



Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor
2020 – 2nd 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 April 1, 2020, through June 30, 2020 (2020 – 2nd 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.

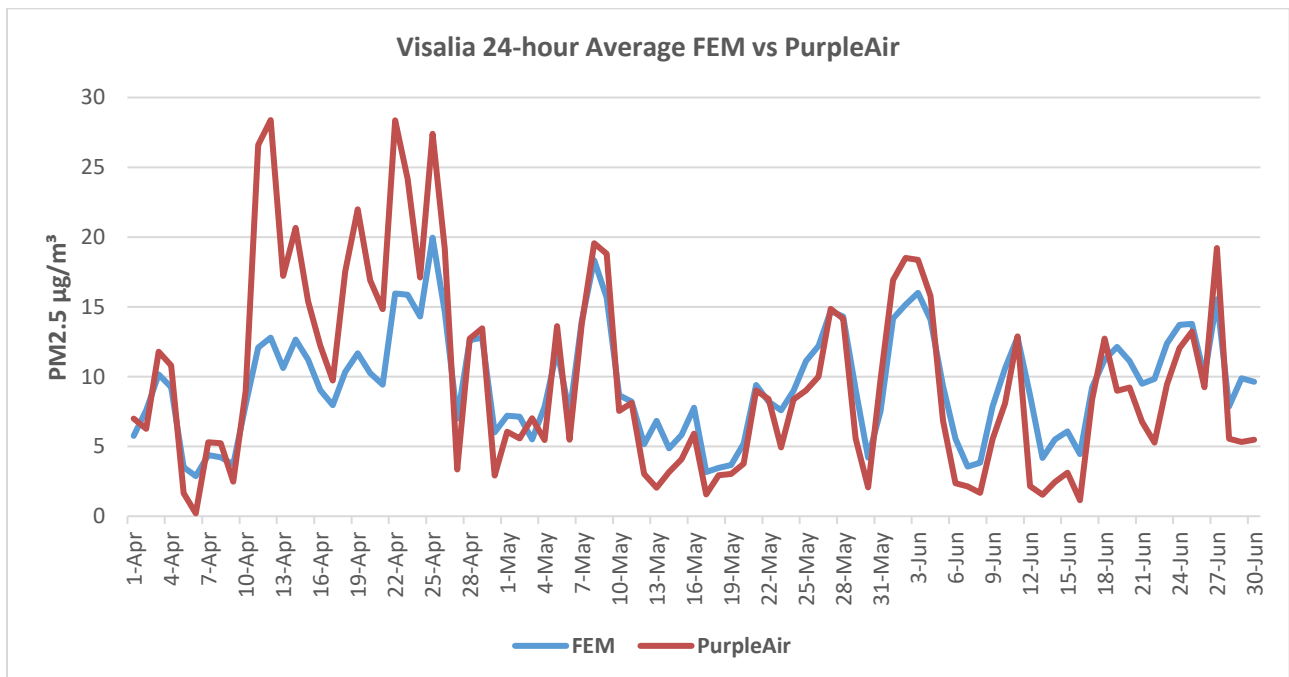
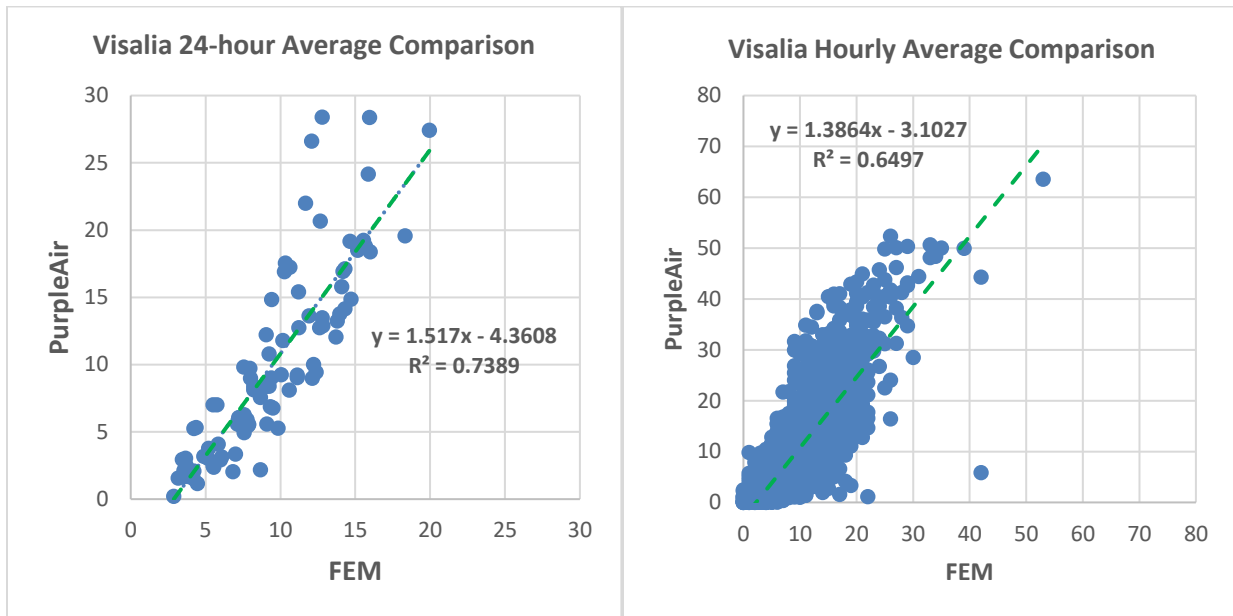
The beginning of April brought above average rainfall across the Valley and was followed by high pressure and warmer temperatures later in the month. Due to upper level disturbances gusty winds were present in May throughout Kern County. Breezy conditions persisted through the month as a low pressure system passed through the San Joaquin Valley during the end of May. June brought high pressure systems and low pressure systems that moved through the region in typical alternating fashion. Temperatures were above average and precipitation was below average during the month of June.

Overall, the sensors operating during this period had high results compared to the regulatory monitors. The PurpleAir #3 sensor at Clovis-Villa had the highest 24-hour average bias of 1.8 $\mu\text{g}/\text{m}^3$ higher than the FEM while the PurpleAir sensor in Visalia has the lowest 24-hour bias of 0.4 $\mu\text{g}/\text{m}^3$ higher than the FEM.

Site Specific Analysis of PurpleAir PA-II Sensor Performance

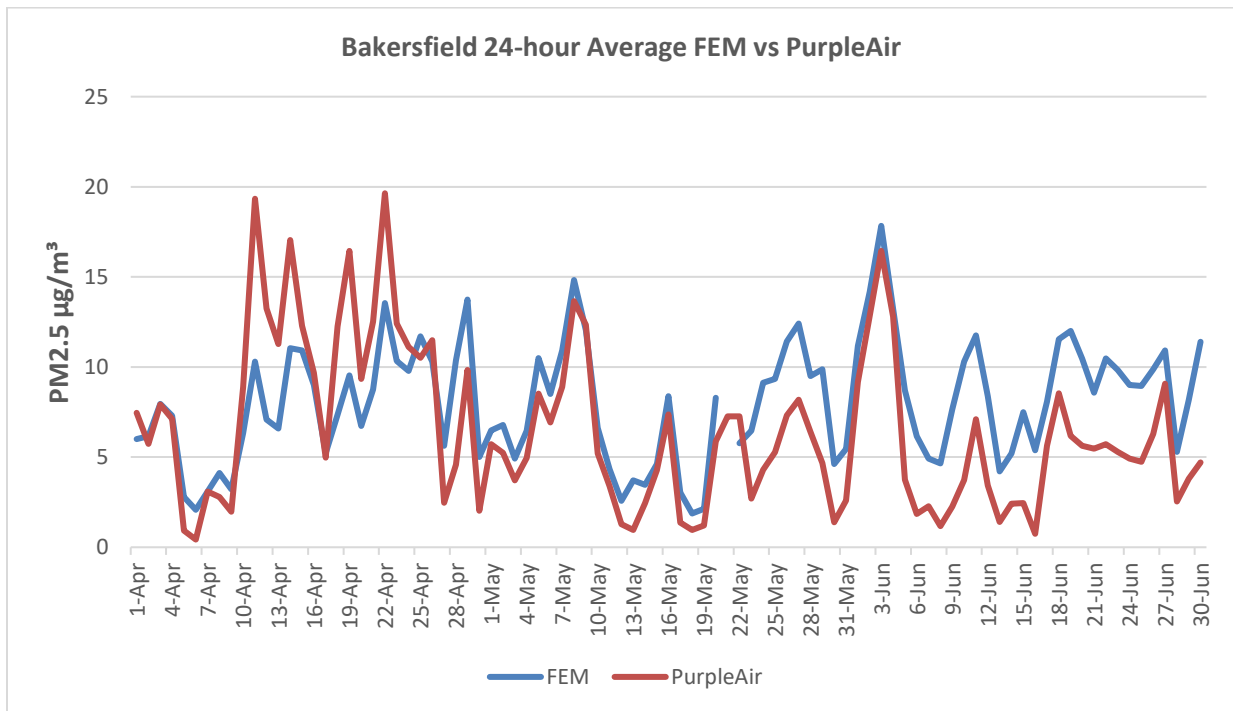
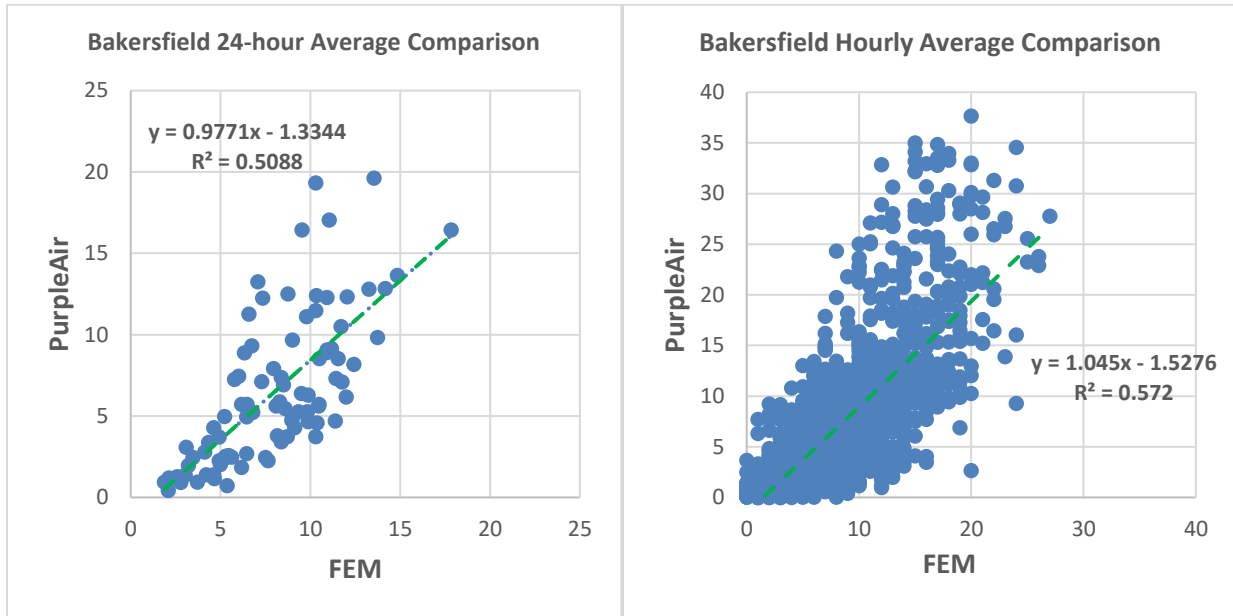
Visalia-Church

For the 24-hour average, PurpleAir data had a 0.4 $\mu\text{g}/\text{m}^3$ high bias during the April 1, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a high bias of 0.5 $\mu\text{g}/\text{m}^3$ over the same period.



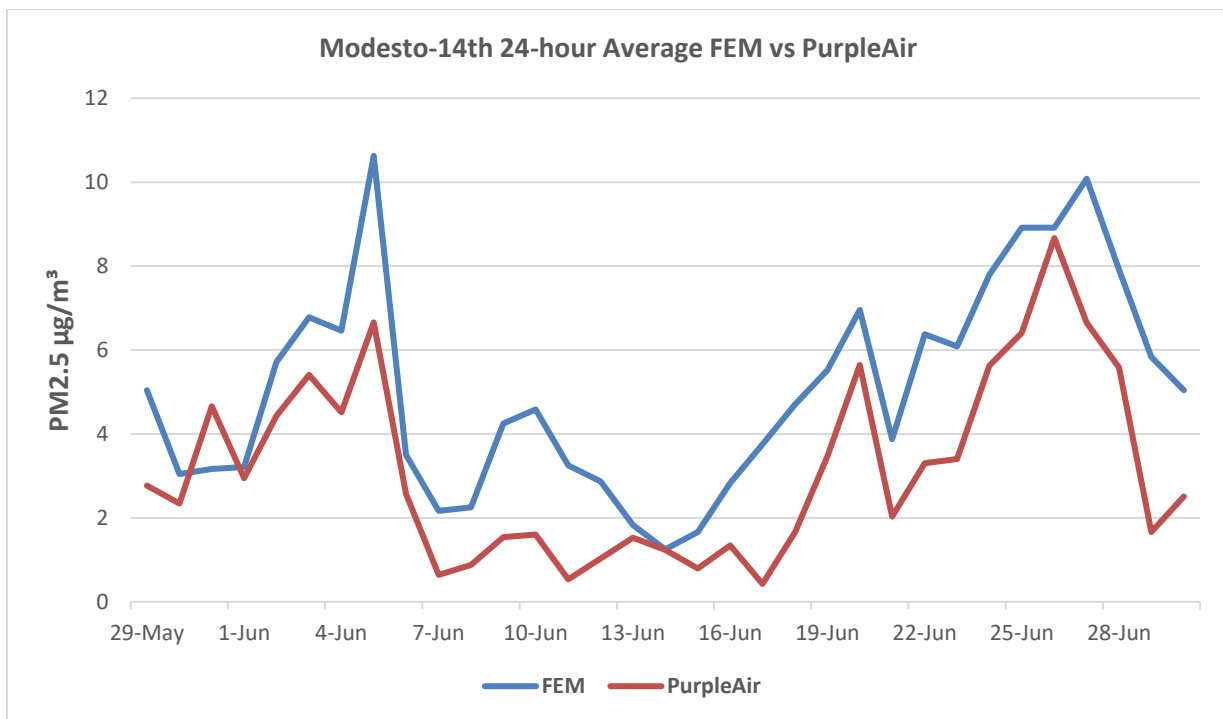
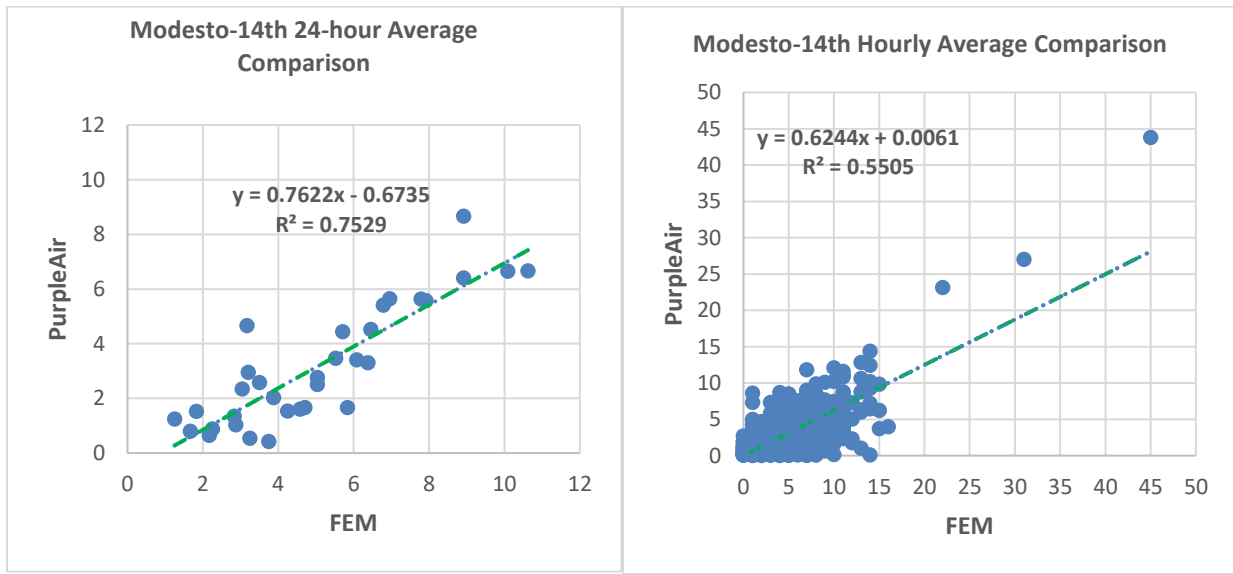
Bakersfield-California

For the 24-hour average, PurpleAir data had a $1.5 \mu\text{g}/\text{m}^3$ low bias during the April 1, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a low bias of $1.4 \mu\text{g}/\text{m}^3$ over the same period.



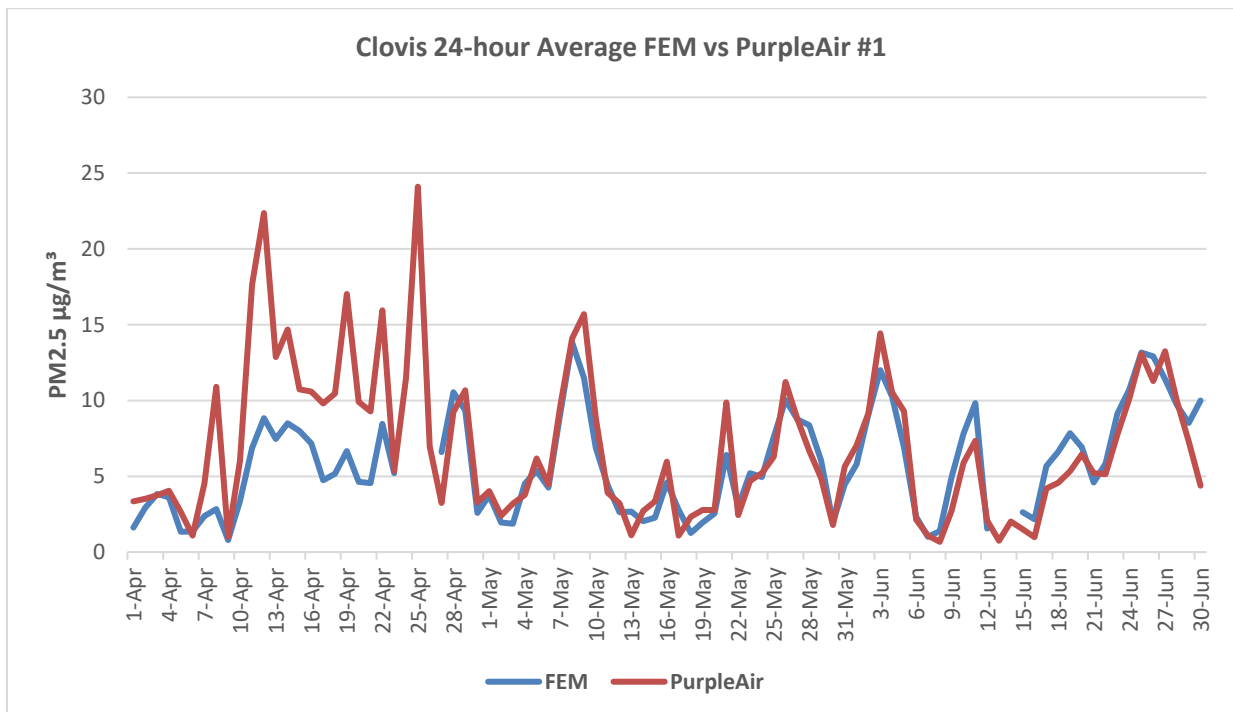
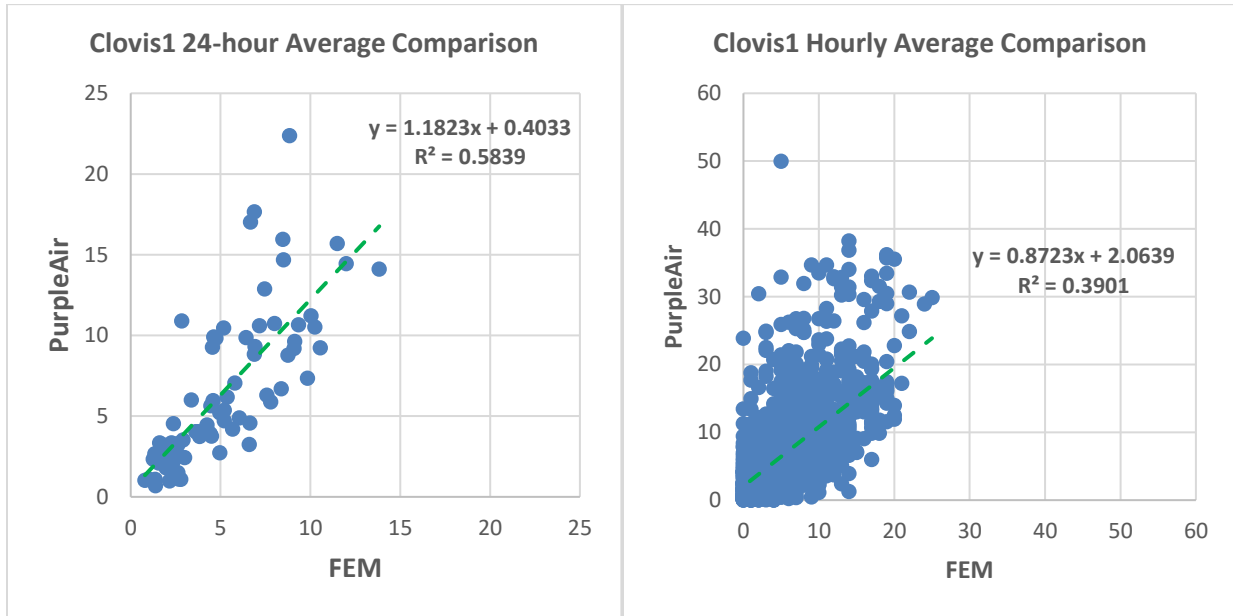
Modesto-14th St.

For the 24-hour average, PurpleAir data had a 1.9 $\mu\text{g}/\text{m}^3$ low bias during the May 29, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a low bias of 1.9 $\mu\text{g}/\text{m}^3$ over the same period.



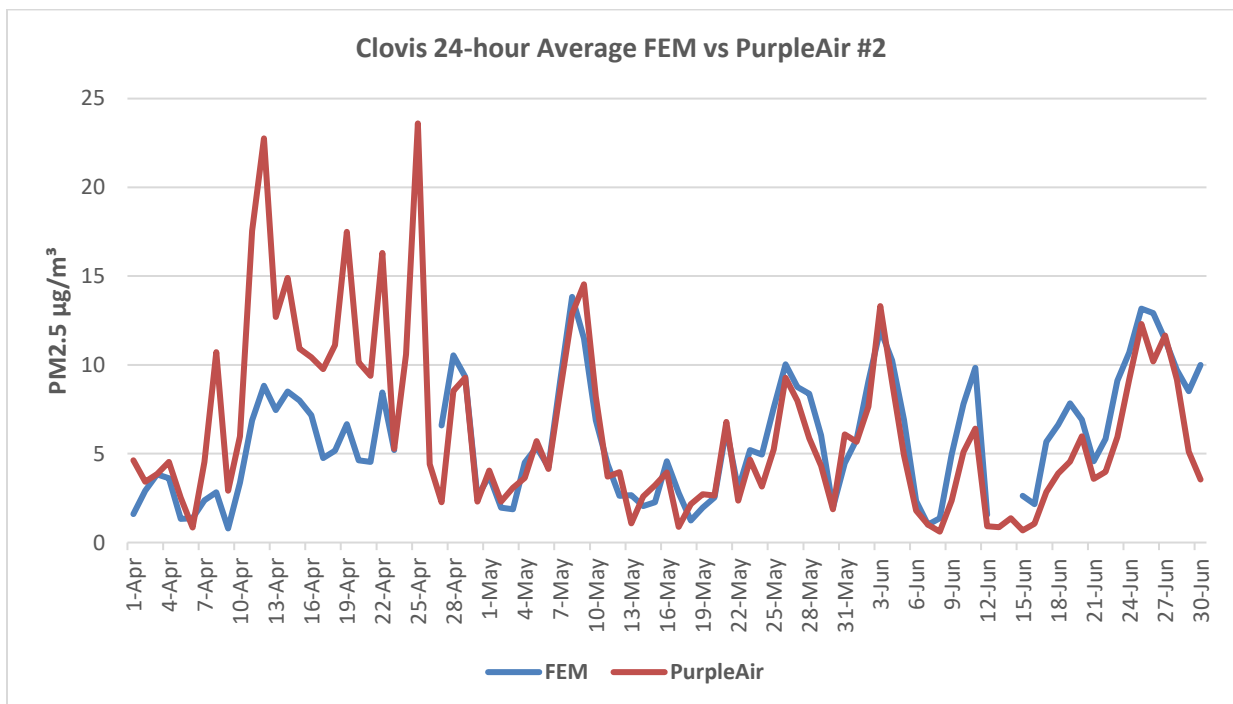
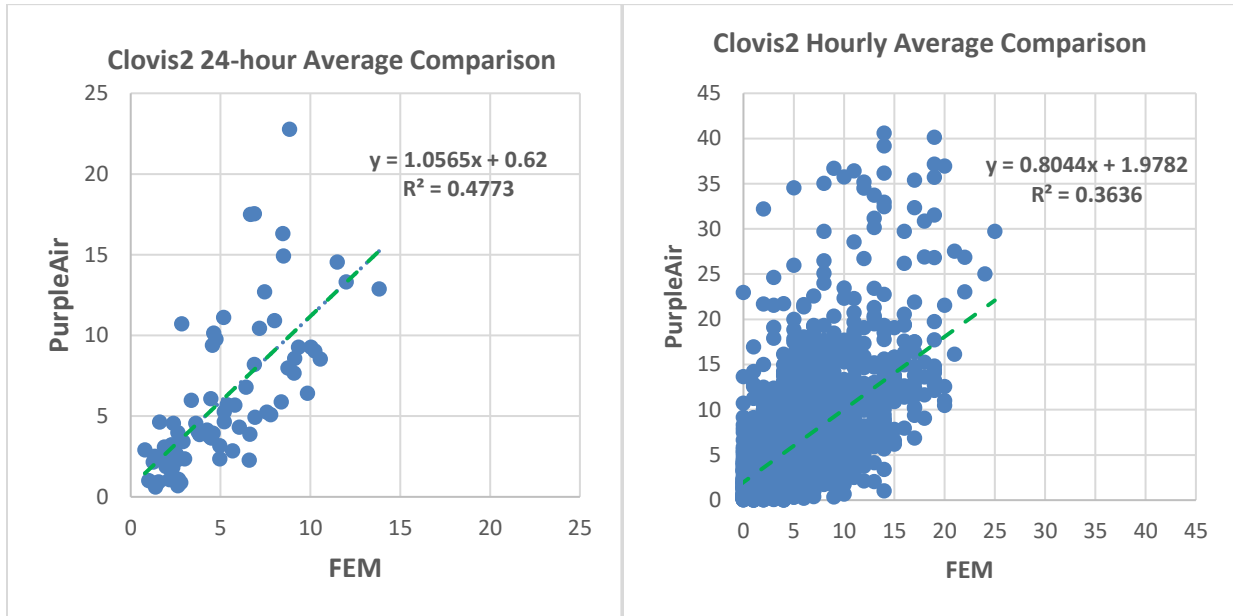
Clovis-Villa #1

For the 24-hour average, PurpleAir data had a 1.2 $\mu\text{g}/\text{m}^3$ high bias during the April 1, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a high bias of 1.1 $\mu\text{g}/\text{m}^3$ over the same period.



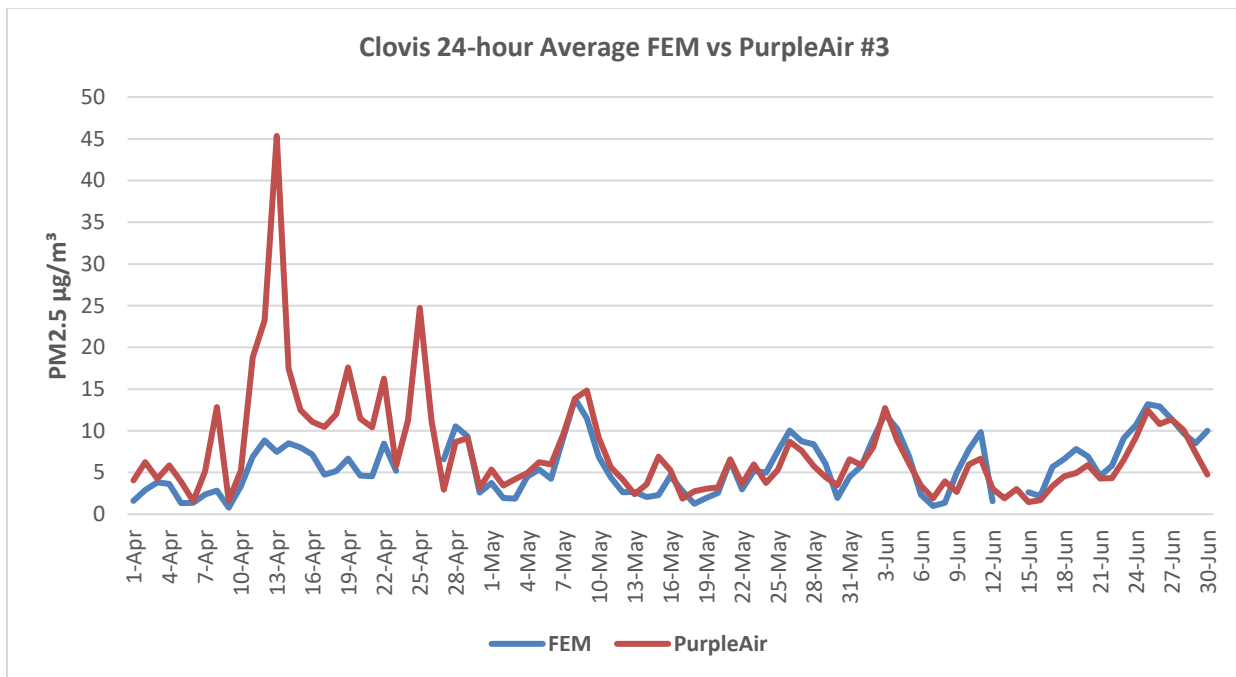
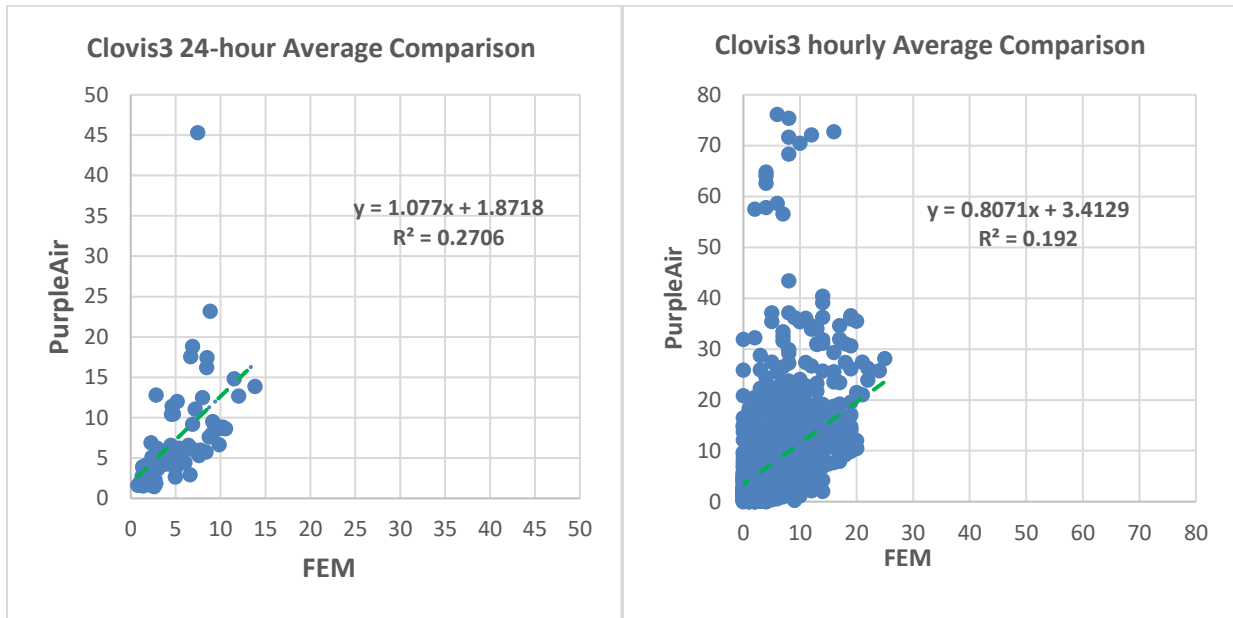
Clovis-Villa #2

For the 24-hour average, PurpleAir data had a 0.6 $\mu\text{g}/\text{m}^3$ high bias during the April 1, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a high bias of 0.6 $\mu\text{g}/\text{m}^3$ over the same period.



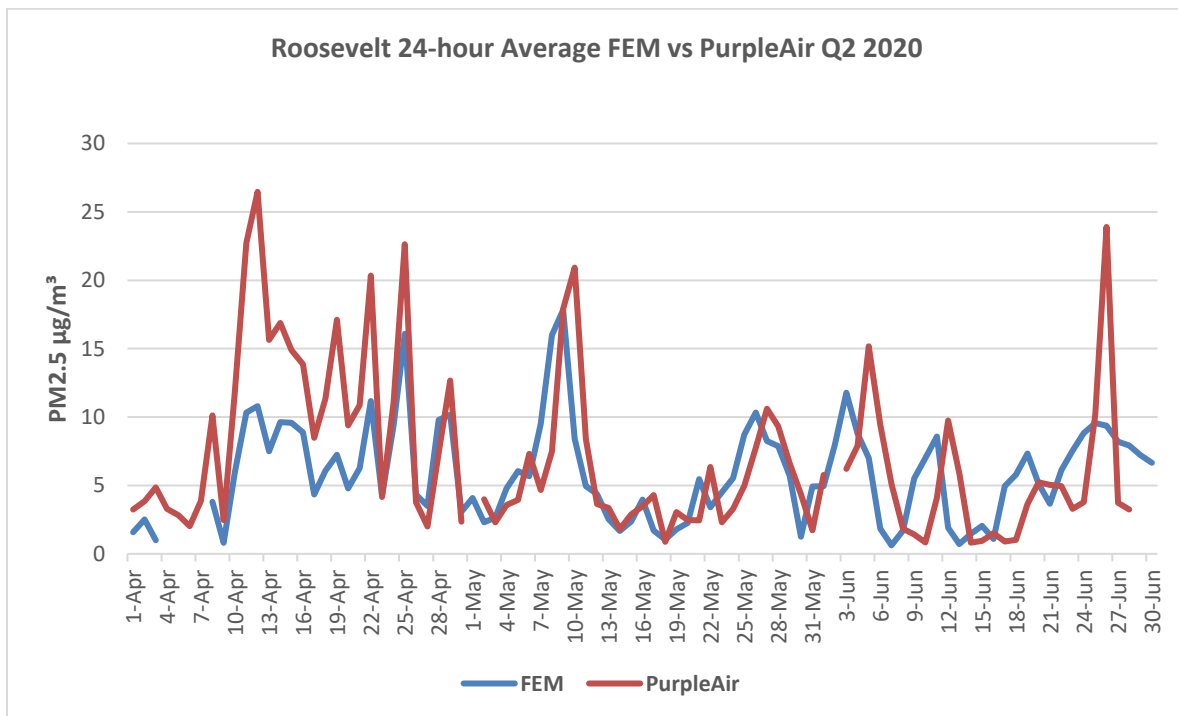
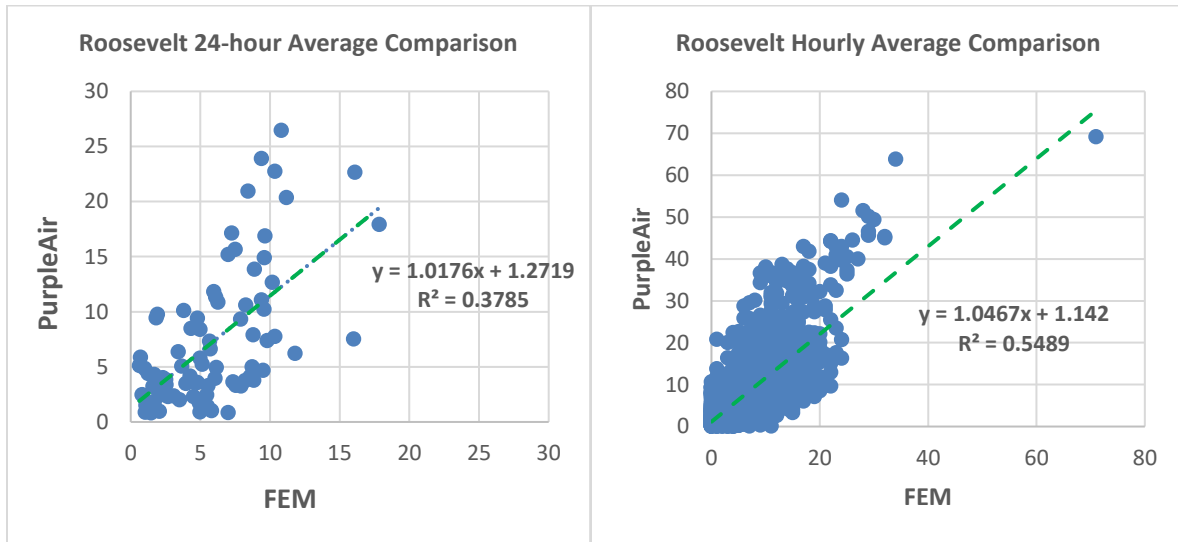
Clovis-Villa #3

For the 24-hour average, PurpleAir data had a 1.8 µg/m³ high bias during the April 1, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a high bias of 1.8 µg/m³ over the same period.



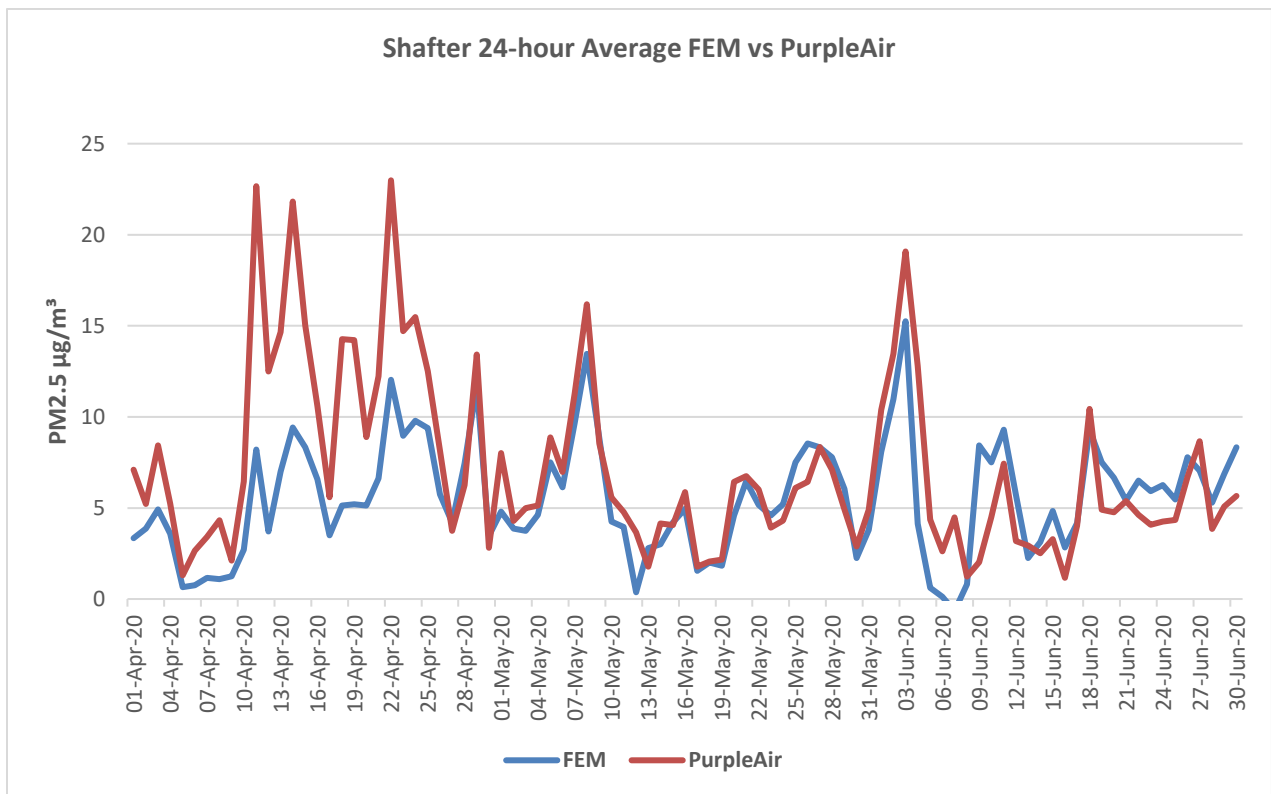
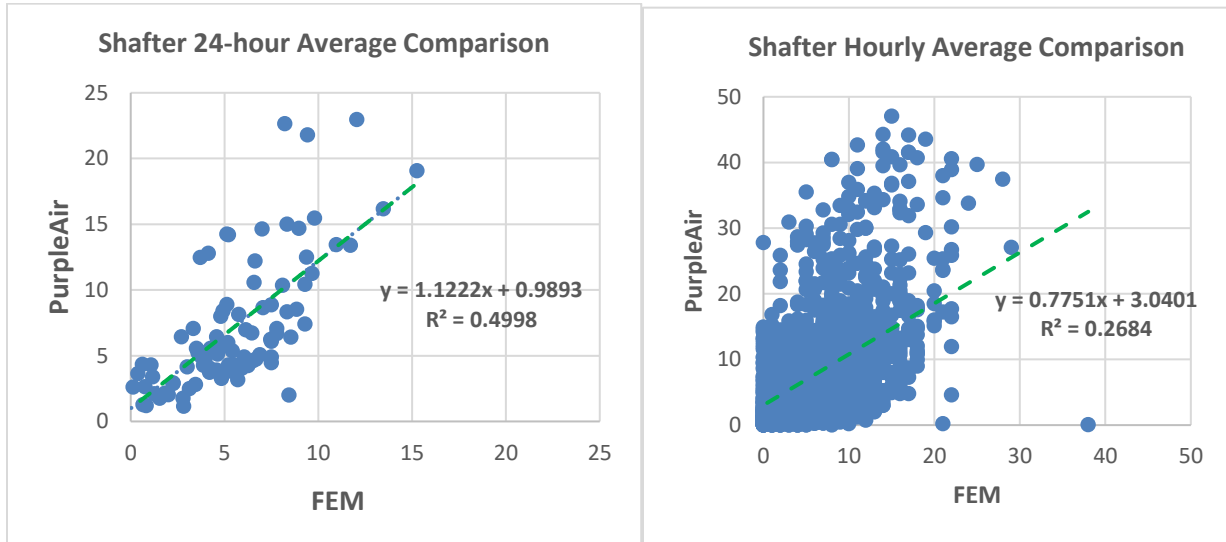
South Central Fresno – Roosevelt High School

For the 24-hour average, PurpleAir data had a 1.2 µg/m³ high bias during the April 1, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a high bias of 1.0 µg/m³ over the same period.



Shafter

For the 24-hour average, PurpleAir data had a 1.6 µg/m³ low bias during the April 1, 2020, through June 30, 2020, period. For the hourly average, PurpleAir data had a low bias of 1.6 µg/m³ over the same period.



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-Cal	Modesto
FEM Avg 24-hr	PurpleAir sensor at this site did not report during this period	9.4	8.0	5.0
Sensor Avg 24-hr		9.9	6.5	3.2
FEM Max 1-hr		53.0	27	45
Sensor Max 1-hr		63.5	37.7	43.8
FEM Max 24-hr		19.9	17.8	10.6
Sensor Max 24-hr		28.4	19.6	8.7
1-hr R ²		0.6497	0.572	0.0061
1-hr Slope		1.3864	1.045	0.6244
1-hr Intercept		-3.1027	-1.5276	0.5505
24-hr R ²		.7389	0.5088	0.7529
24-hr Slope		1.517	0.9771	0.7622
24-hr Intercept		-4.3608	-1.3344	0.6735

Table B – Clovis-Villa Site

Statistic	Clovis-Villa PurpleAir #1	Clovis-Villa PurpleAir #2	Clovis-Villa PurpleAir #3
FEM Avg 24-hr	5.8	5.8	5.8
Sensor Avg 24-hr	6.9	6.4	7.6
FEM Max 1-hr	54	54	54
Sensor Max 1-hr	66.5	62.9	76.1
FEM Max 24-hr	13.8	13.8	13.8
Sensor Max 24-hr	24.1	23.6	45.3
1-hr R ²	0.3901	0.3636	0.192
1-hr Slope	0.8723	0.8044	0.8071
1-hr Intercept	2.0639	1.9872	3.4129
24-hr R ²	0.5839	0.4773	0.2706
24-hr Slope	1.1823	1.0565	1.077
24-hr Intercept	0.4033	0.62	1.8718

Table C – South Central Fresno and Shafter Sites

Statistic	South Central Fresno	Shafter
FEM Avg 24-hr	5.9	5.5
Sensor Avg 24-hr	7.1	7.1
FEM Max 1-hr	71	38
Sensor Max 1-hr	69.2	47.1
FEM Max 24-hr	17.8	15.3
Sensor Max 24-hr	26.5	22.9
1-hr R ²	0.5489	0.2684
1-hr Slope	1.0467	0.7751
1-hr Intercept	1.142	3.0401
24-hr R ²	0.3785	0.4998
24-hr Slope	1.0176	1.1222
24-hr Intercept	1.2719	0.9893