AQ-SPEC

Air Quality Sensor Performance Evaluation Center

Evaluation Summary

Sensor Description

Manufacturer/Model:
PurpleAir/
PA-I Indoor

Pollutants:
$PM_{1.0}$, $PM_{2.5}$ and PM_{10} mass concentration

Time Resolution:
2-minute

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

- Overall, the accuracy of the PA-I Indoor sensors increased with increasing $PM_{1.0}$ mass conc. The accuracy was negative at low $PM_{2.5}$ mass conc. and fairly constant for $PM_{2.5}$ mass conc. > 50 µg/m³; and the accuracy decreased as the PM_{10} mass conc. increased. The PA-I Indoor sensors underestimated $PM_{1.0}$ at $PM_{1.0}$ mass conc. > 50 µg/m³ and all PM_{10} levels; the sensors overestimated $PM_{2.5}$ measurements from the reference instruments in the laboratory experiments.
- The PA-I Indoor sensors exhibited high precision for all PM conc., T and RH combinations for $PM_{1.0}$ and $PM_{2.5}$ mass conc. The precision for PM_{10} mass conc. cannot be determined due to the inherent variability of the test dust used.
- The PA-I Indoor sensors (IDs: 29D1, A3CA and BB9F) showed low to moderate intra-model variability.
- Data recovery was ~ 100% from all units in the field and in the laboratory.
- For $PM_{2.5}$, the PA-I Indoor sensors showed strong correlations with FEM BAM from the field ($PM_{2.5}$ R^2 ~ 0.75) and very strong correlations with GRIMM in the laboratory studies (R^2 > 0.99 for $PM_{1.0}$ and $PM_{2.5}$). For PM_{10}, the PA-I Indoor sensors showed weak correlations with FEM BAM from the field (PM_{10} R^2 < 0.47) and very strong correlations with GRIMM and APS in the laboratory studies (R^2 ~ 0.97 and 0.968, respectively).
- The same three PA-I Indoor units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

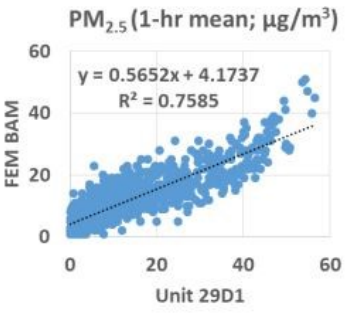
Field Evaluation Highlights

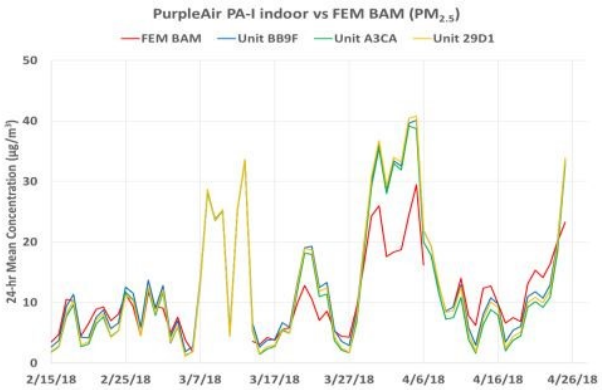
- Deployment period 02/15/2018 - 04/25/2018: the three PA-I Indoor sensors showed strong correlations with the $PM_{2.5}$ mass concentration as measured by FEM BAM and showed weak correlations with the corresponding FEM BAM PM_{10} data.
- The units showed low intra-model variability and data recovery > 99.5%.

1-hr mean, FEM BAM

$PM_{2.5}$: R^2 ~ 0.75

PM_{10}: R^2 < 0.47





Coefficient of Determination (R^2) quantifies how the three sensors followed the $PM_{2.5}$ concentration change by the reference instruments.

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 ($PM_{2.5}$)

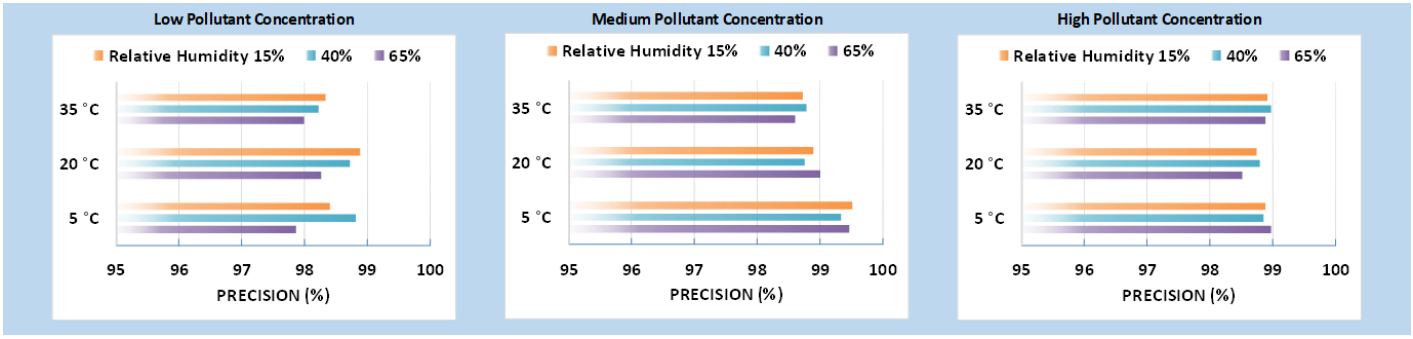
$$A\,(\%) = 100 - \frac{|\bar{X} - \bar{R}|}{\bar{R}} * 100$$

Steady state #	Sensor Mean (µg/m³)	FEM GRIMM (µg/m³)	Accuracy (%)
1	24.4	10.3	-37.1
2	33.9	15.3	-21.5
3	86.3	60.2	56.6
4	216.1	152.6	58.3
5	387.4	255.2	48.2

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.

A negative % means sensors' overestimation by more than two fold. The higher the positive value (close to 100%), the higher the sensor's accuracy.

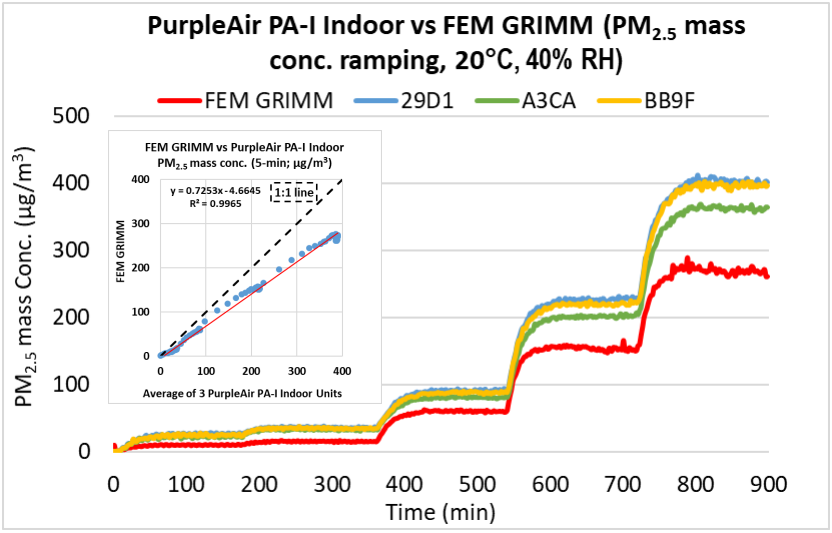
Precision ($PM_{2.5}$)



100% represents high precision.

Sensor's ability to generate precise measurements of $PM_{2.5}$ 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



The PA-I Indoor sensors showed very strong correlations with the corresponding FEM $PM_{2.5}$ data ($R^2 > 0.99$) at 20 °C and 40% RH. For conc. ramping experiments of $PM_{1.0}$ and PM_{10}, please see the lab report.

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the PA-I Indoor sensors except that the sensors showed spiked concentration changes at the 65% RH Set-point at 5 °C.

Observed Interferents

N/A