



Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor
2021 – 4th 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 monitors. The study is focused on the conditions in the San Joaquin Valley and is based at California Air Resources Board (CARB) air monitoring sites of, Fresno-Garland, Modesto-14th St, Visalia-Church, and Bakersfield-California. In 2019, the District began operating PurpleAir sensors at the District's Clovis-Villa air monitoring site and in the Shafter and South Central Fresno AB 617 communities.

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 CARB and District 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

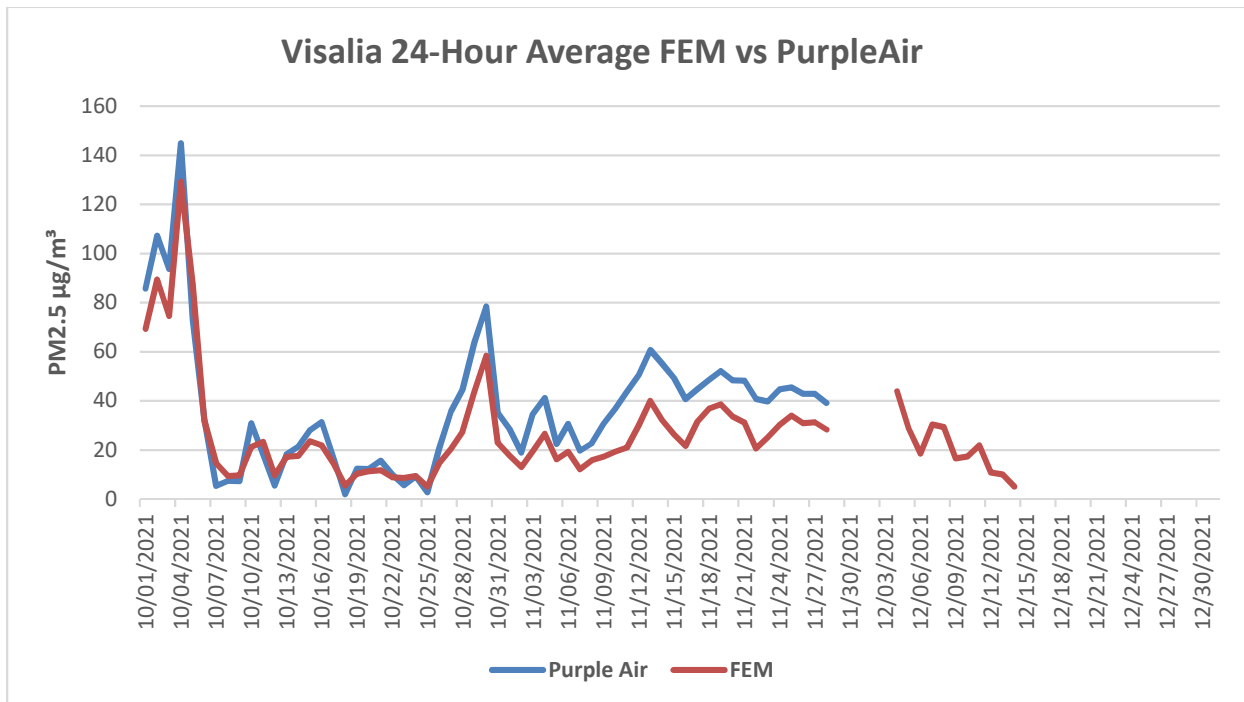
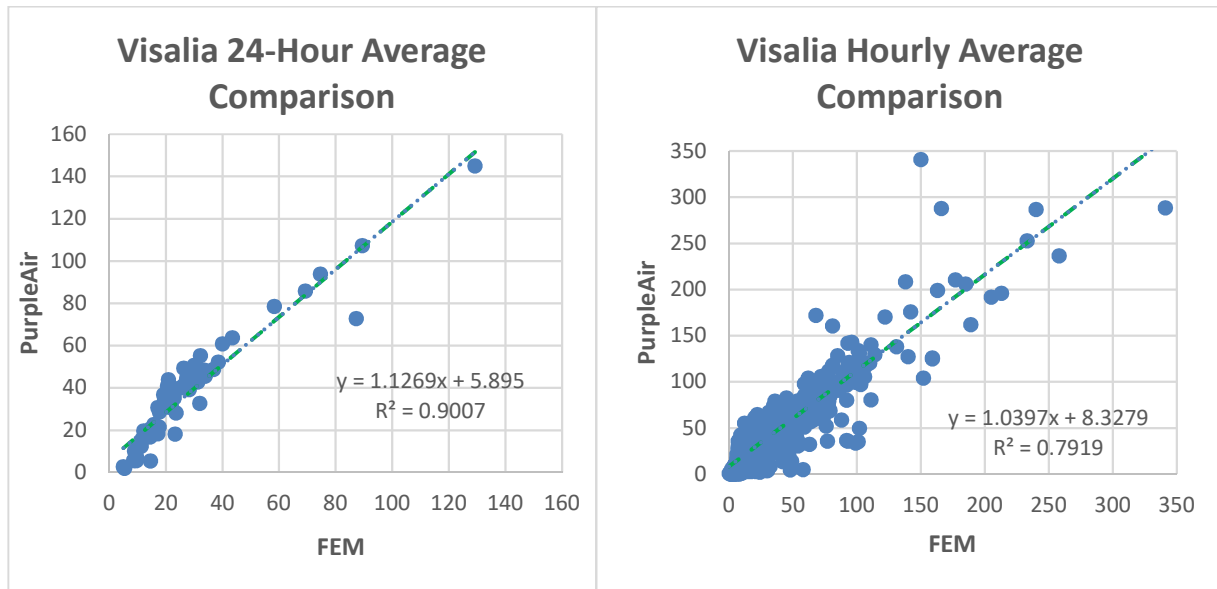
The analysis for this report covers the time period of October 1, 2021, through December 31, 2021 (2021 – 4th quarter). During this period, hourly data was removed from the calculation of bias when either the PurpleAir sensor or regulatory monitor did not have a valid hourly sample. For the 24-hour averages, only days with 18 or more valid hourly samples (75% or greater completeness) are included.

Seasonally, PM2.5 is typically highest during the winter months and lowest during the summer months. Weather systems can influence PM2.5 levels by either trapping pollutants near the surface or dispersing them. Generally, California's weather pattern is characterized by high pressure systems and low pressure systems that move through the region every two to four days in alternating fashion however the high pressure systems that built over the region in November 2021 remained in place for longer durations of time. Much of November was characterized by elevated PM2.5 levels due to the combination of extended periods of strong stability and wildfire smoke impacts. Wildfire activity subsided by the beginning of October 2021 and PM2.5 concentrations were able to decrease through the month. An alternating pattern of high and low pressures systems moved through region during December, however, the trajectories of most of the low pressure systems that passed through were such that they did not provide good dispersion for the Valley. Thus the majority of December was governed by stability and elevated PM2.5 levels.

Site Specific Analysis of PurpleAir PA-II Sensor Performance

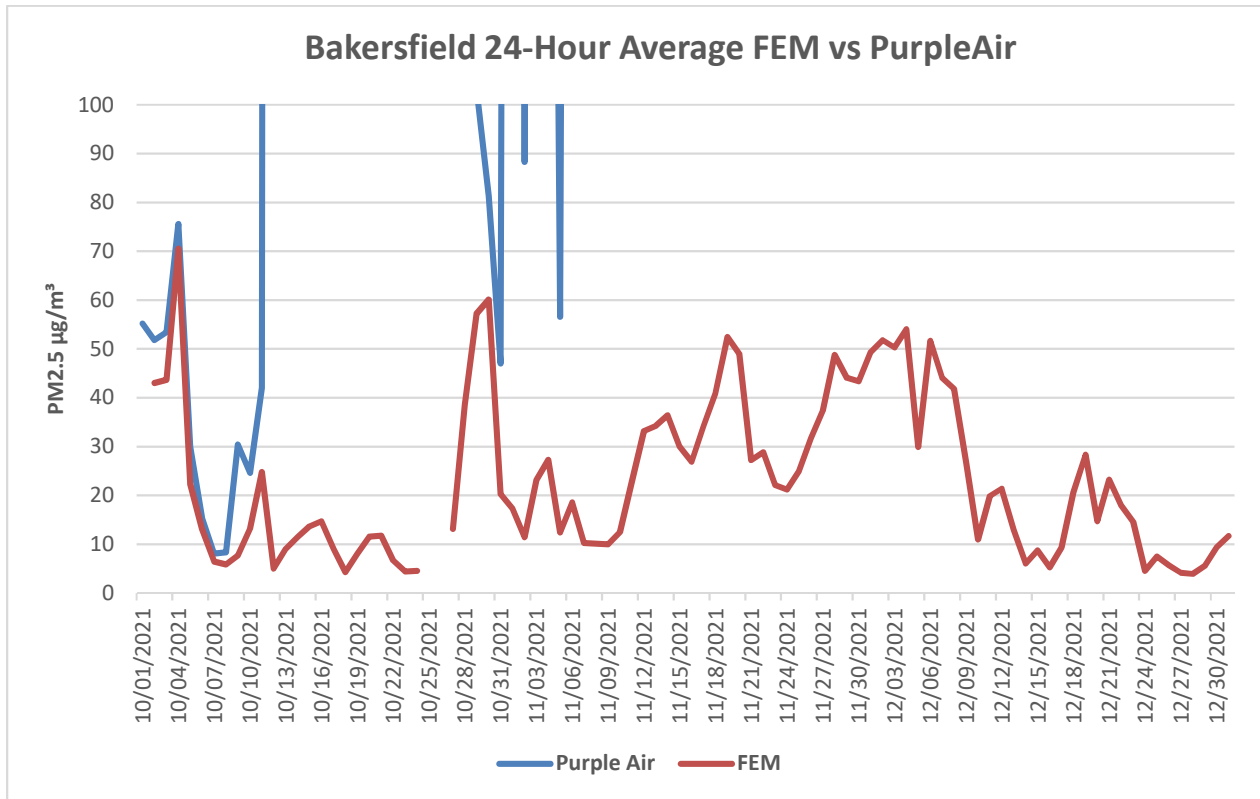
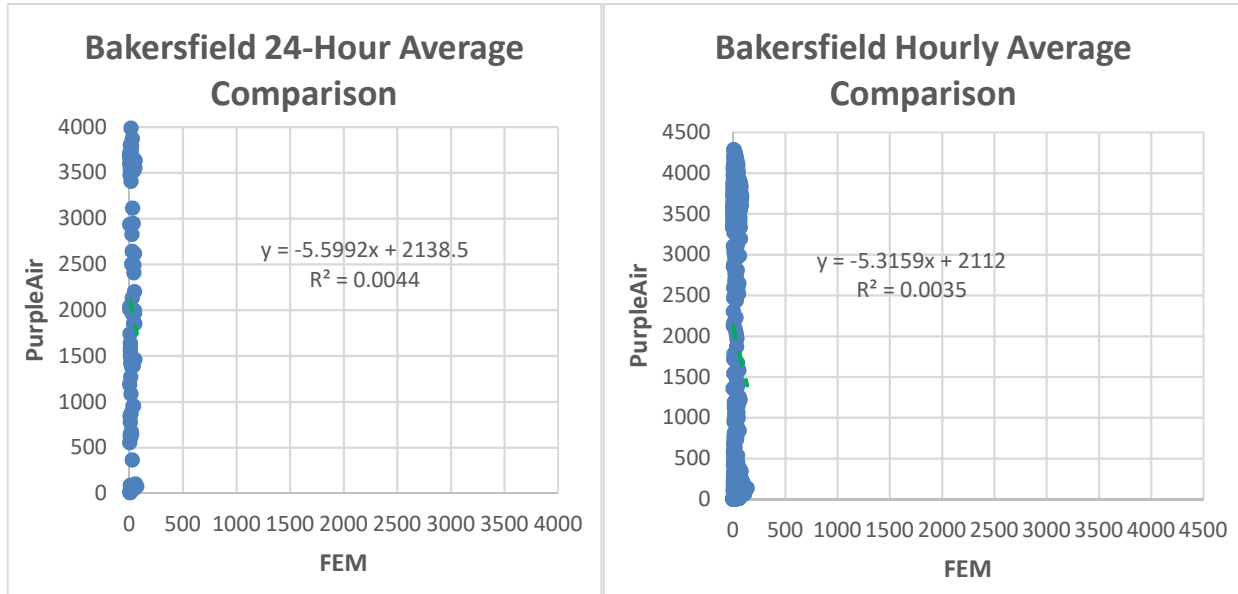
Visalia-Church

For the 24-hour average, PurpleAir data had a 10.5 $\mu\text{g}/\text{m}^3$ high bias during the October 1, 2021, through December 31, 2021, period. For the hourly average, PurpleAir data had a high bias of 10.2 $\mu\text{g}/\text{m}^3$ over the same period.



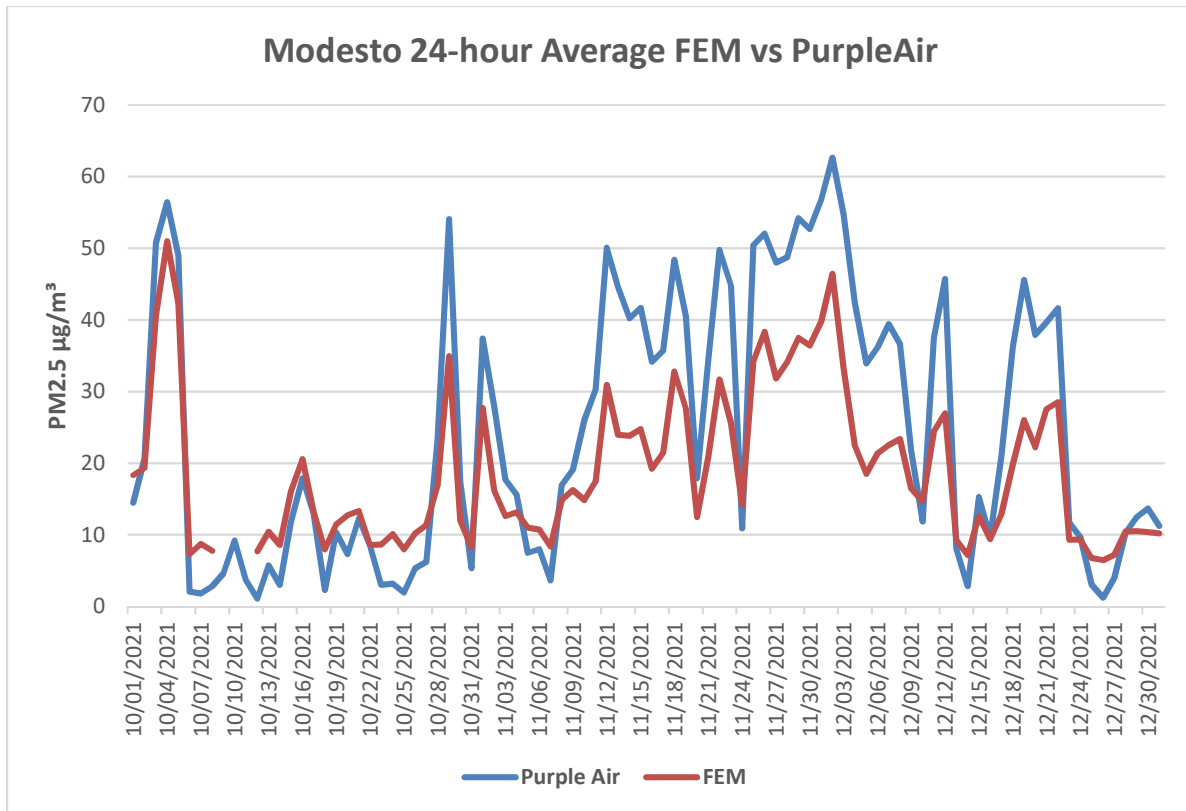
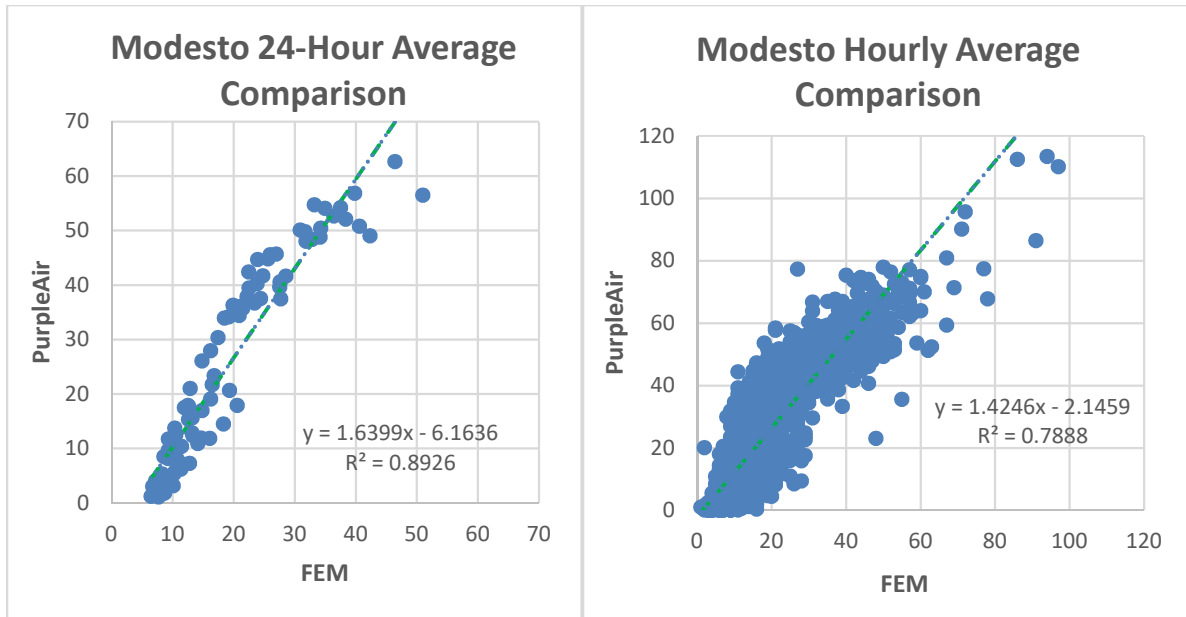
Bakersfield-California

For the 24-hour average, PurpleAir data had a 1966.0 µg/m³ high bias during the October 1, 2021, through December 31, 2021, period. For the hourly average, PurpleAir data had a high bias of 1965.8 µg/m³ over the same period.



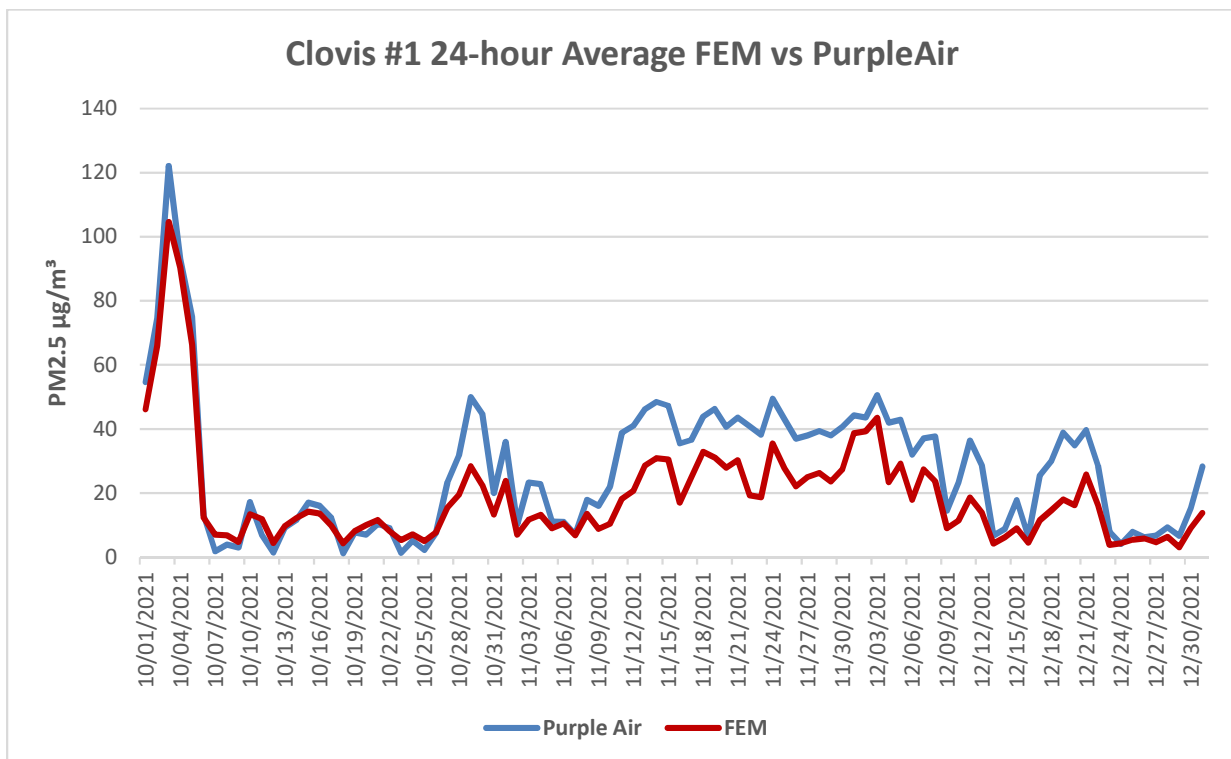
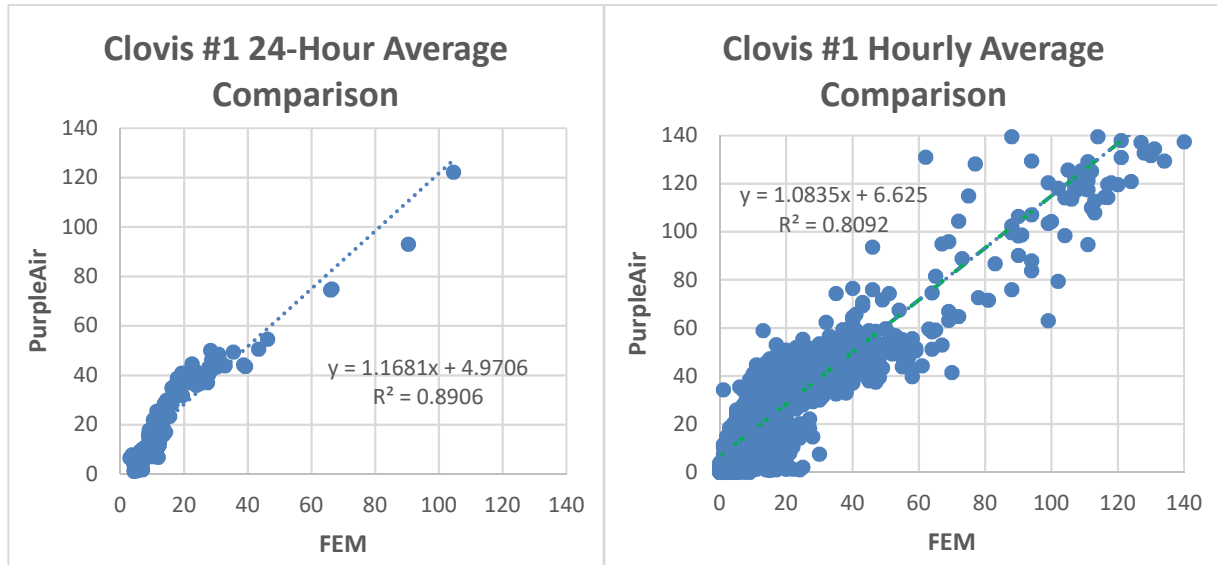
Modesto-14th St.

For the 24-hour average, PurpleAir data had a 5.4 $\mu\text{g}/\text{m}^3$ low bias during the October 1, 2021, through December 31, 2021, period. For the hourly average, PurpleAir data had a low bias of 5.5 $\mu\text{g}/\text{m}^3$ over the same period.



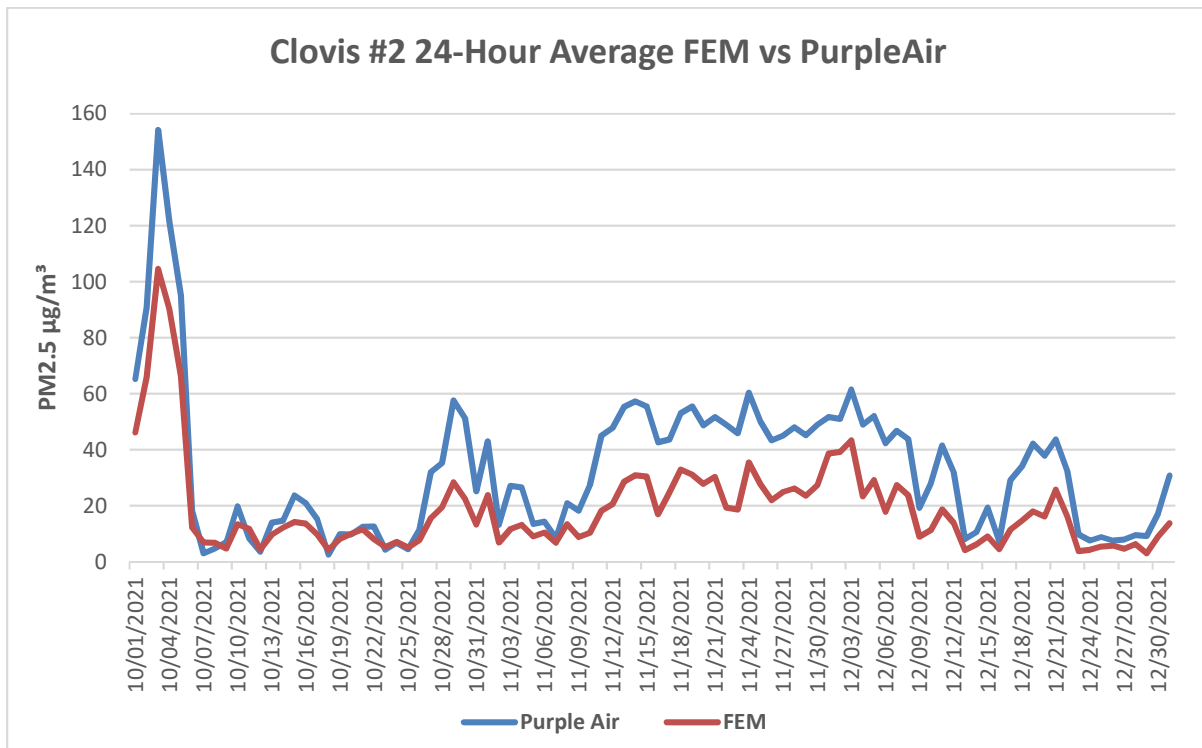
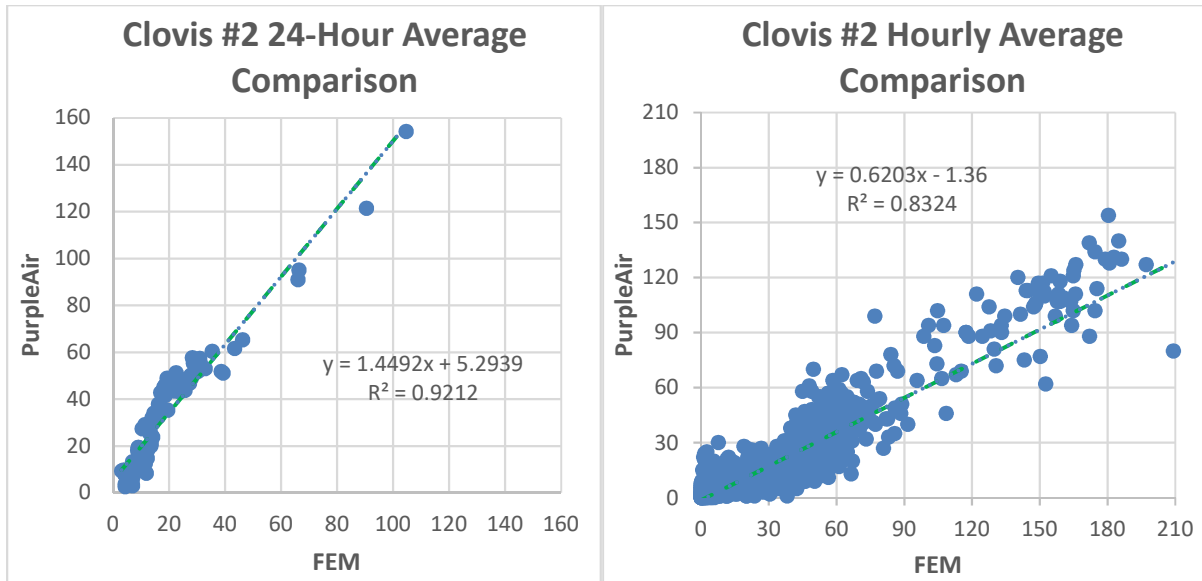
Clovis-Villa #1

For the 24-hour average, PurpleAir data had an 8.2 $\mu\text{g}/\text{m}^3$ high bias during the October 1, 2021, through December 31, 2021, period. For the hourly average, PurpleAir data had a high bias of 8.2 $\mu\text{g}/\text{m}^3$ over the same period.



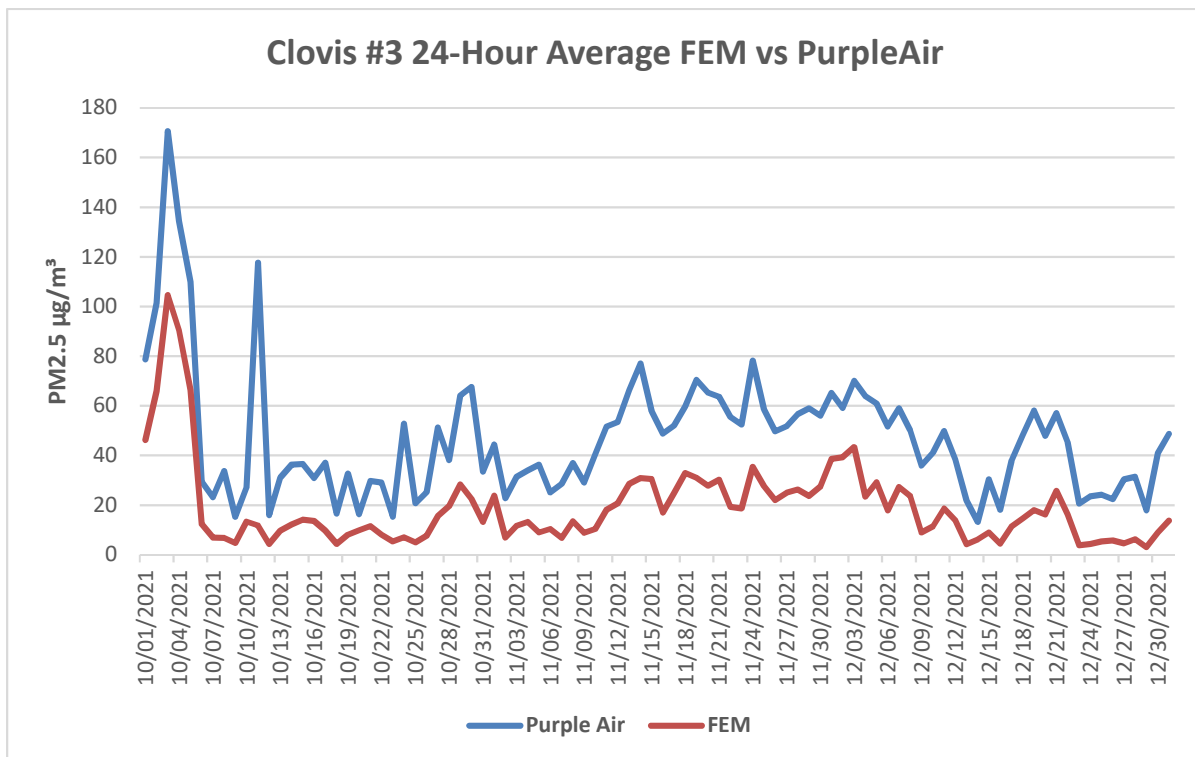
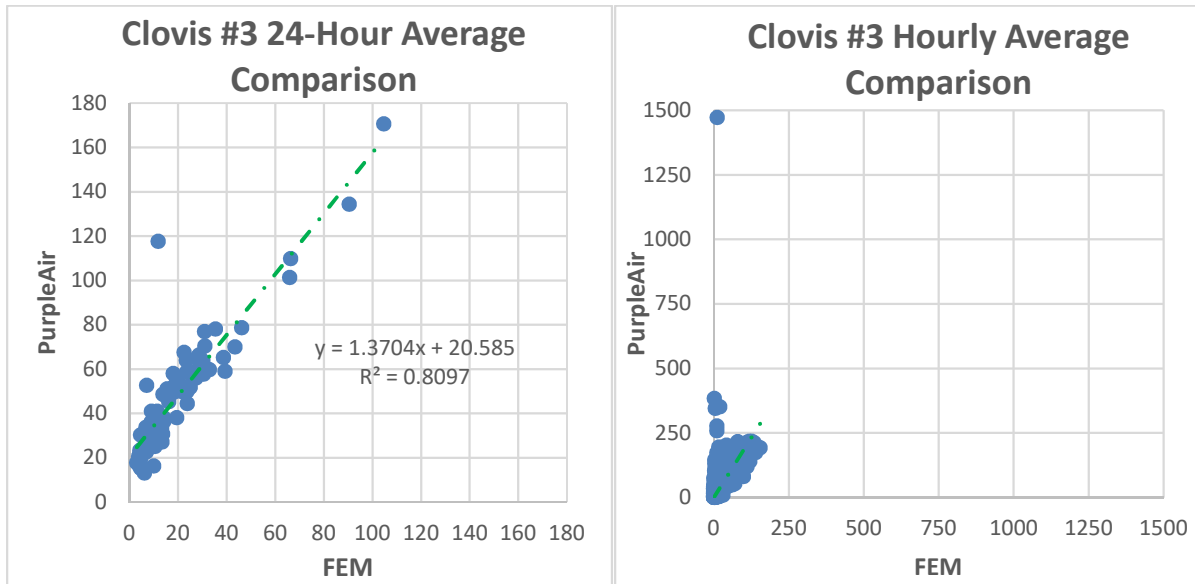
Clovis-Villa #2

For the 24-hour average, PurpleAir data had a 13.9 $\mu\text{g}/\text{m}^3$ high bias during the October 1, 2021, through December 31, 2021, period. For the hourly average, PurpleAir data had a high bias of 14.0 $\mu\text{g}/\text{m}^3$ over the same period.



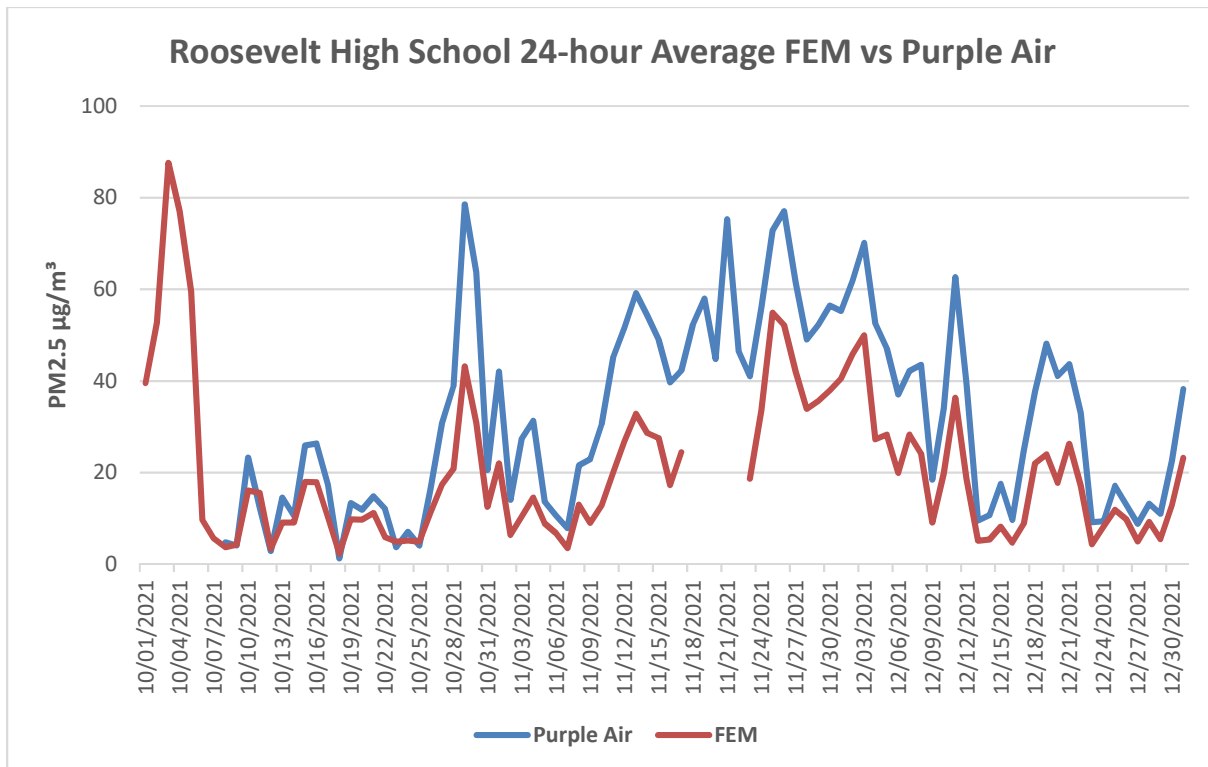
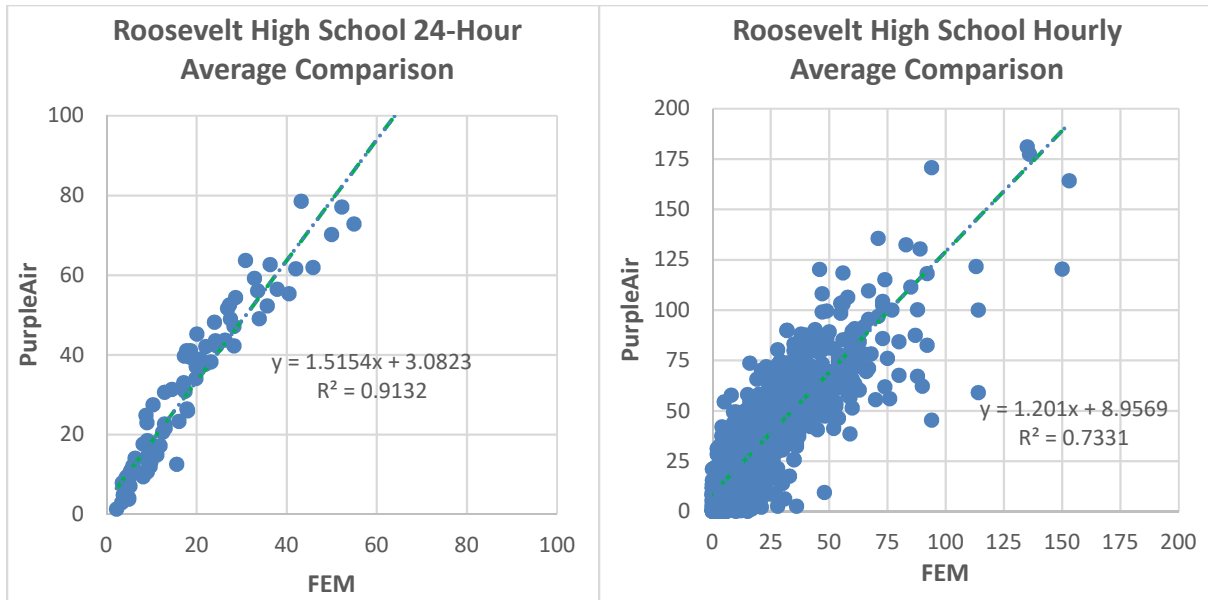
Clovis-Villa #3

For the 24-hour average, PurpleAir data had a 27.7 $\mu\text{g}/\text{m}^3$ high bias during the October 1, 2021, through December 31, 2021, period. For the hourly average, PurpleAir data had a high bias of 27.8 $\mu\text{g}/\text{m}^3$ over the same period.



South Central Fresno – Roosevelt High School

For the 24-hour average, PurpleAir data had an 11.6 µg/m³ low bias during the October 1, 2021, through December 31, 2021, period. For the hourly average, PurpleAir data had a high bias of 11.3 µg/m³ over the same period.



Non-Reporting Sites

Shafter #2

Data from this sensor was not available for the October 1, 2021, through December 31, 2021 period. This sensor will be included in future analysis reports if the data becomes available.

Fresno-Garland

Data from this sensor was not available for the October 1, 2021, through December 31, 2021 period. Data from this sensor is not expected to resume.

Statistical Summary

The following tables provides a statistical summary of the PM2.5 data collected during the analysis period of this report.

Table A – Fresno-Garland, Visalia-Church, Bakersfield-California, and Modesto-14th Sites

Statistic	Fresno-Garland	Visalia-Church	Bakersfield-CA	Modesto-14 th
FEM Avg. 24-hr	PurpleAir sensor at this site did not report during this period	26.8	23.2	19.1
Sensor Avg. 24-hr		37.3	1989.2	24.5
FEM Max 1-hr		341	135.0	97
Sensor Max 1-hr		340.72	4291.0	113.35
FEM Max 24-hr		129.2	70.5	51.0
Sensor Max 24-hr		144.9	3989.6	62.7
1-hr R ²		0.7919	0.0035	0.7888
1-hr Slope		1.0397	-5.3159	1.4246
1-hr Intercept		8.3279	2112	-2.1459
24-hr R ²		0.9007	0.0044	0.8926
24-hr Slope		1.1269	-5.5992	1.6399
24-hr Intercept		5.895	2138.5	-6.1636

Table B – Clovis-Villa Site

Statistic	Clovis-Villa PurpleAir #1	Clovis-Villa PurpleAir #2	Clovis-Villa PurpleAir #3
FEM Avg. 24-hr	19.2	19.2	19.2
Sensor Avg. 24-hr	27.5	33.2	47.0
FEM Max 1-hr	154	154	154
Sensor Max 1-hr	180.5	209.27	1472.89
FEM Max 24-hr	104.6	104.6	104.6
Sensor Max 24-hr	122.1	154.2	170.6
1-hr R ²	0.8092	0.8324	0.2922
1-hr Slope	1.0835	0.6203	1.3041
1-hr Intercept	6.6250	-1.3600	21.922
24-hr R ²	0.8906	0.9212	0.8097
24-hr Slope	1.1681	1.4492	1.3704
24-hr Intercept	4.9706	5.2939	20.585

Table C – South Central Fresno and Shafter Sites

Statistic	South Central Fresno	Shafter
FEM Avg. 24-hr	20.7	PurpleAir sensor at this site did not report during this period
Sensor Avg. 24-hr	32.3	
FEM Max 1-hr	153	
Sensor Max 1-hr	180.98	
FEM Max 24-hr	87.6	
Sensor Max 24-hr	78.6	
1-hr R ²	0.7331	
1-hr Slope	1.2010	
1-hr Intercept	8.9569	
24-hr R ²	0.9132	
24-hr Slope	1.5154	
24-hr Intercept	3.0823	