy (%)
1	37.4	12.1	-108.1
2	77.3	32.7	-36.5
3	157.7	73.3	-15.2
4	295.9	142.8	-7.2

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. Negative % means sensors' overestimation by more than two fold. The higher the positive value (close to 100%), the higher the sensor's accuracy.
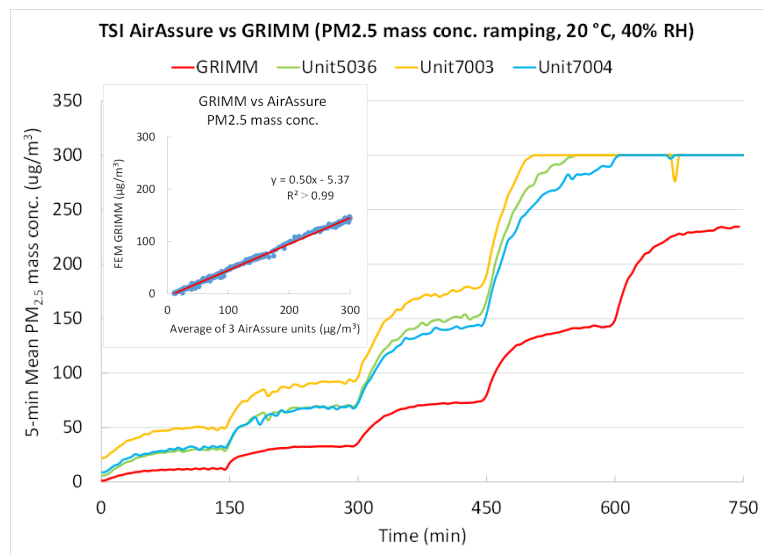
Units IDs: 5036, 7003, 7004

Precision (PM$_{2.5}$)

Low PM$_{2.5}$ Conc.

Relative Humidity 15%   40%   65%

(horizontal bar chart: PRECISION (%) axis from 95 to 100; rows for 35 °C, 20 °C, 5 °C)

Medium PM$_{2.5}$ Conc.

Relative Humidity 15%   40%   65%

(horizontal bar chart: PRECISION (%) axis from 95 to 100; rows for 35 °C, 20 °C, 5 °C)

High PM$_{2.5}$ Conc.

Relative Humidity 15%   40%   65%

(rows for 35 °C, 20 °C, 5 °C)

At high PM$_{2.5}$ concentration (higher than 150 µg/m³, measured by GRIMM), AirAssure plateaued at 300 µg/m³, and stopped to report valid measurements.

100% represents high precision.

Sensor's ability of generating precise measurements of PM 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%).

Coefficient of Determination

TSI AirAssure vs GRIMM (PM2.5 mass conc. ramping, 20 °C, 40% RH)

GRIMM   Unit5036   Unit7003   Unit7004

(line chart: 5-min Mean PM$_{2.5}$ mass conc. (ug/m³) vs Time (min))

Inset: GRIMM vs AirAssure PM2.5 mass conc.
FEM GRIMM (µg/m³) vs Average of 3 AirAssure units (µg/m³)
$y = 0.50x - 5.37$
$R^2 > 0.99$

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

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the AirAssure sensors' precision. At the set-points of RH changes, AirAssure reported spiked changes in concentrations.

Observed Interferents

N/A