AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Evaluation Summary

- Overall, the HabitatMap AirBeam2 sensors showed moderate accuracy as compared to the reference instrument for $PM_{1.0}$ and $PM_{2.5}$, for a conc. range between 0 to 300 $\mu g/m^3$. Accuracy was fairly constant over the range of $PM_{1.0}$ and $PM_{2.5}$ concentrations tested.
- The AirBeam2 sensors exhibited high precision for all T/RH combinations and all PM concentrations.
- The AirBeam2 sensors (IDs: F4F1, 6FE0 and 63CC) showed low intra-model variability.
- Data recovery was ~ 77% and 100% from all units in the field and in the laboratory, respectively
- For $PM_{1.0}$ and $PM_{2.5}$, the AirBeam2 sensors showed strong correlations with GRIMM ($PM_{1.0}$ R^2 ~ 0.75) and moderate to strong correlations with the FEM GRIMM, FEM BAM and FEM T640 from the field ($PM_{2.5}$ $0.68 < R^2 < 0.79$) and very strong correlations with GRIMM in the laboratory studies ($R^2 > 0.99$ for $PM_{1.0}$ and $PM_{2.5}$).
- The same three AirBeam2 units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).
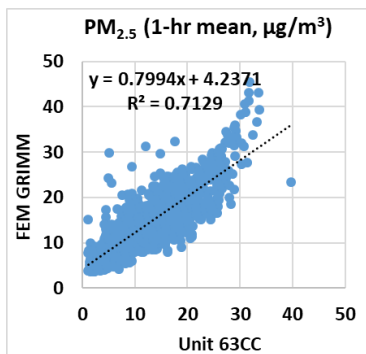
Field Evaluation Highlights

- Deployment period 07/20/2018 - 09/19/2018: the three AirBeam2 sensors showed moderate to strong correlations with the $PM_{1.0}$ and $PM_{2.5}$ mass concentration as monitored by FEM GRIMM, FEM BAM and FEM T640. PM_{10} mass conc. showed no correlations with the corresponding GRIMM, FEM BAM and T640 data

- The units showed very low intra-model variability and data recovery of ~77%.

Sensor Description

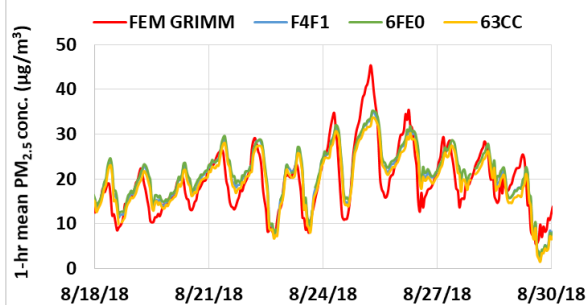Manufacturer/Model:
HabitatMap/
AirBeam2
Pollutants:
$PM_{1.0}$, $PM_{2.5}$ and PM_{10} mass concentration

Time Resolution:
1-minute

Type: Optical

Additional

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

1-hr mean, all ref. instr.

$PM_{1.0}$: $0.74 < R^2 < 0.77$

$PM_{2.5}$: $0.68 < R^2 < 0.79$

PM_{10}: $R^2 < 0.1$

PM$_{2.5}$ (1-hr mean, $\mu g/m^3$)

$y = 0.7994x + 4.2371$
$R^2 = 0.7129$

FEM GRIMM

Unit 63CC

AirBeam2 vs FEM GRIMM

1-hr mean $PM_{2.5}$ conc. ($\mu g/m^3$)

FEM GRIMM — F4F1 — 6FE0 — 63CC

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	15.1	10.2	51.4
2	21.6	15.2	57.8
3	46.3	59.6	77.7
4	103.7	153.1	67.7
5	173.0	270.1	64.1

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.
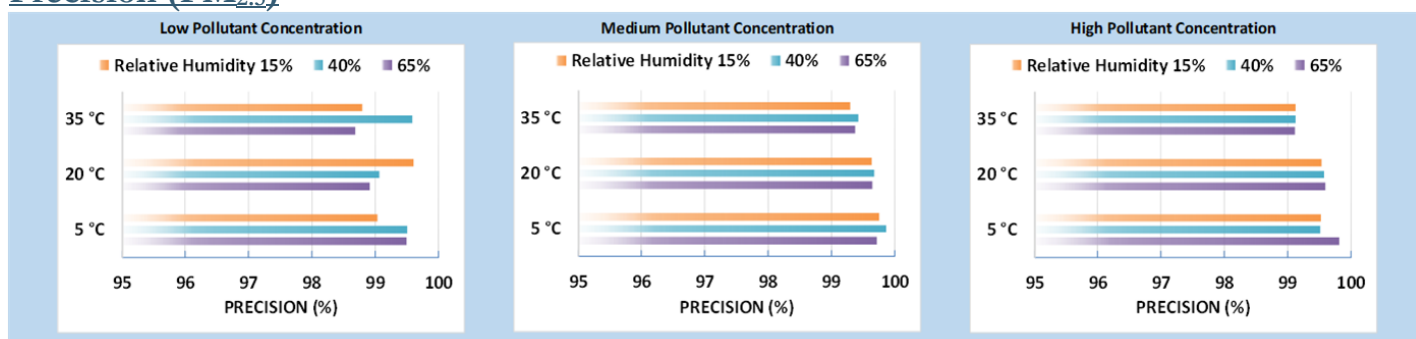
Sensor's ability to generate precise measurements of PM$_{2.5}$ concentration at low, medium, and high pollutant levels were evaluated under 9 combinations of T and RH, including extreme weather conditions like cold and dry (5 °C and 15%) cold and humid (5 °C and 65%), hot and humid (35 °C and 65%), or hot and dry (35 °C and 15%).

Coefficient of Determination
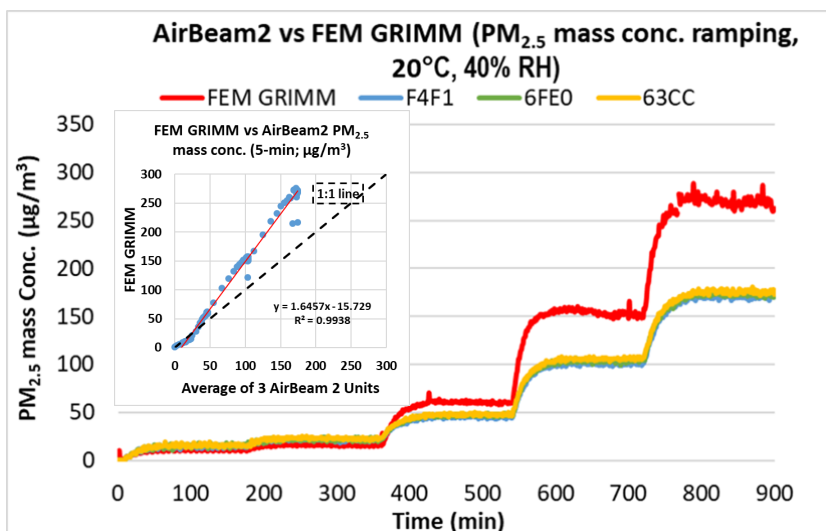
The AirBeam2 sensors showed very strong correlations with the corresponding FEM PM$_{2.5}$ data (R^2 > 0.99) at 20 °C and 40% RH.
For conc. ramping experiments of PM$_{1.0}$, please see the lab report.

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the AirBeam2 sensor performance.

Observed Interferents

N/A