



Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor
2020 – 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, 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, Visalia-Church, Modesto-14th St, 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 January 1, 2020, through March 31, 2020 (2020 – 1st 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.

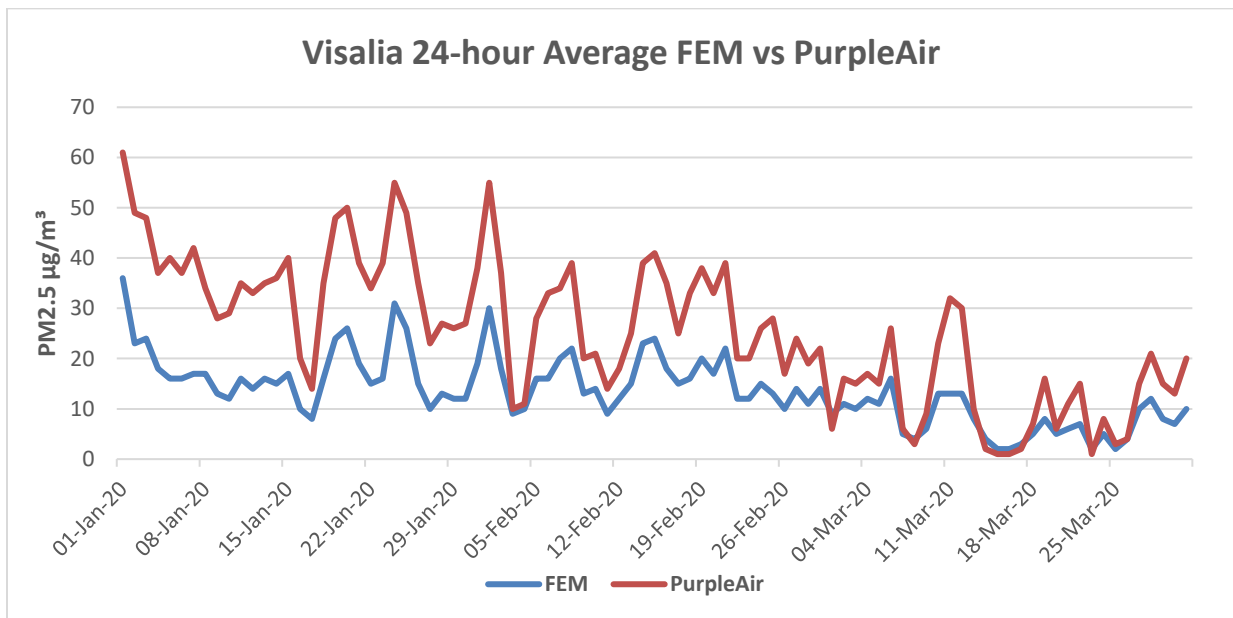
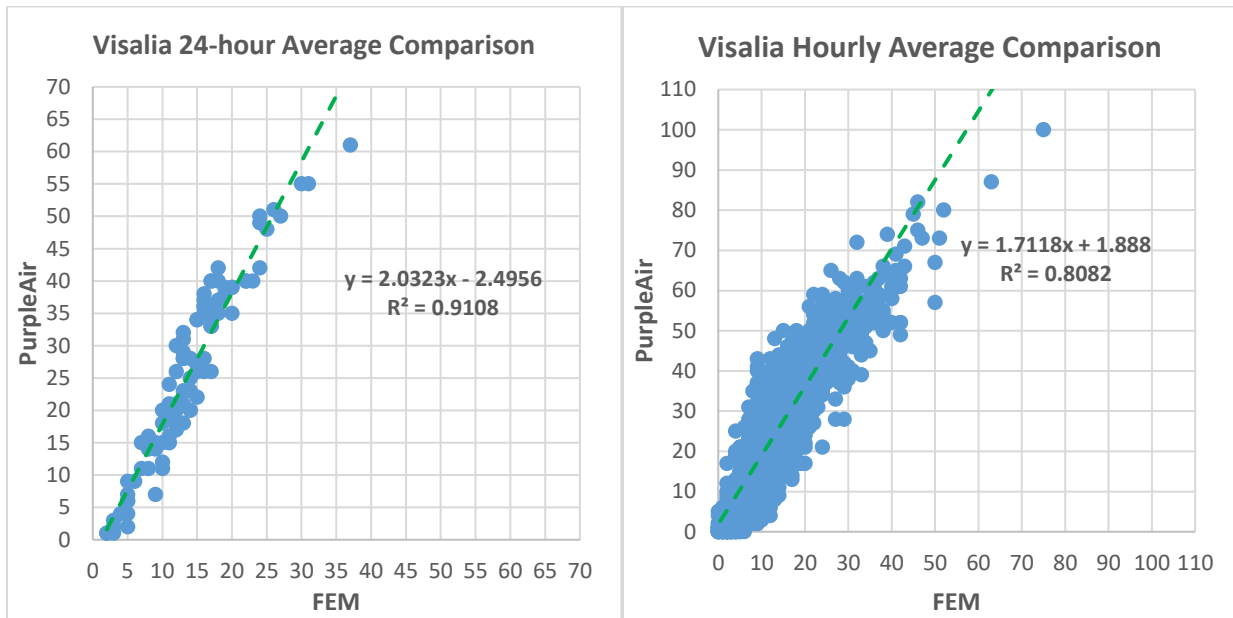
During January and February of the 1st quarter of 2020, high pressure systems and low pressure systems moved through the region in typical alternating fashion. As such, January and February saw PM2.5 concentrations increase when high pressure and poor dispersion were present and decrease when dispersion improved as low pressure systems moved through the region. In contrast, low PM2.5 concentrations prevailed throughout March as dispersive low pressure systems passed through the region quite consecutively.

Overall, the sensors operating during this period had high results compared to the regulatory monitors. The PurpleAir sensor at Shafter had the highest 24-hour average bias of 14.8 $\mu\text{g}/\text{m}^3$ higher than the FEM while the PurpleAir sensor in Bakersfield has the lowest 24-hour bias of 7.2 $\mu\text{g}/\text{m}^3$ higher than the FEM.

Site Specific Analysis of PurpleAir PA-II Sensor Performance

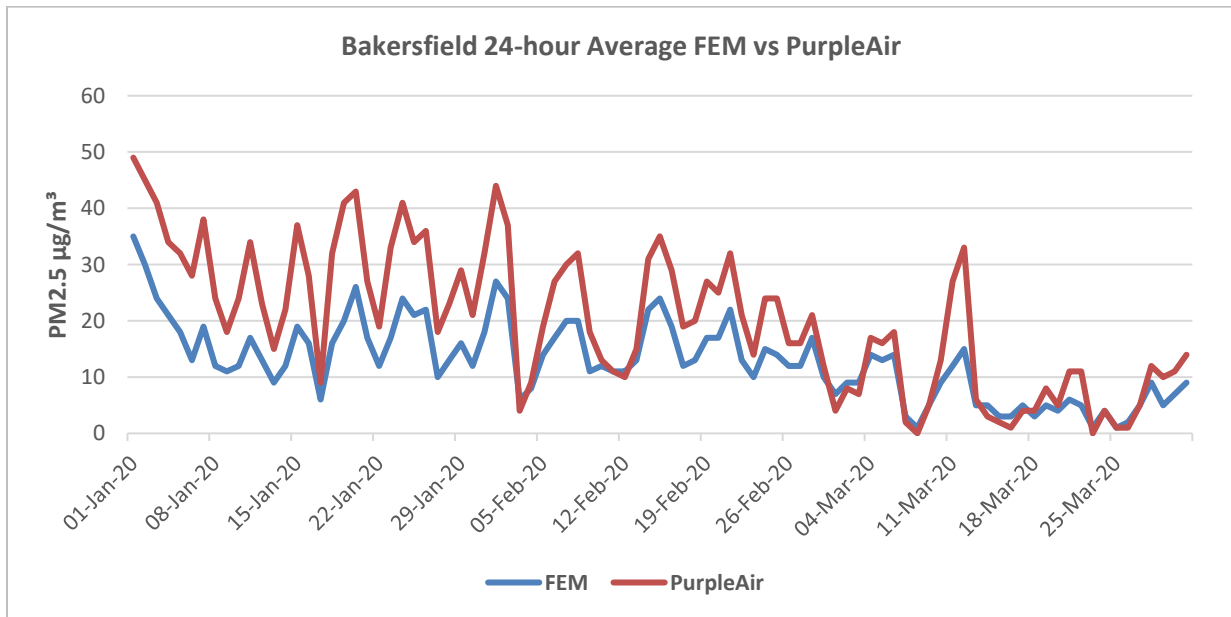
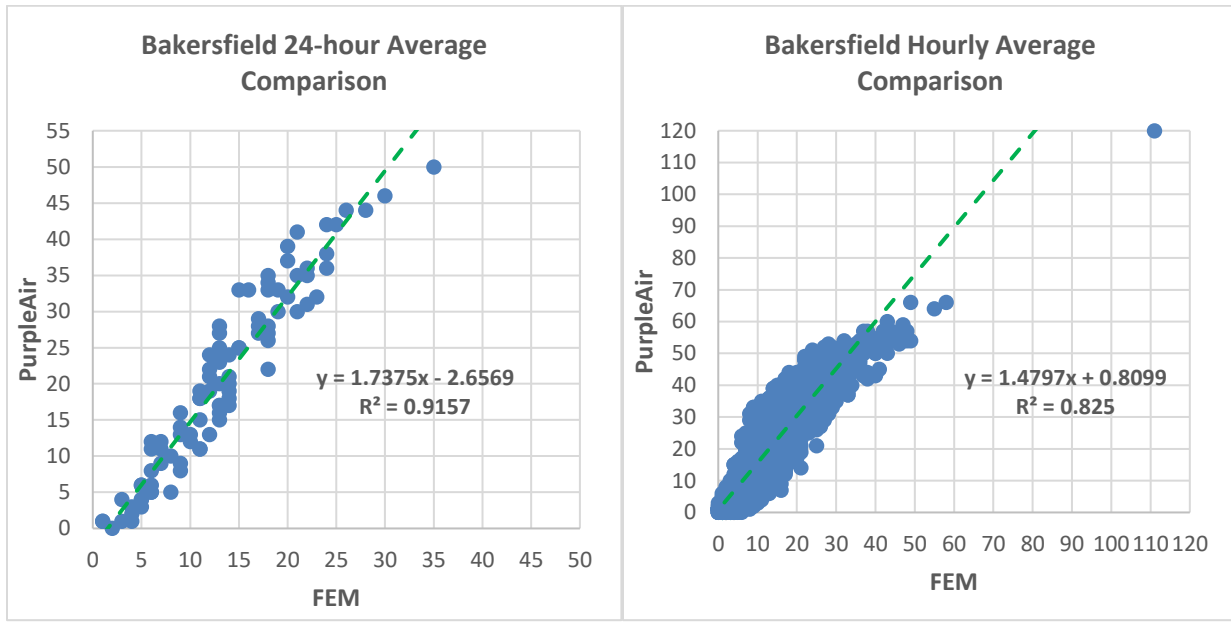
Visalia-Church

For the 24-hour average, PurpleAir data had a 12.0 µg/m³ high bias during the January 1, 2020, through March 31, 2020, period. For the hourly average, PurpleAir data had a high bias of 11.9 µg/m³ over the same period.



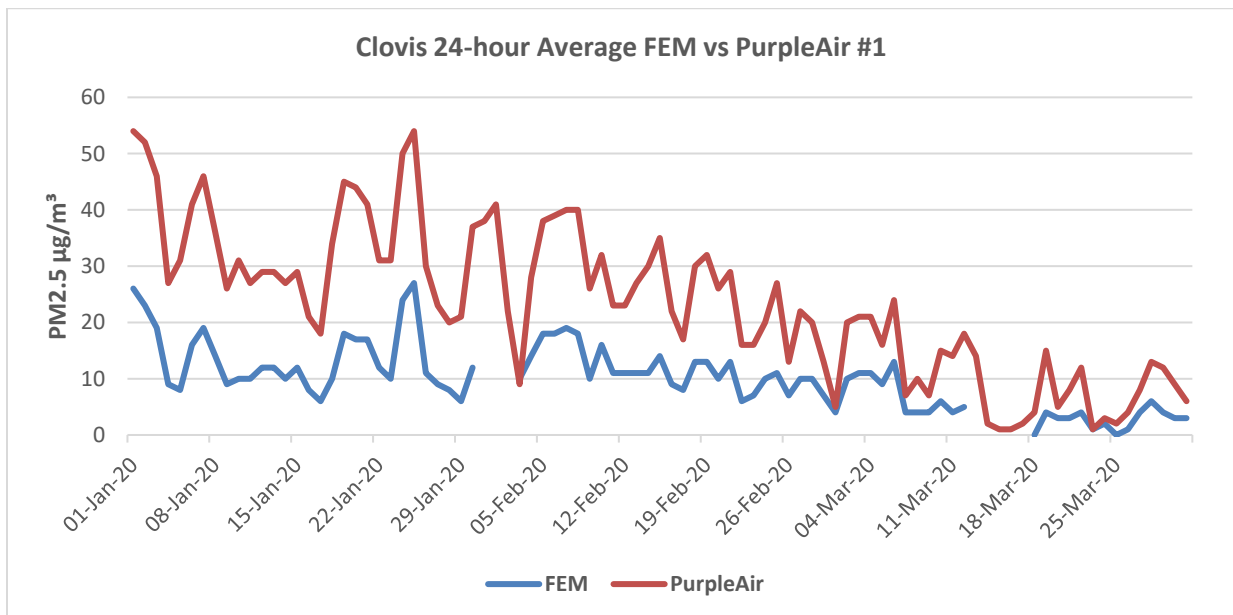
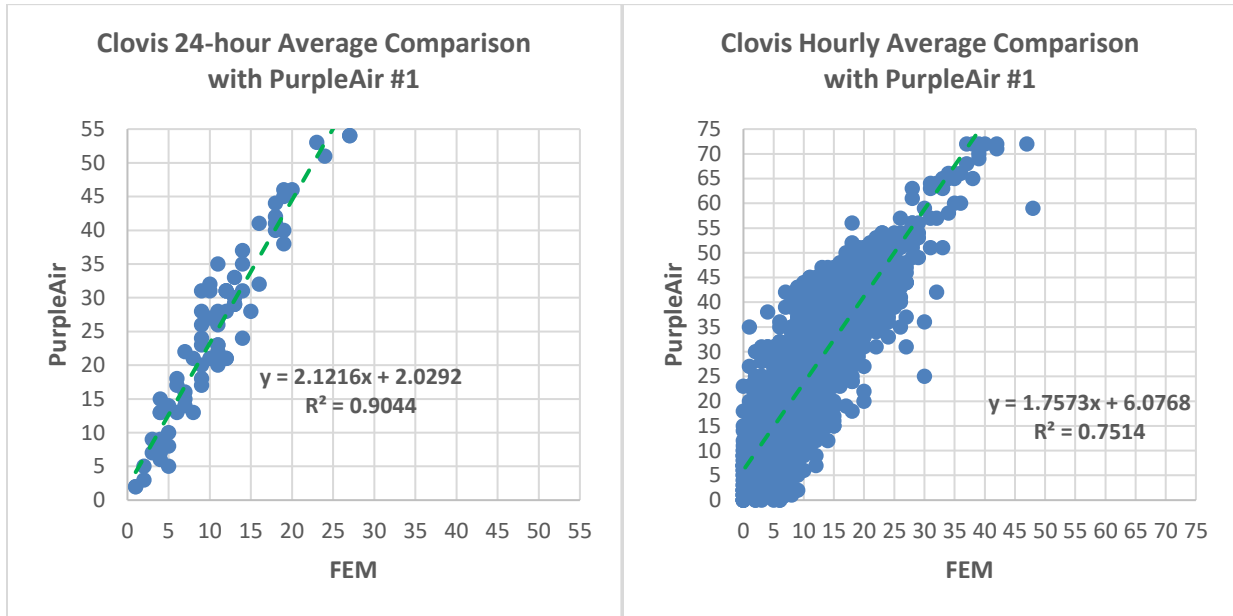
Bakersfield-California

For the 24-hour average, PurpleAir data had a 7.2 $\mu\text{g}/\text{m}^3$ high bias during the January 1, 2020, through March 31, 2020, period. For the hourly average, PurpleAir data had a high bias of 7.2 $\mu\text{g}/\text{m}^3$ over the same period.



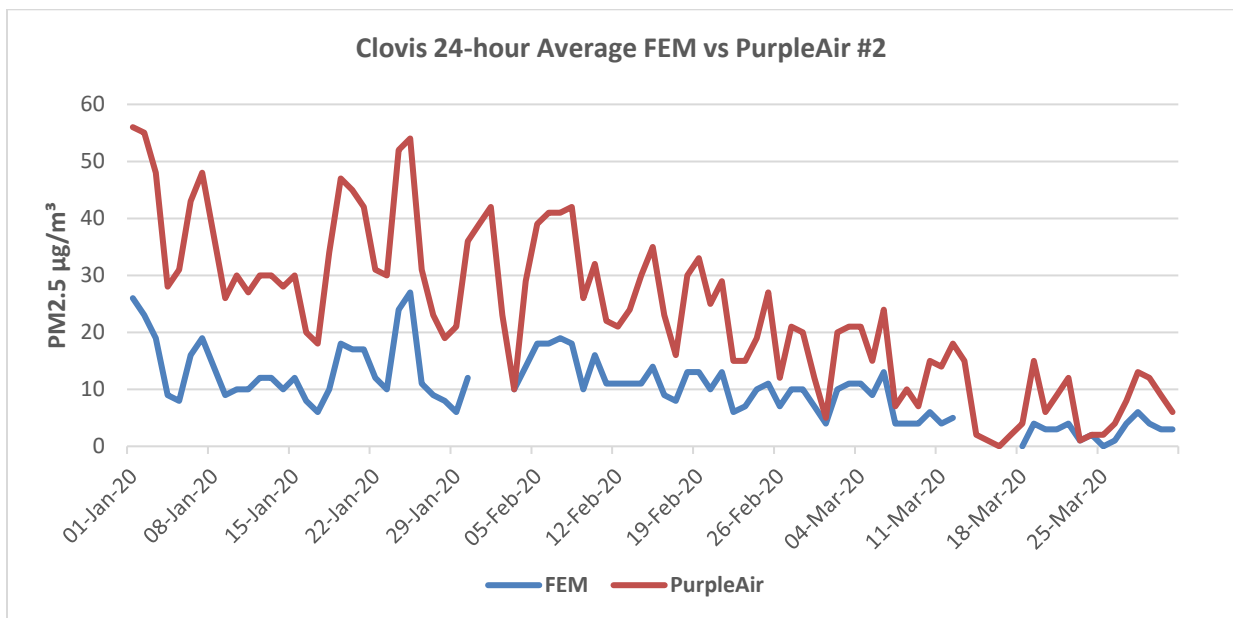
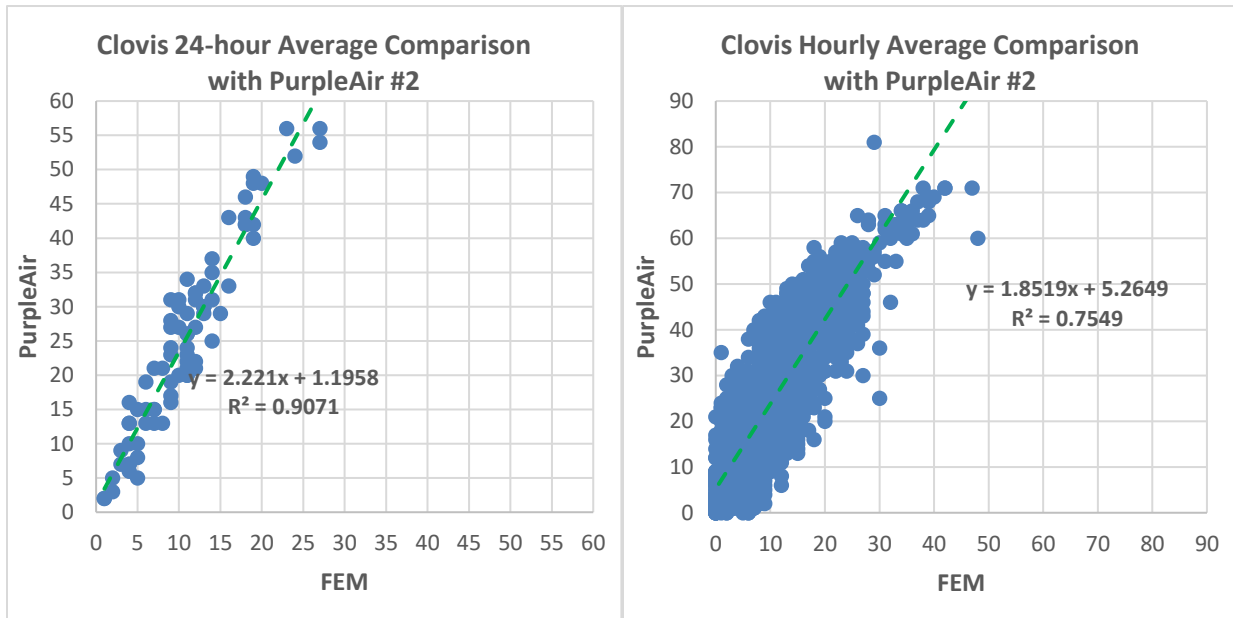
Clovis-Villa #1

For the 24-hour average, PurpleAir data had a 14.1 $\mu\text{g}/\text{m}^3$ high bias during the January 1, 2020, through March 31, 2020, period. For the hourly average, PurpleAir data had a high bias of 14.2 $\mu\text{g}/\text{m}^3$ over the same period.



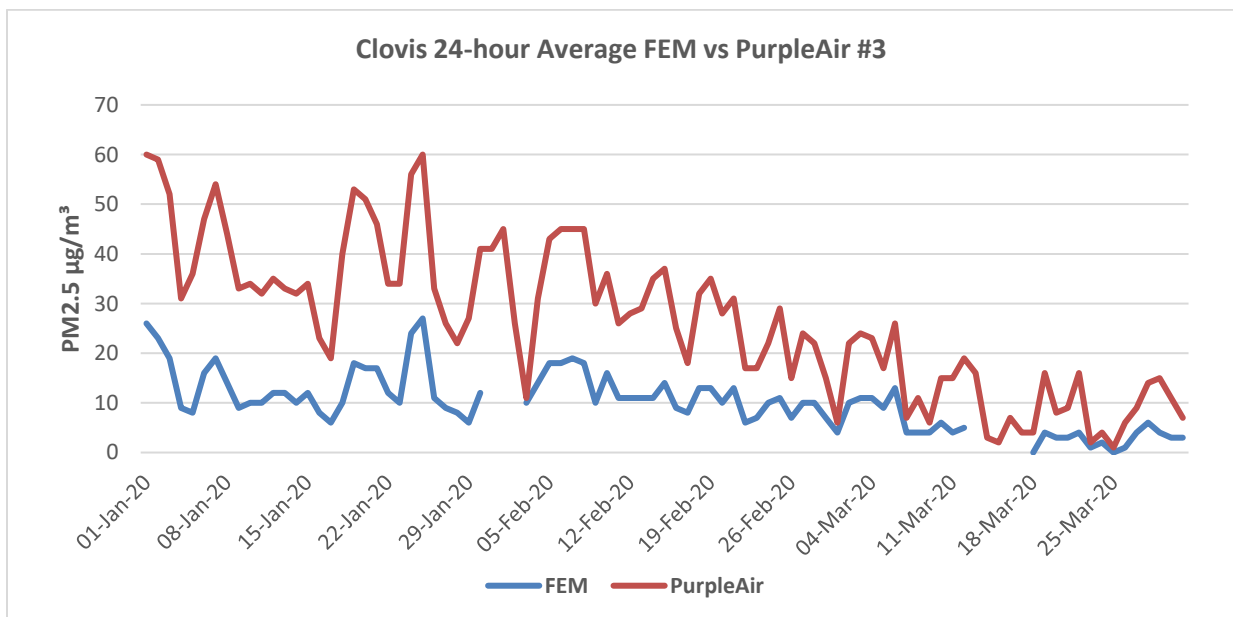
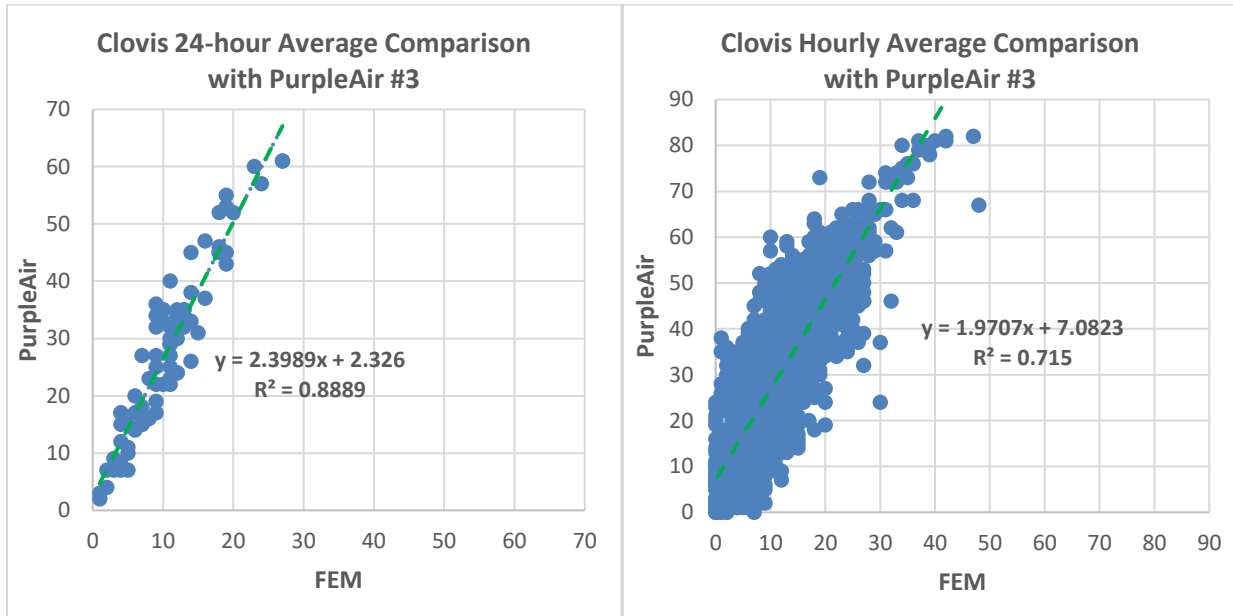
Clovis-Villa #2

For the 24-hour average, PurpleAir data had a 14.4 $\mu\text{g}/\text{m}^3$ high bias during the January 1, 2020, through March 31, 2020, period. For the hourly average, PurpleAir data had a high bias of 14.4 $\mu\text{g}/\text{m}^3$ over the same period.



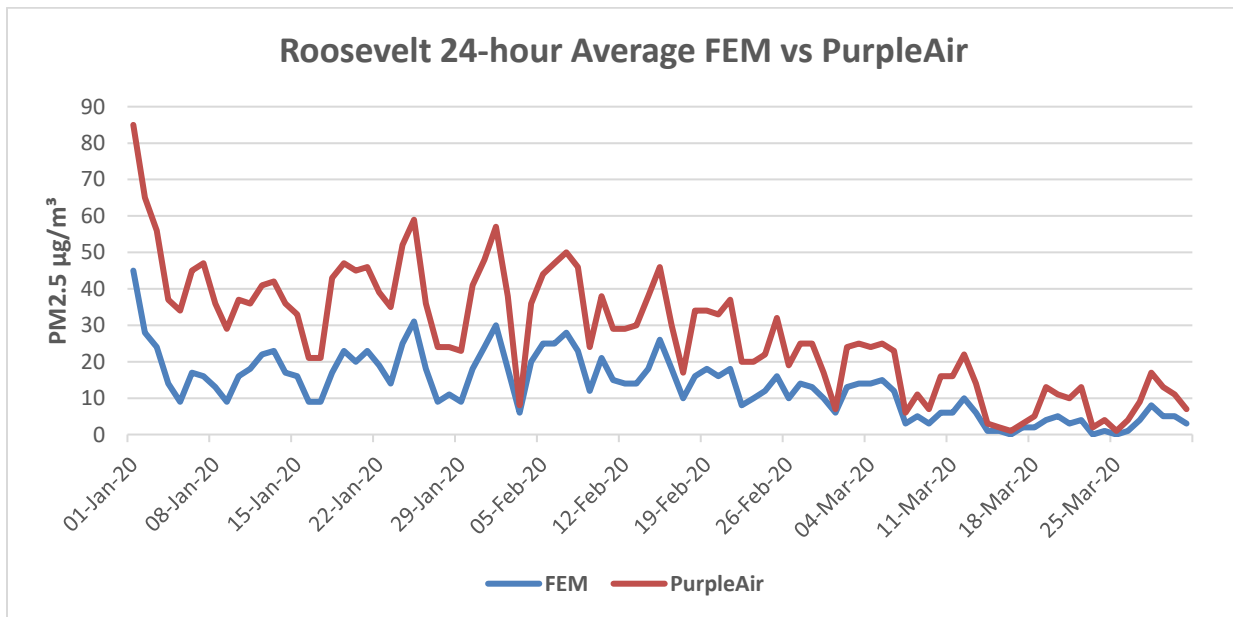
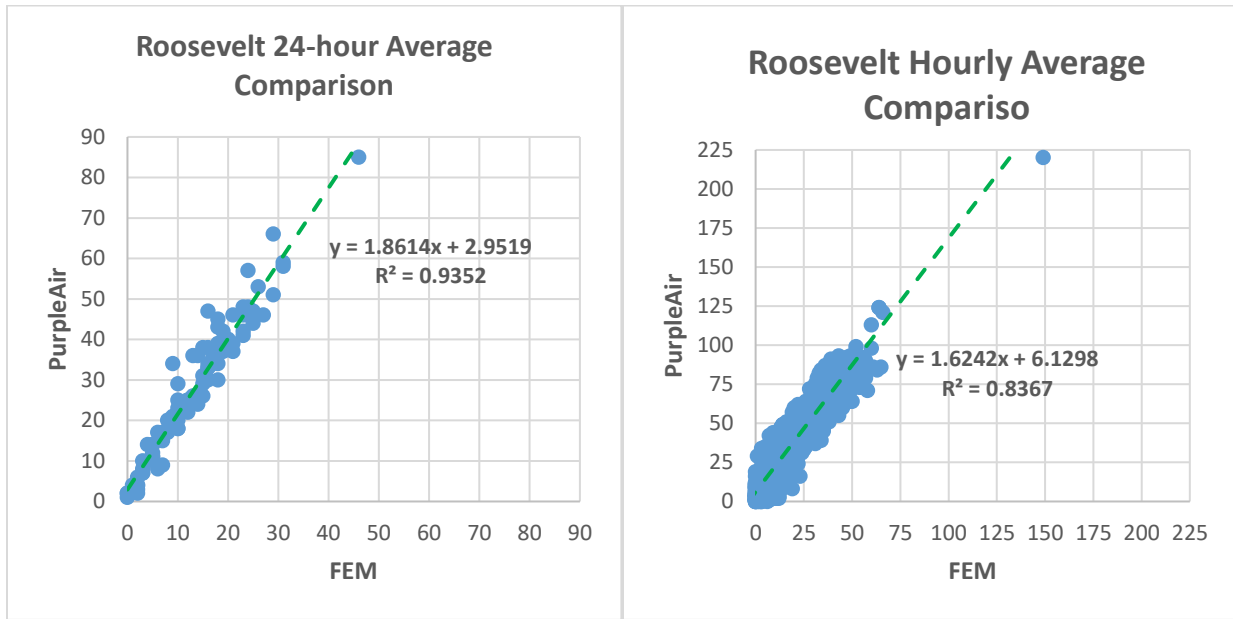
Clovis-Villa #3

For the 24-hour average, PurpleAir data had a 17.4 $\mu\text{g}/\text{m}^3$ high bias during the January 1, 2020, through March 31, 2020, period. For the hourly average, PurpleAir data had a high bias of 17.6 $\mu\text{g}/\text{m}^3$ over the same period.



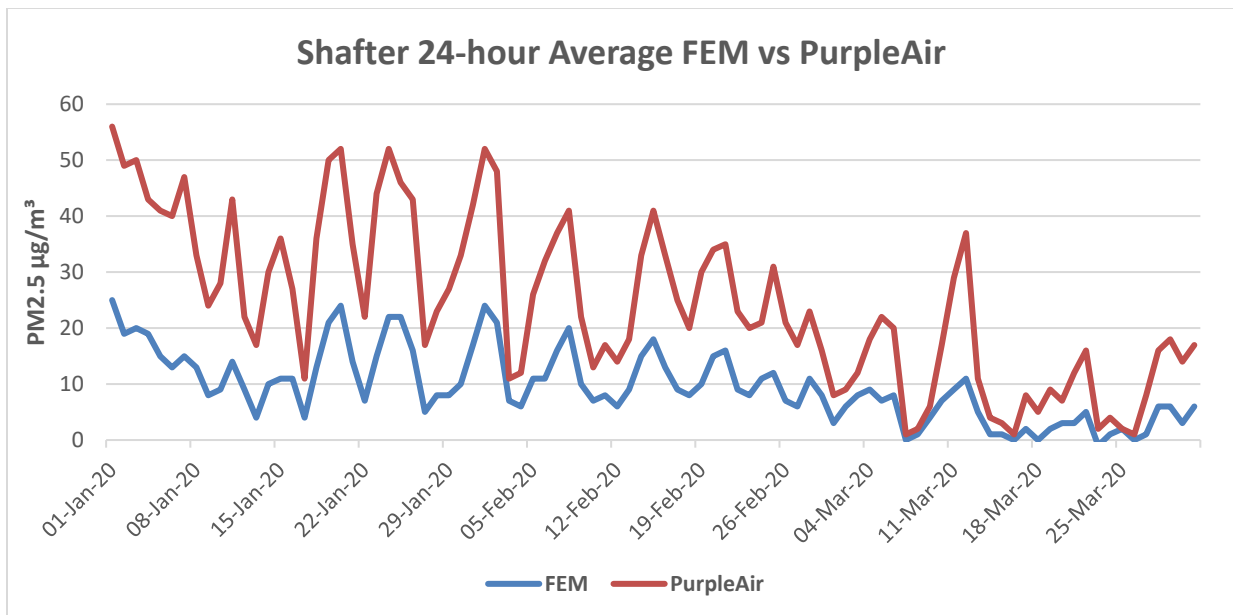
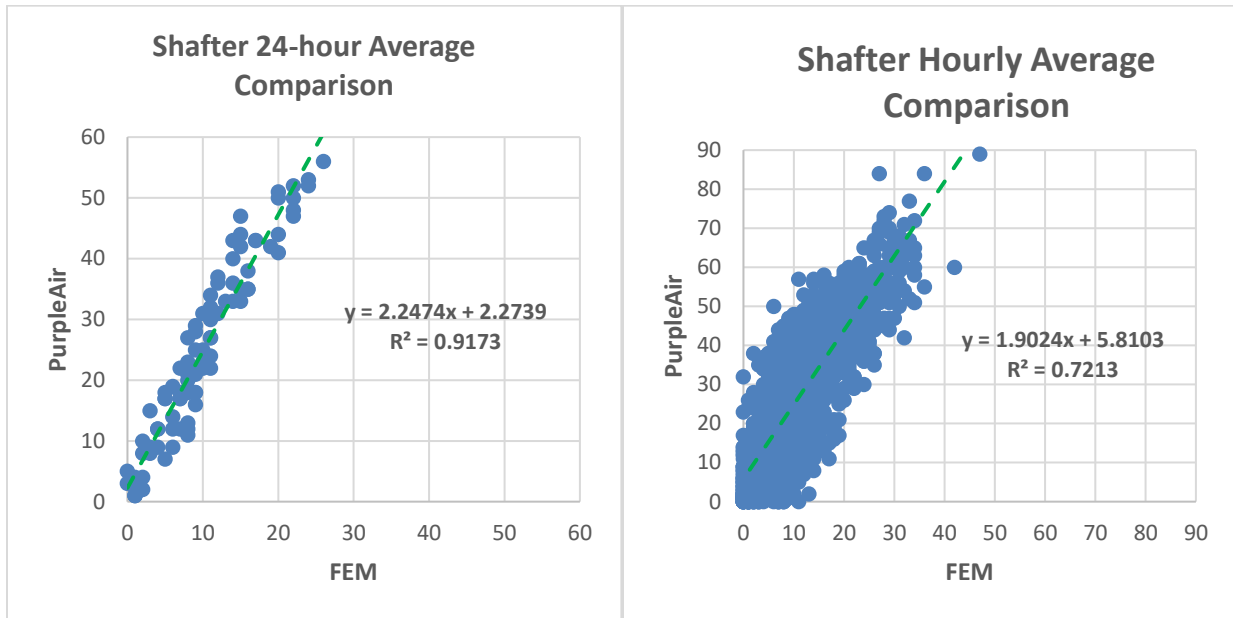
South Central Fresno – Roosevelt High School

For the 24-hour average, PurpleAir data had a 14.7 $\mu\text{g}/\text{m}^3$ high bias during the January 1, 2020, through March 31, 2020, period. For the hourly average, PurpleAir data had a high bias of 14.7 $\mu\text{g}/\text{m}^3$ over the same period.



Shafter

For the 24-hour average, PurpleAir data had a 14.8 $\mu\text{g}/\text{m}^3$ high bias during the January 1, 2020, through March 31, 2020, period. For the hourly average, PurpleAir data had a high bias of 14.9 $\mu\text{g}/\text{m}^3$ over the same period.



Non-Reporting Sites

Fresno-Garland

Data from this sensor was not available for the January 1, 2020, through March 31, 2020, period. This sensor will be included in future analysis reports if the data becomes available.

Modesto-14th St.

Data from this sensor was not available for the January 1, 2020, through March 31, 2020, period. This sensor will be included in future analysis reports if the data becomes available.

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	14.0	13.4	PurpleAir sensor at this site did not report during this period
Sensor Avg 24-hr		26.0	20.6	
FEM Max 1-hr		75	111	
Sensor Max 1-hr		100	120	
FEM Max 24-hr		37	35	
Sensor Max 24-hr		61	50	
1-hr R ²		0.8082	0.825	
1-hr Slope		1.7118	1.4797	
1-hr Intercept		1.888	0.8099	
24-hr R ²		0.9108	0.9157	
24-hr Slope		2.0323	1.7375	
24-hr Intercept		-2.4956	-2.6569	

Table B – Clovis-Villa Site

Statistic	Clovis-Villa PurpleAir #1	Clovis-Villa PurpleAir #2	Clovis-Villa PurpleAir #3
FEM Avg 24-hr	10.8	10.8	10.8
Sensor Avg 24-hr	24.9	25.2	28.2
FEM Max 1-hr	48	48	48
Sensor Max 1-hr	72	81	82
FEM Max 24-hr	27	27	27
Sensor Max 24-hr	54	56	61
1-hr R ²	0.7514	0.7549	0.715
1-hr Slope	1.7573	1.8519	1.9707
1-hr Intercept	6.0768	5.2649	7.0823
24-hr R ²	0.9044	0.9071	0.8889
24-hr Slope	2.1216	2.221	2.3989
24-hr Intercept	2.0292	1.1958	2.326

Table C – South Central Fresno and Shafter Sites

Statistic	South Central Fresno	Shafter
FEM Avg 24-hr	13.7	26
Sensor Avg 24-hr	28.4	56
FEM Max 1-hr	149	47
Sensor Max 1-hr	220	89
FEM Max 24-hr	46	10.1
Sensor Max 24-hr	85	24.9
1-hr R ²	0.8367	0.7213
1-hr Slope	1.6242	1.9024
1-hr Intercept	6.1298	5.8103
24-hr R ²	0.9352	0.9173
24-hr Slope	1.8614	2.2474
24-hr Intercept	2.9519	2.2739