



Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor
2018 – 1st Quarter*



Introduction and Sensor Profile

This analysis report is focused on assessing the performance of the PurpleAir PA-II sensor as a part of the District's Technical Evaluation of Sensor Technology (TEST) Program. The PurpleAir PA-II sensor uses an optical laser-based particle counting methodology to estimate the mass of varying diameters of particulate matter, including PM₁, PM_{2.5}, and PM₁₀. The PA-II sensor also measures temperature, pressure, and relative humidity.

Background and Approach of Evaluation Test

In November of 2017, the National Aeronautics and Space Administration (NASA) began an air quality study to compare the performance of PurpleAir sensors to regulatory PM_{2.5} analyzers. The study is focused on the conditions in the San Joaquin Valley and is based at the California Air Resources Board (CARB) air monitoring sites of Modesto, Fresno-Garland, Visalia-Church, and Bakersfield-California. The data sets compare PurpleAir sensor PM_{2.5} data to that of the regulatory PM_{2.5} data that is collocated at the four CARB sites. The scatter plots and time series graphs below show how the datasets compare for both hourly values and the 24-hour average.

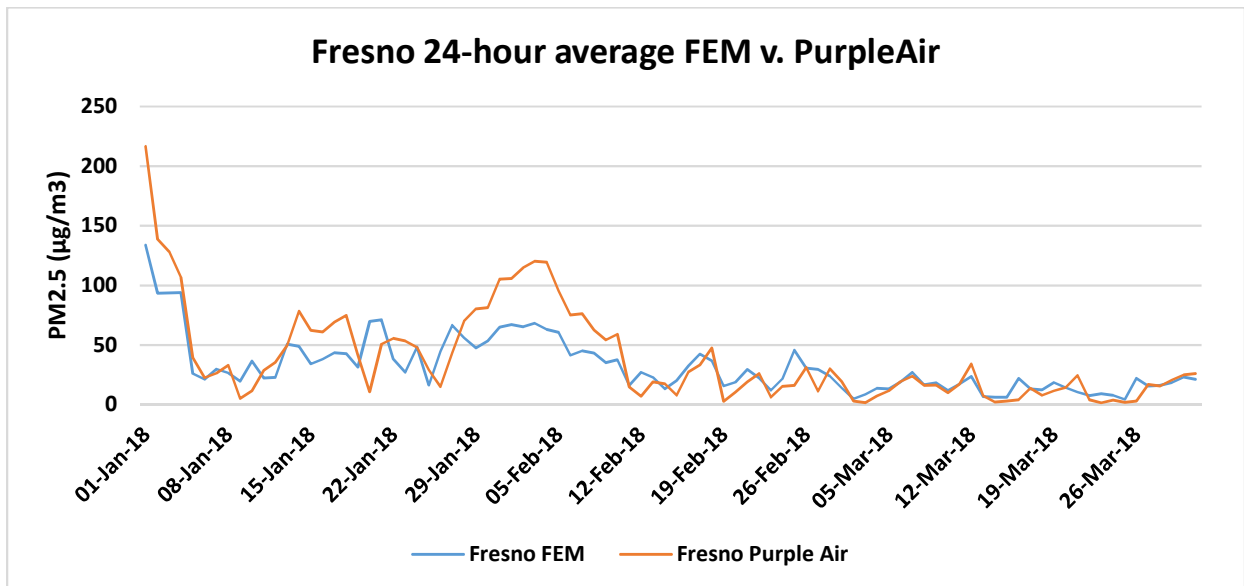
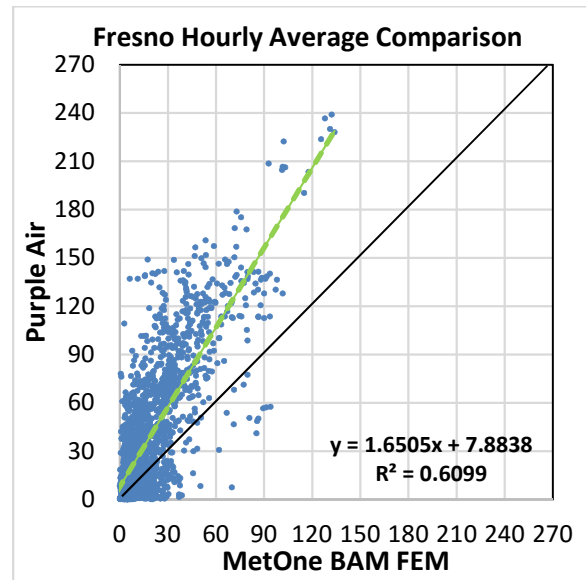
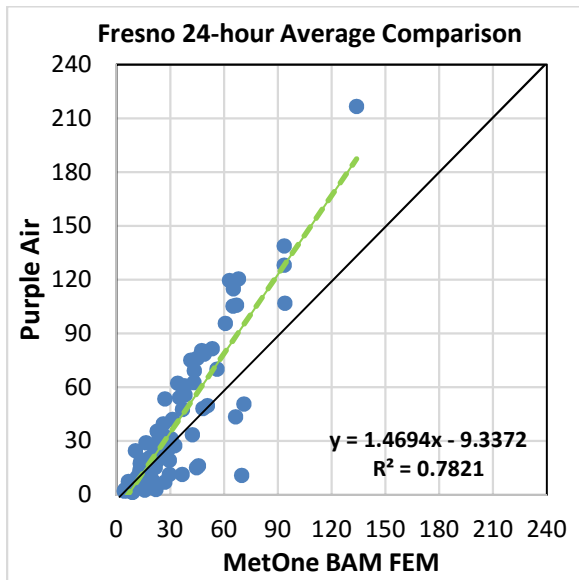
Overview of Analysis Findings from Current Period

The analysis for this report covers the time period of January 2018 through March 2018 (2018 – 1st quarter). The beginning of the 1st quarter of 2018 began with a period of very poor dispersion and elevated PM readings throughout the Valley. New Year's Eve carried with it fireworks activities which impacted PM_{2.5} concentrations. The early morning of January 1st, 2018, had the highest readings of the period with PurpleAir sensors producing hourly PM_{2.5} readings of 260 µg/m³ in Visalia, 265 µg/m³ in Bakersfield, and 239 µg/m³ in Fresno. Conversely, the regulatory FEM monitors read 171 µg/m³ in Visalia, 151 µg/m³ in Bakersfield, and 134 µg/m³ in Fresno, respectively, for these same hours. For this peak event on January 1, 2018, the PurpleAir data was higher than the regulatory data at all three sites. As the plots below show, PurpleAir PM_{2.5} data is typically biased higher than the District's regulatory data. NASA added a PurpleAir sensor to the Modesto CARB air monitoring site in March 2018. This site started to disseminate complete data beginning on March 20th, 2018.

Site Specific Analysis of PurpleAir PA-II Sensor Performance

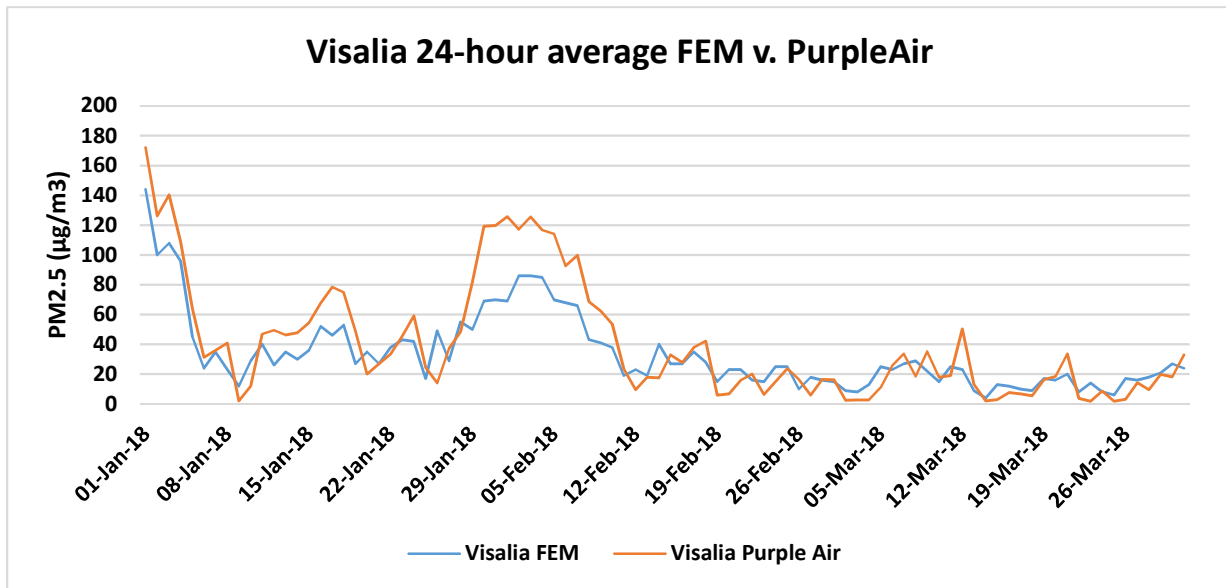
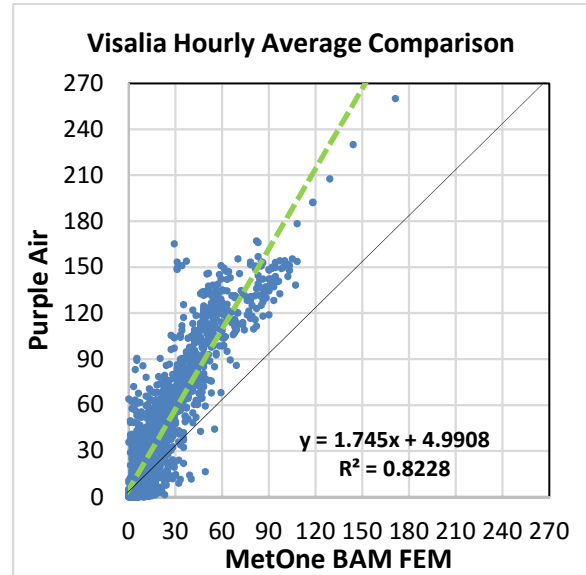
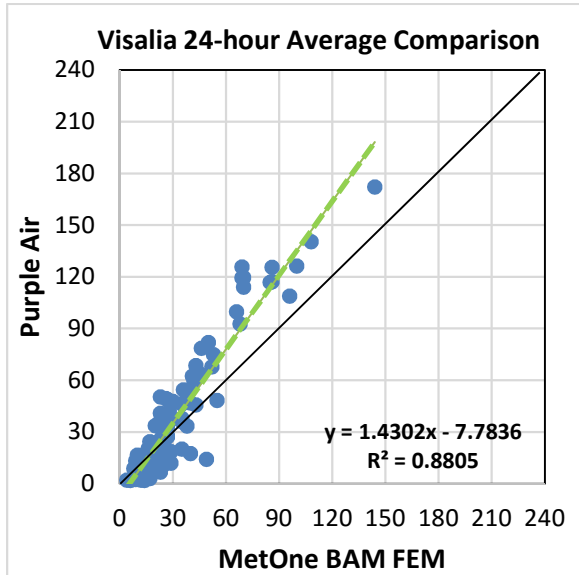
Fresno-Garland

For the 24-hour average, PurpleAir data had a 6.30 $\mu\text{g}/\text{m}^3$ high bias during the January 2018 through March 2018 period. For the hourly average, PurpleAir data had a 19.88 $\mu\text{g}/\text{m}^3$ high bias over the same period.



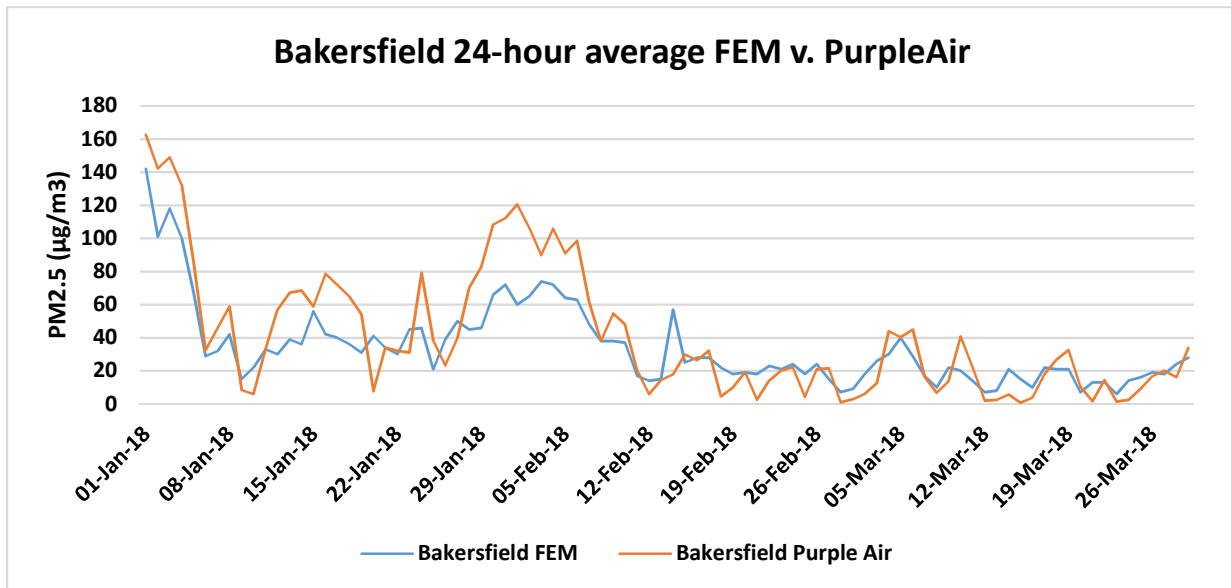
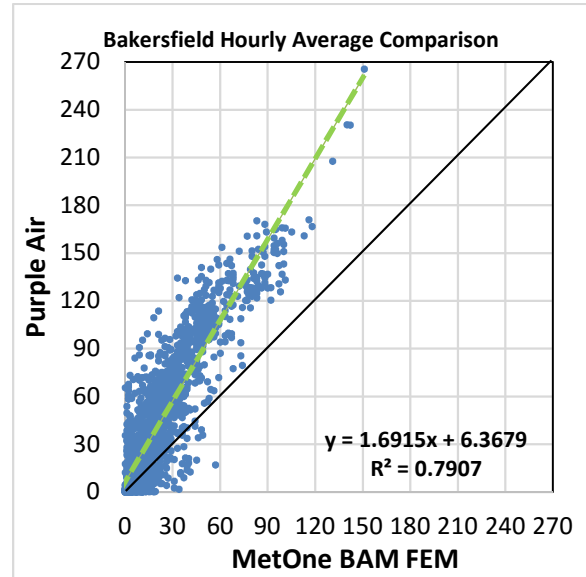
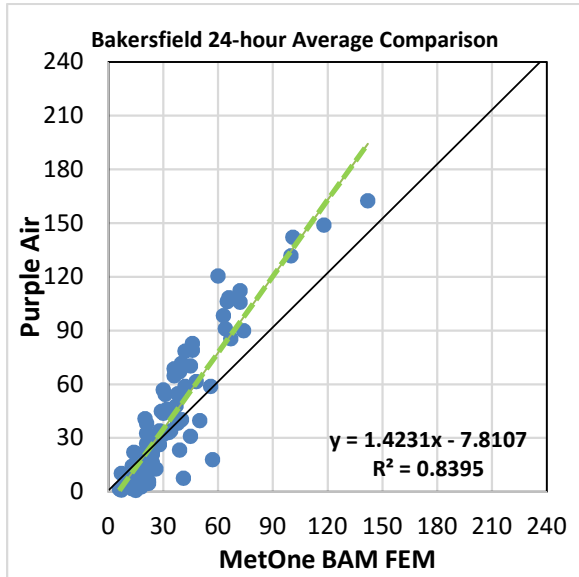
Visalia-Church

For the 24-hour average, PurpleAir data had a 7.18 $\mu\text{g}/\text{m}^3$ high bias during the January 2018 through March 2018 period. For the hourly average, PurpleAir data had a 19.45 $\mu\text{g}/\text{m}^3$ high bias over the same period.



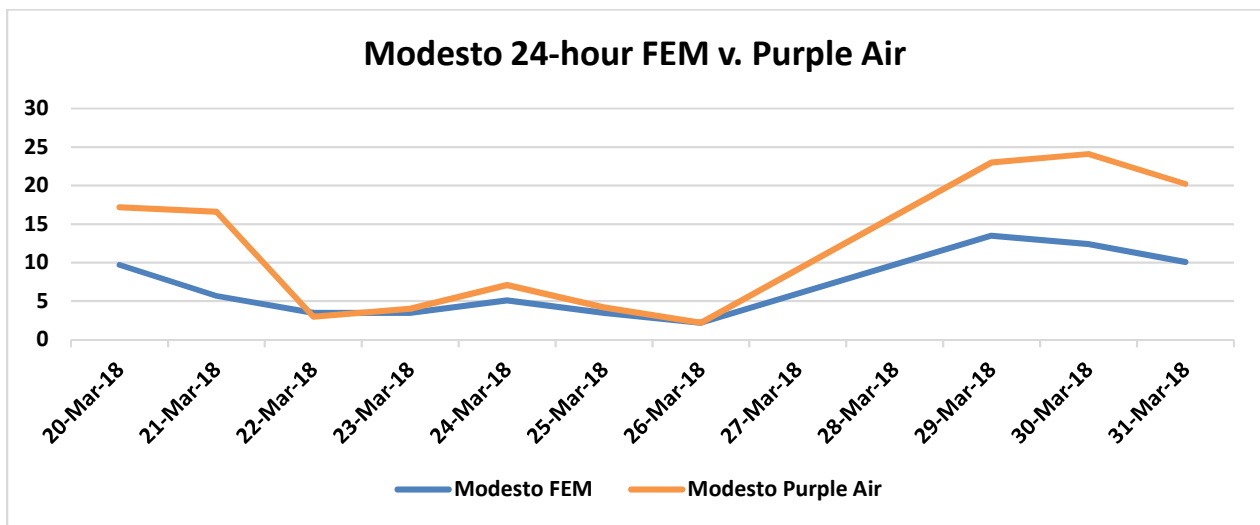
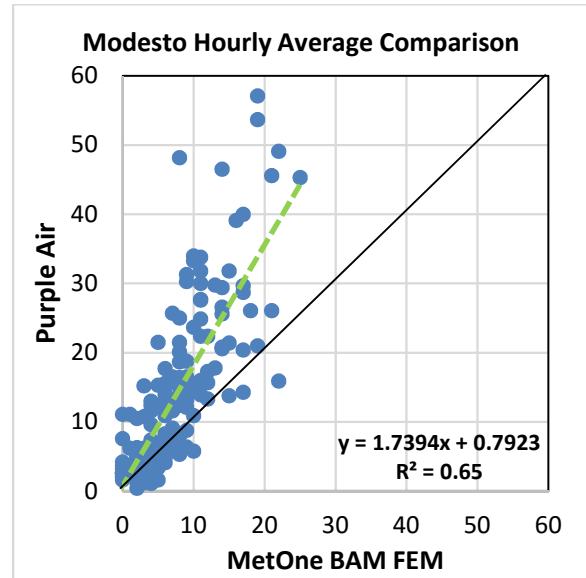
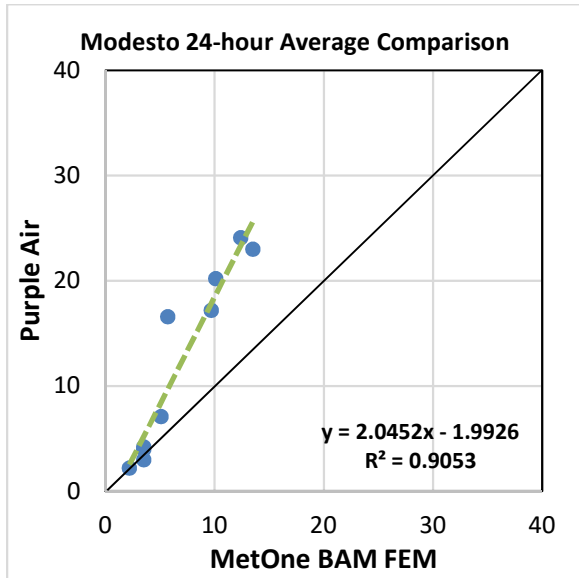
Bakersfield-California

For the 24-hour average, PurpleAir data had a 6.73 $\mu\text{g}/\text{m}^3$ high bias during the January 2018 through March 2018 period. For the hourly average, PurpleAir data had a 20.76 $\mu\text{g}/\text{m}^3$ high bias over the same period.



Modesto-14th St.

For the 24-hour average, PurpleAir data had a 5.24 $\mu\text{g}/\text{m}^3$ high bias during the Mar 20, 2018 through March 31, 2018 period. For the hourly average, PurpleAir data had a 5.40 $\mu\text{g}/\text{m}^3$ high bias over the same period.



Statistical Summary

The following table provides a statistical summary of the data collected during the analysis period of this report.

Statistic	Fresno-Garland	Visalia-Church	Bakersfield-Cal	Modesto
FEM Avg	32.7	33.82	34.27	6.9
Sensor Avg	39	41	41	12.2
FEM 1-hr Max	134	171	151	25
Sensor 1-hr Max	239	260	265	57.1
FEM 24-hr Max	133.9	144	142	13.5
Sensor 24-hr Max	217	172	163	24.1
1-hr R ²	0.6099	0.8228	0.7907	0.65
1-hr Slope	1.6505	1.745	1.6915	1.7934
1-hr Intercept	7.8838	4.9908	6.3679	0.7923
24-hr R ²	0.7821	0.8805	0.8395	0.9053
24-hr Slope	1.4694	1.4302	1.4231	2.0452
24-hr Intercept	-9.3372	-7.7836	-7.8107	-1.9926