



Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor
2018 – 3rd 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, PM2.5, and PM10. The PA-II sensor also measures temperature, pressure, and relative humidity.

Background and Approach of Evaluation Test

In November of 2017, NASA began an air quality study to compare the performance of PurpleAir sensors to regulatory PM2.5 analyzers. The study is focused on the conditions in the San Joaquin Valley and is based at the ARB air monitoring sites of Fresno-Garland, Visalia-Church, Modesto-14th St., and Bakersfield-California. The data sets analyzed for this report compare PM2.5 data collected from PurpleAir sensors and Federal Equivalent Method (FEM) monitors that are collocated at the ARB air monitoring sites listed above. 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 July 2018 through September 2018 (2018 – 3rd quarter). The 3rd quarter presented a very high bias for the PurpleAir monitors. As PM2.5 concentrations increased, the sensors strayed further from the FEM monitors. The daily average across all four locations for the entire period saw PurpleAir read 10.4 $\mu\text{g}/\text{m}^3$ higher than the FEM monitors. The only exception to this overall observation was the hourly peak in Visalia. The FEM measured an hourly average of 244 $\mu\text{g}/\text{m}^3$ on July 4th, 2018 at 8:00pm PDT. This was most likely due to fireworks associated with the Independence Day holiday. The peak PurpleAir reading was 169 $\mu\text{g}/\text{m}^3$ for the same time.

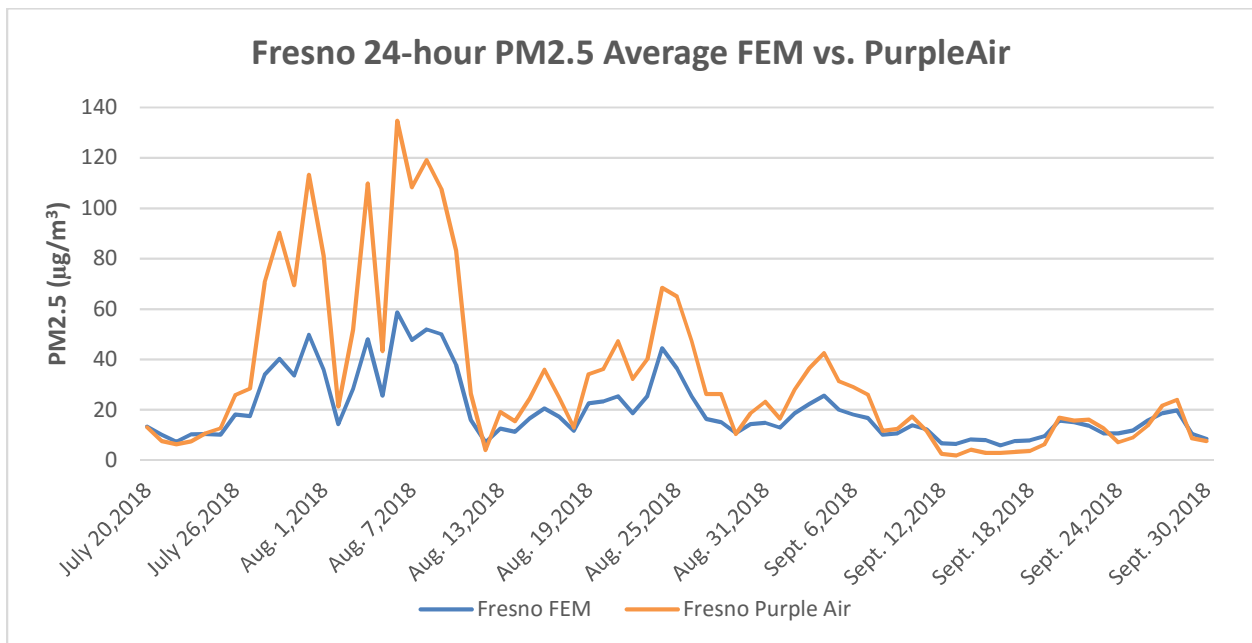
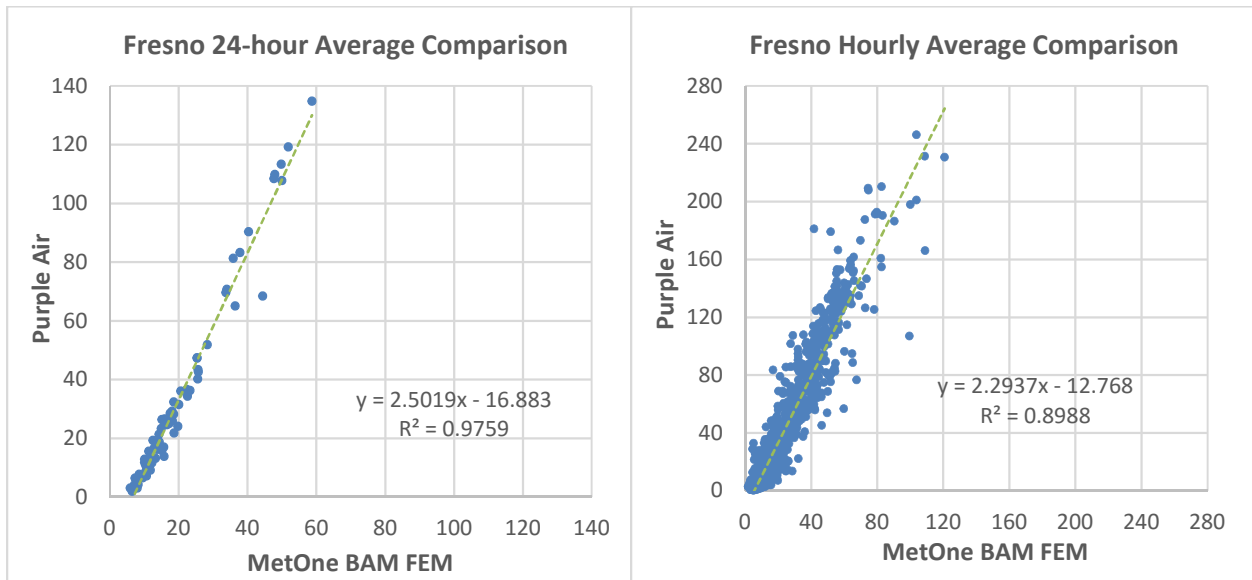
The Valley's air quality was significantly impacted by wildfires during the 3rd quarter. The Mendocino Complex (containing the Ranch and River wildfires) along with the Carr fire both started within a week of each other in late July. All sites were affected by smoke from approximately July 22nd thru August 13th. These three fires combined to burn over 600,000 acres in northern California. With the abundant fuels, long periods of wind stagnation and natural barriers of the San Joaquin Valley, very high PM2.5 readings were inevitable, and are clearly seen on the charts below.

Fresno-Garland is only reporting from July 22nd thru September 30th. This is due to the PurpleAir monitor not reporting data from June 25th thru July 22nd at 8:00am PDT.

Site Specific Analysis of PurpleAir PA-II Sensor Performance

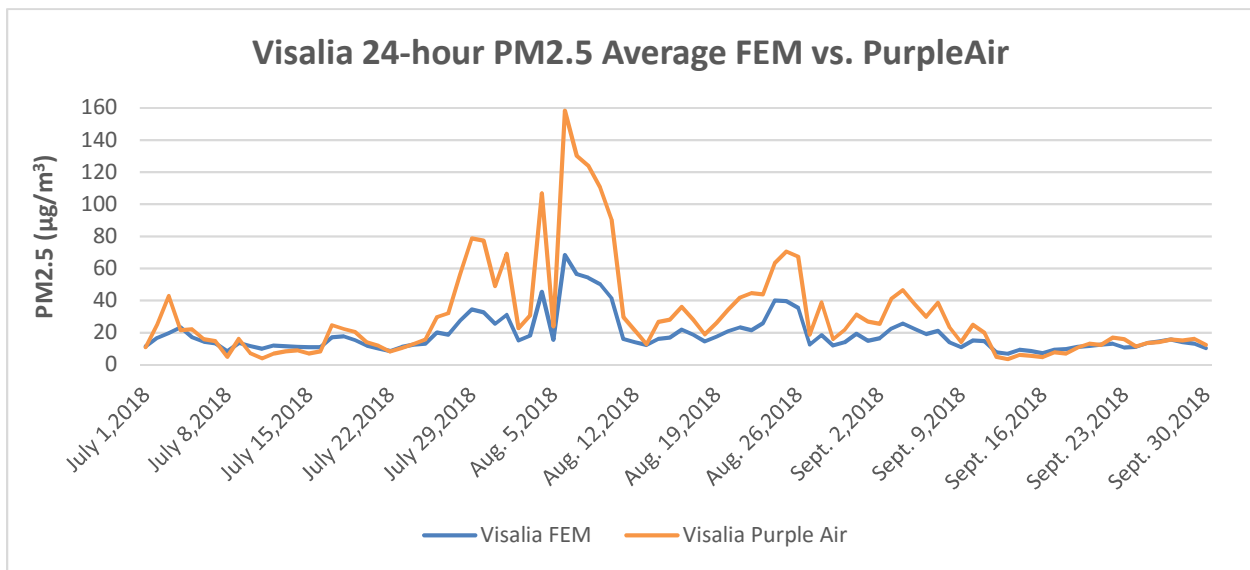
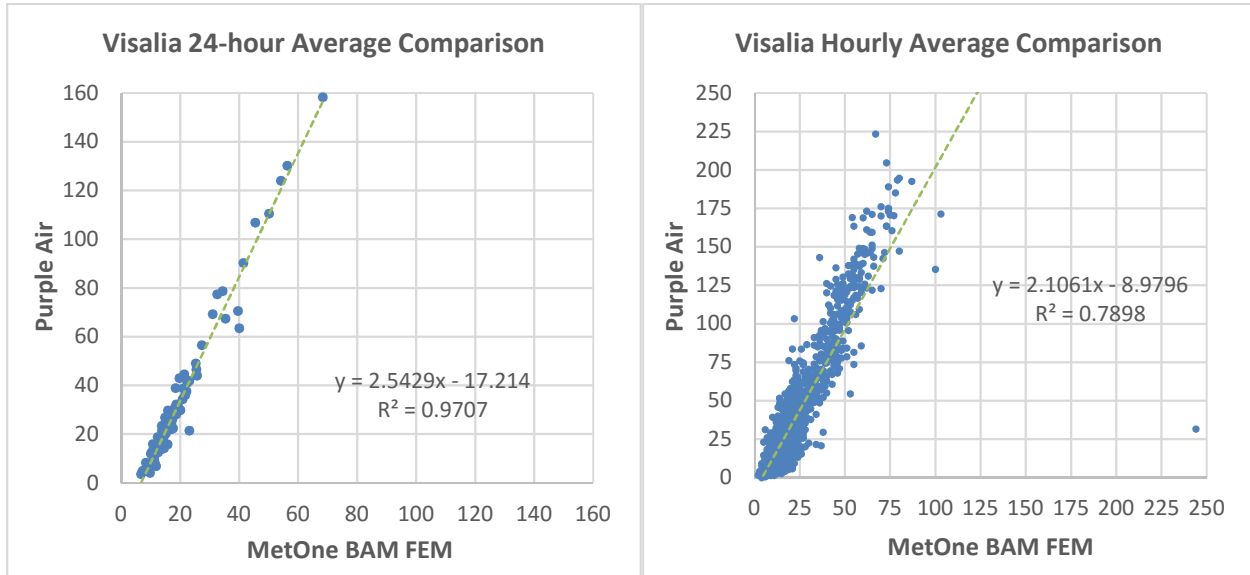
Fresno-Garland

For the 24-hour average, PurpleAir data had a 13.0 $\mu\text{g}/\text{m}^3$ high bias during the July 2018 through September 2018 period. For the hourly average, PurpleAir data had the same 13.0 $\mu\text{g}/\text{m}^3$ high bias over the same period.



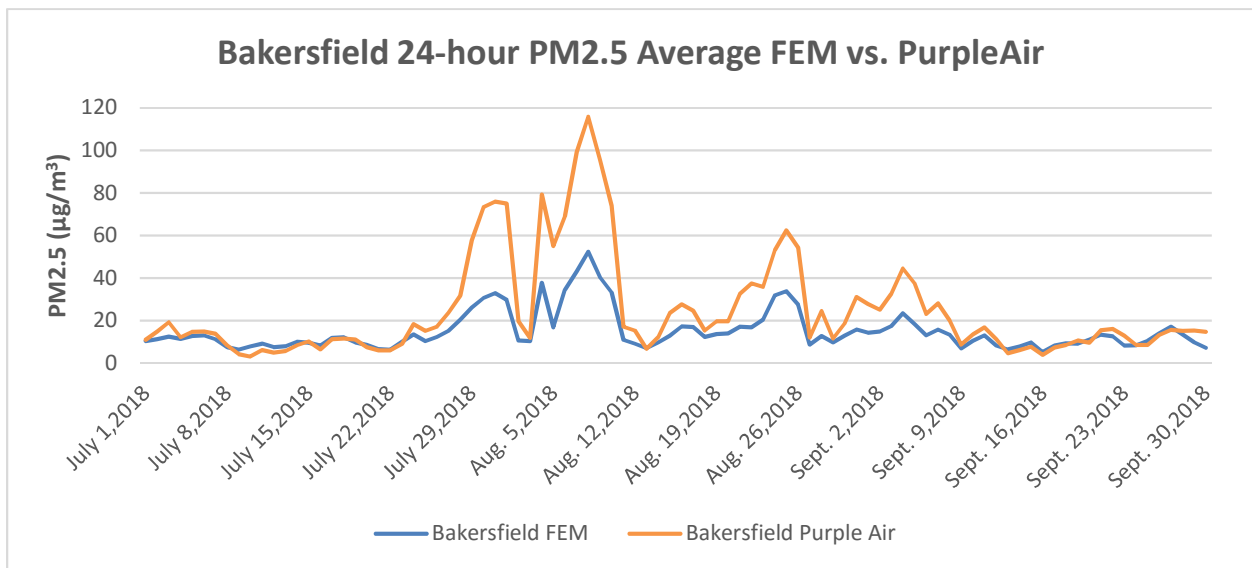
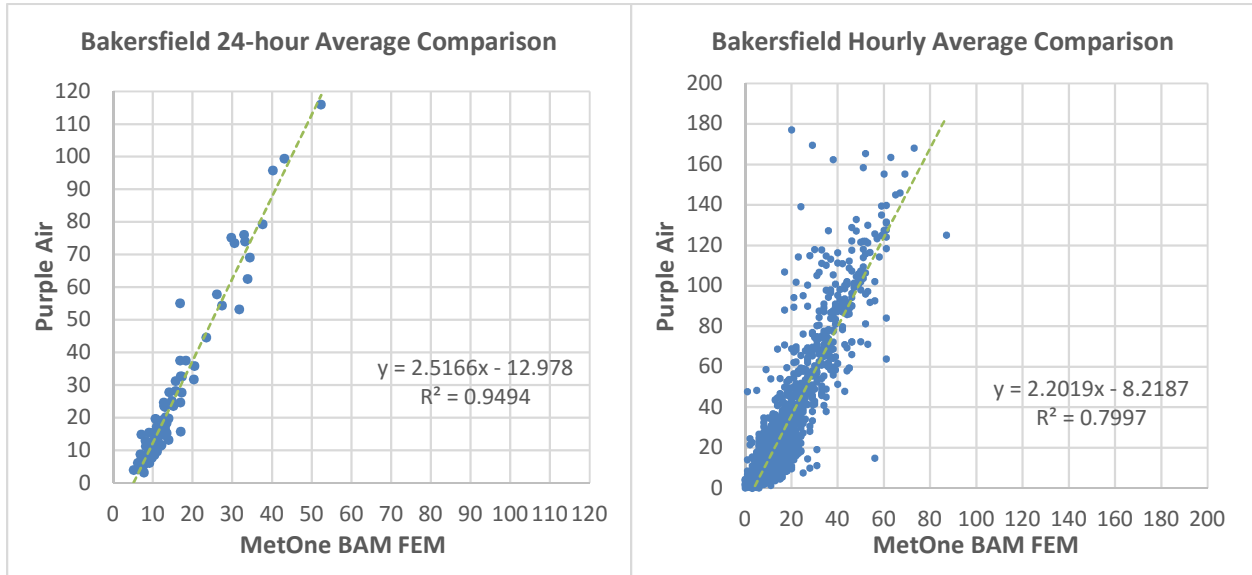
Visalia-Church

For the 24-hour average, PurpleAir data had an 11.7 $\mu\text{g}/\text{m}^3$ high bias during the July 2018 through September 2018 period. For the hourly average, PurpleAir data had an 11.8 $\mu\text{g}/\text{m}^3$ high bias over the same period.



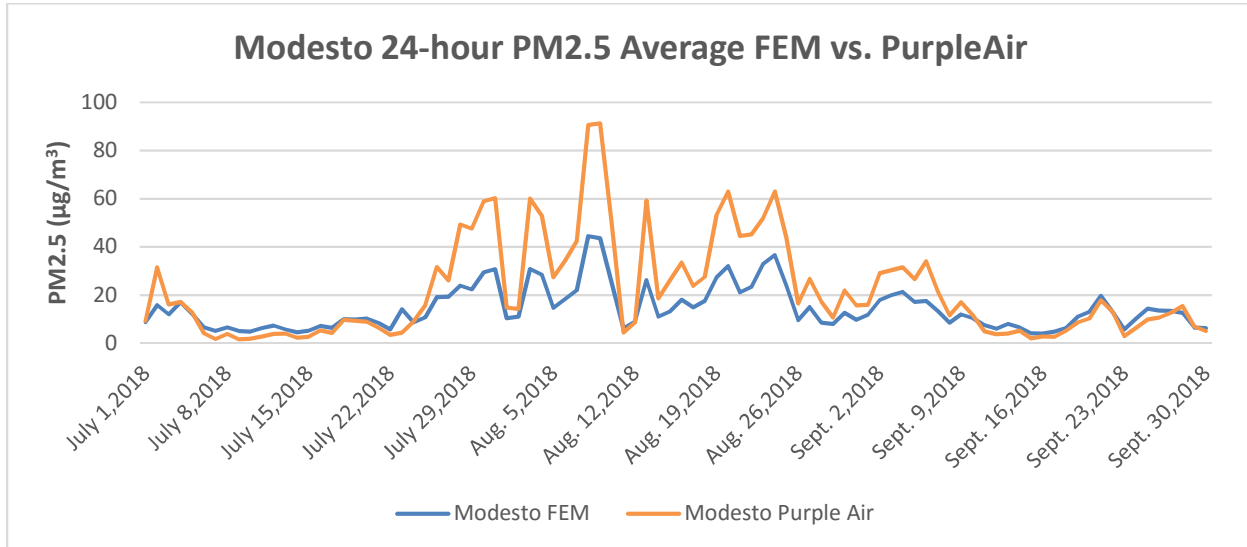
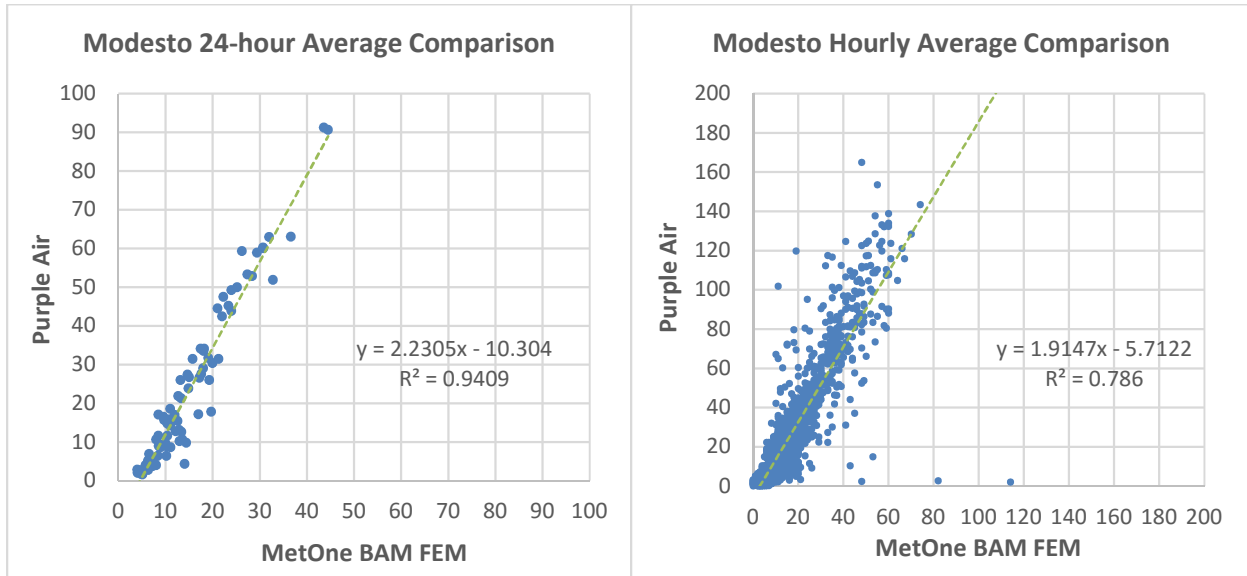
Bakersfield-California

For the 24-hour average, PurpleAir data had a 9.70 µg/m³ high bias during the July 2018 through September 2018 period. For the hourly average, PurpleAir data had a 9.8 µg/m³ high bias over the same period.



Modesto-14th St.

For the 24-hour average, PurpleAir data had a 7.3 µg/m³ high bias during the July 2018 through September 2018 period. For the hourly average, PurpleAir data had a 7.4 µg/m³ 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	19.9	18.8	14.9	14.4
Sensor Avg	32.9	30.5	24.6	21.7
FEM 1-hr Max	120.8	244	87	114
Sensor 1-hr Max	246	224	177	165
FEM 24-hr Max	58.7	68.4	52.4	44.5
Sensor 24-hr Max	134.7	158.3	115.9	91.3
1-hr R ²	0.8988	0.7898	0.7997	0.7860
1-hr Slope	2.2937	2.1061	2.2019	1.9147
1-hr Intercept	-12.768	-8.9796	-8.2187	-5.7122
24-hr R ²	0.9759	0.9707	0.9494	0.9409
24-hr Slope	2.5019	2.5429	2.5166	2.2305
24-hr Intercept	-16.883	-17.214	-12.978	-10.304