San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

PurpleAir PA-II Sensor
2019 – 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, 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

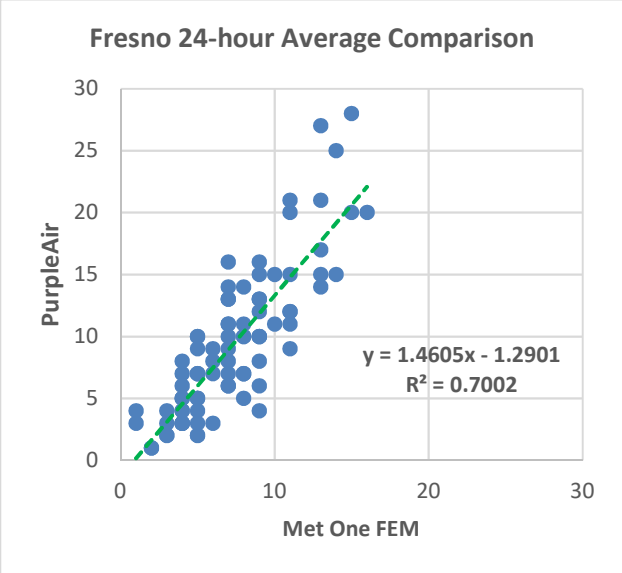
This assessment compares the Purple Air PA-II sensor performance against the Met One 1020 (Fresno-Garland, Visalia-Church, Modesto-14th, Bakersfield-California, and Clovis-Villa) and the Met One 1022 (Shafter and South Central Fresno) near-continuous particulate monitors. The analysis for this report covers the time period of April 2019 through June 2019 (2019 – 2nd quarter). During this this period, hourly data was removed from the calculation of bias and average concentrations when either the Purple Air sensor or regulatory monitor did not have a valid sample. For the 24 hour average line graphs, all available data is shown for each collocated analyzer and sensor.

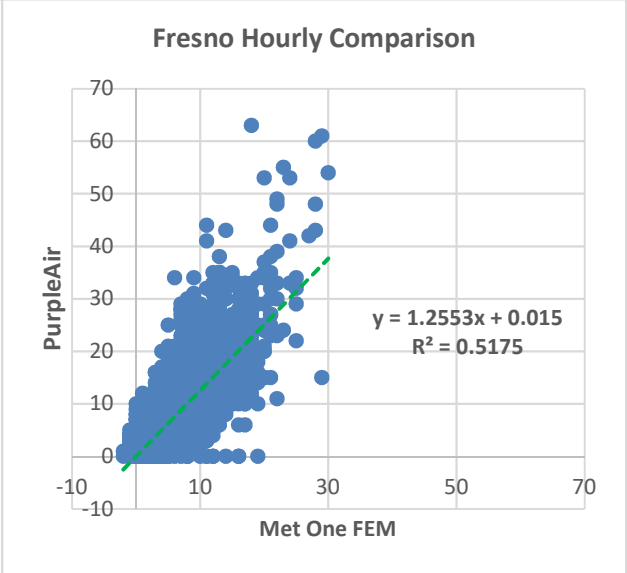
Seasonally, PM2.5 is typically highest during the winter months and lowest during the summer months. Weather systems can also influence PM2.5 levels by either trapping pollutants near the surface or dispersing them. The 2nd quarter of 2019 was dominated by dispersive low pressure systems that scoured pollutants out of the Valley and helped PM2.5 levels remain low. Although some high pressure systems developed over the Valley during the 2nd quarter, they were all short-lived and not strong enough to cause elevated PM2.5 concentrations.

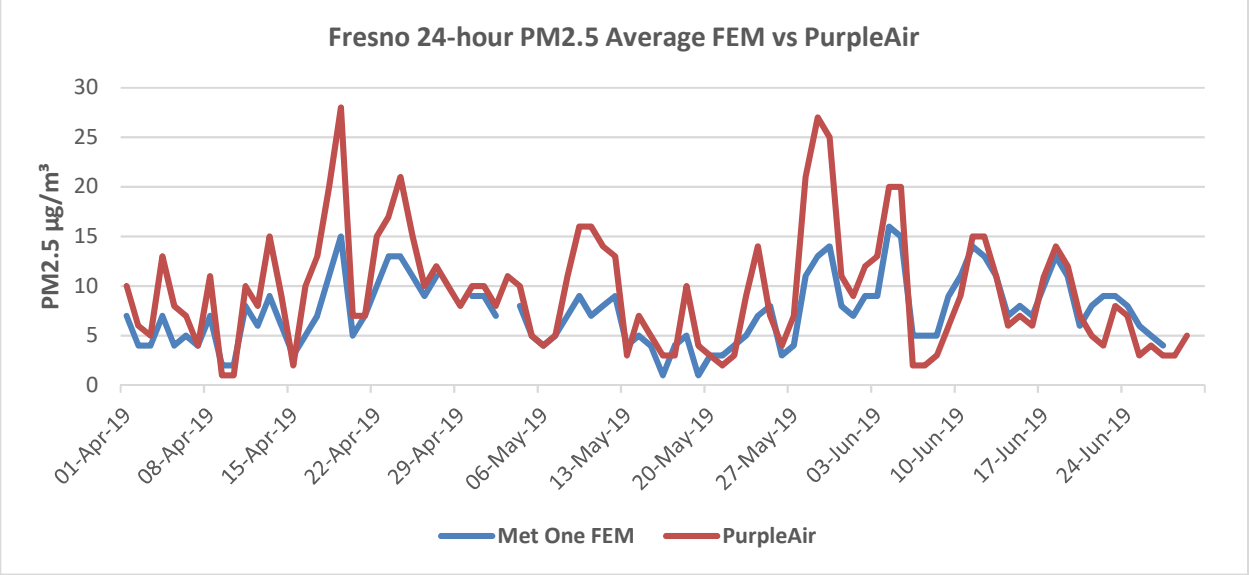
Site Specific Analysis of PurpleAir PA-II Sensor Performance

Fresno-Garland

For the 24-hour average, PurpleAir data had a 2.1 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 1.9 µg/m^3 over the same period.

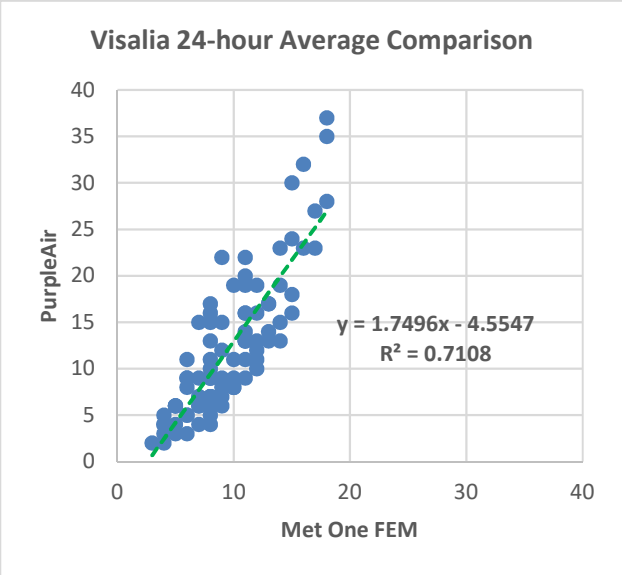


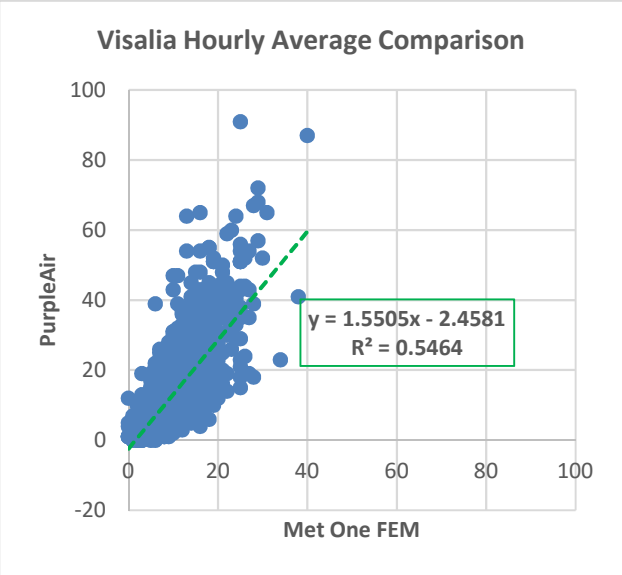


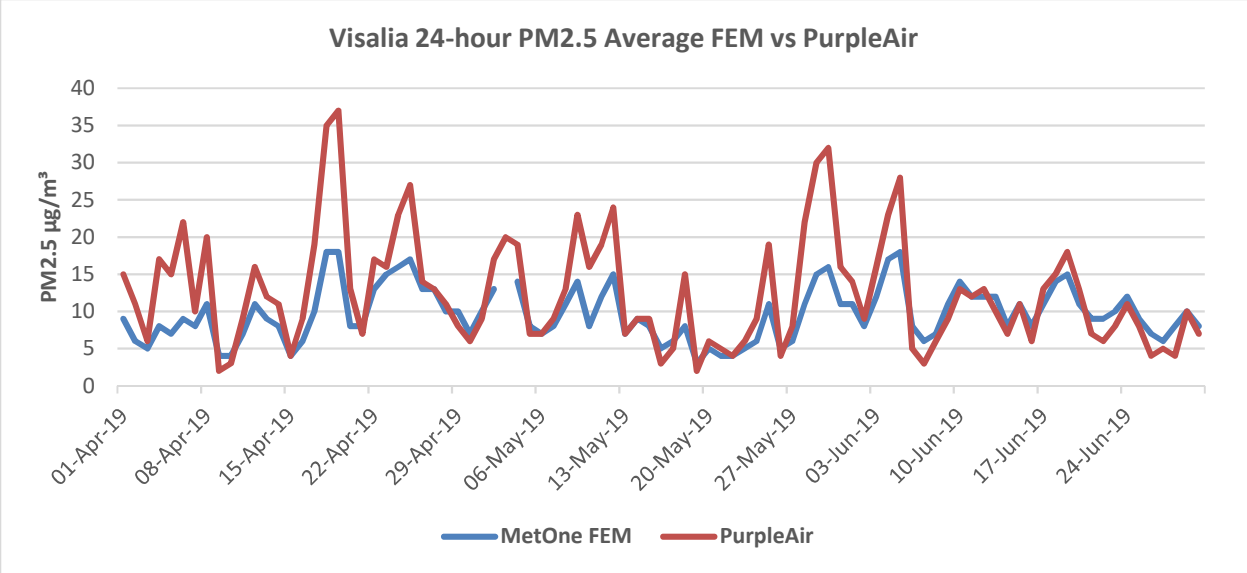


Visalia-Church

For the 24-hour average, PurpleAir data had a 2.7 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 2.8 µg/m^3 over the same period.

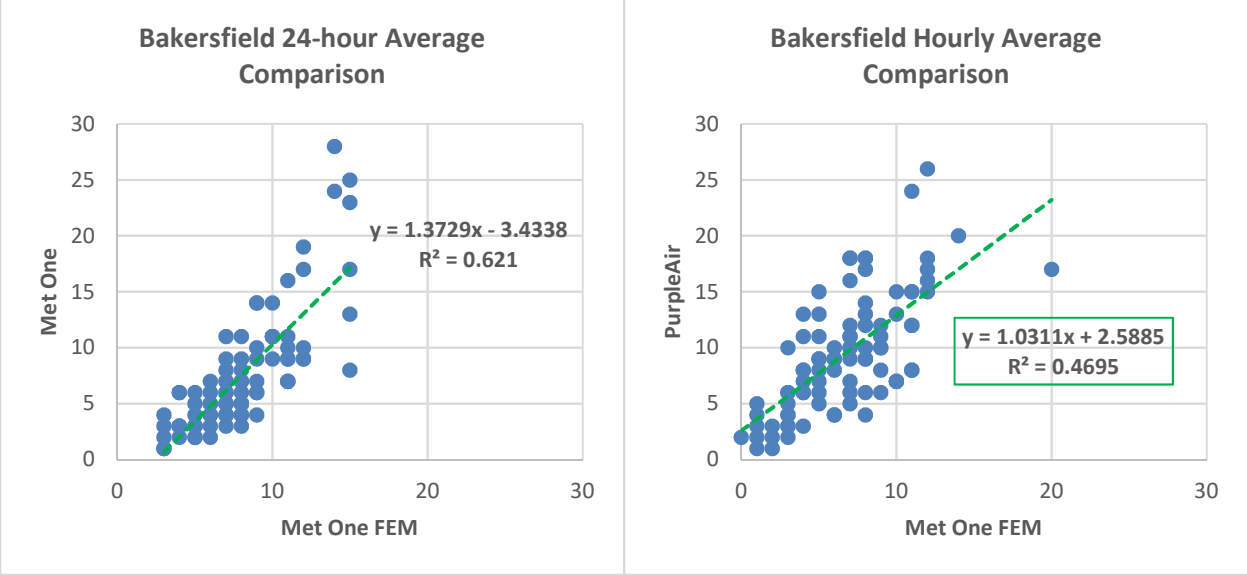


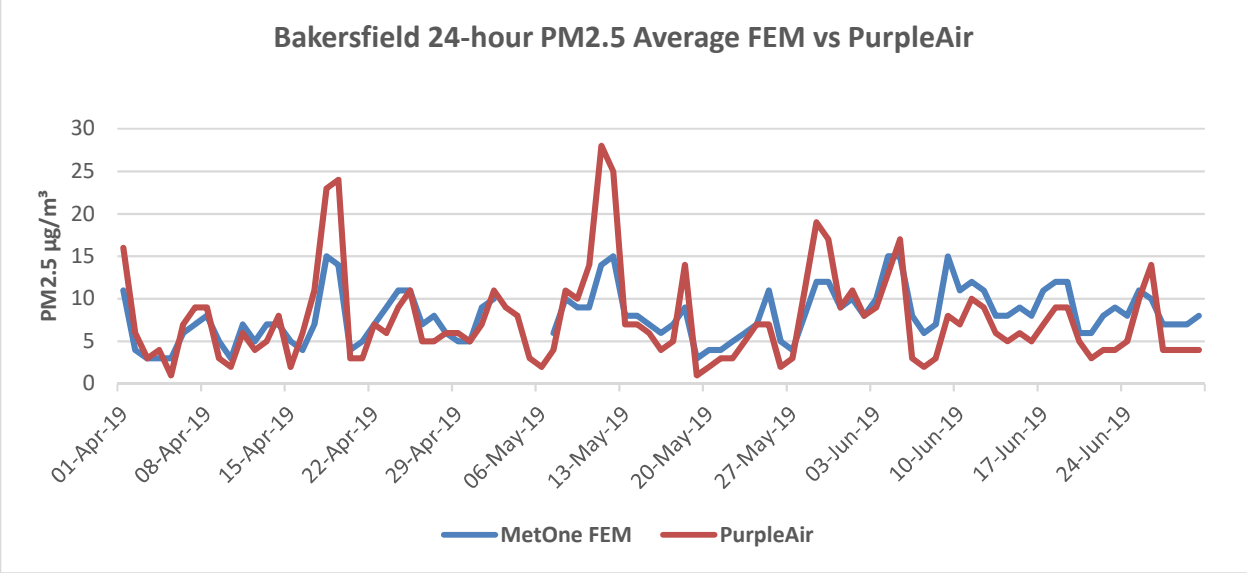




Bakersfield-California

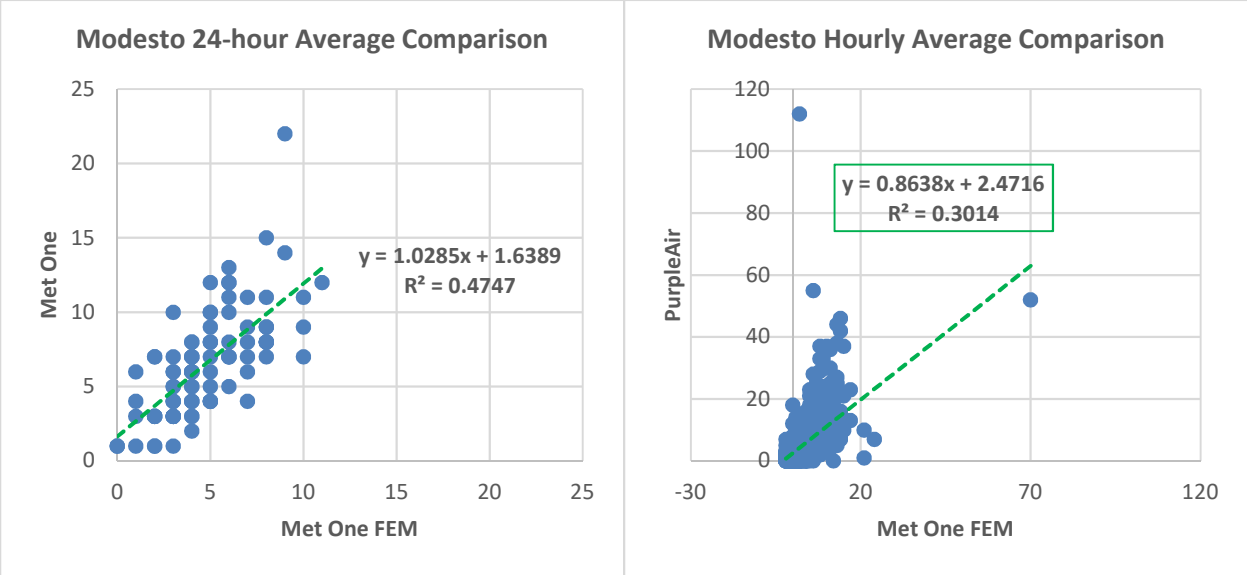
For the 24-hour average, PurpleAir data had a -0.4 µg/m^3 low bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a low bias of -0.4 µg/m^3 over the same period.

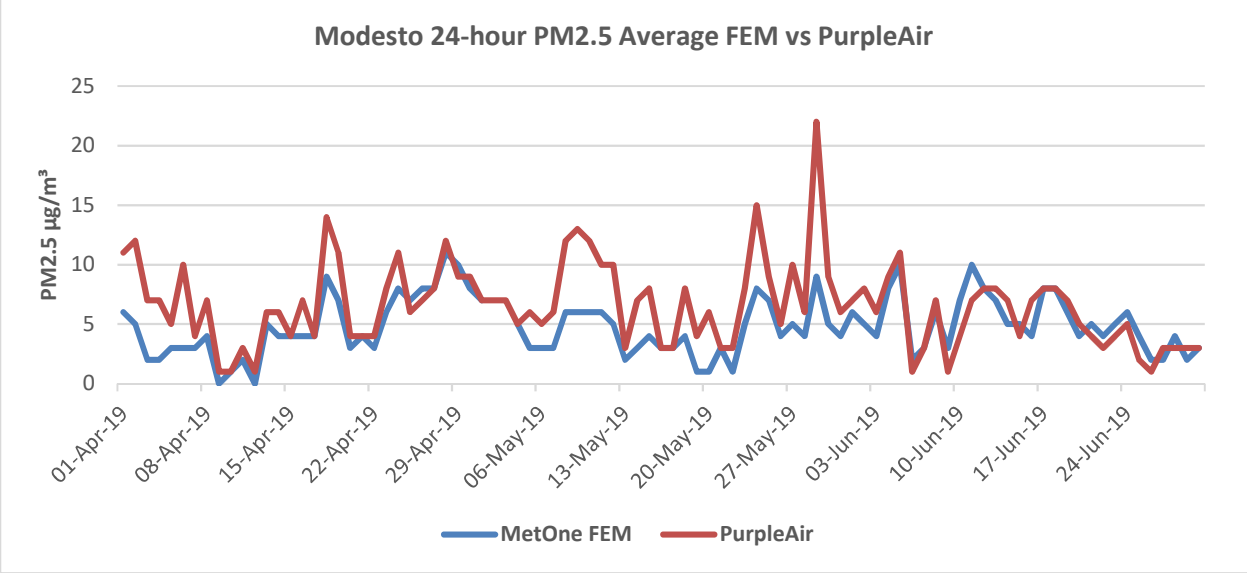




Modesto-14th St.

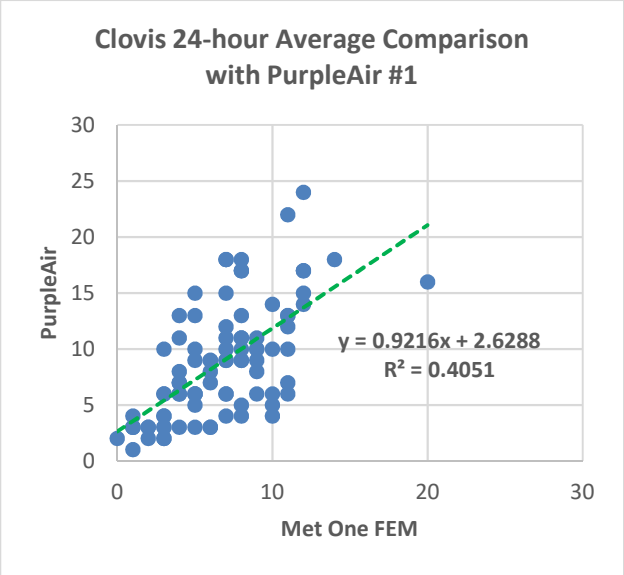
For the 24-hour average, PurpleAir data had a 1.8 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 1.7 µg/m^3 over the same period.

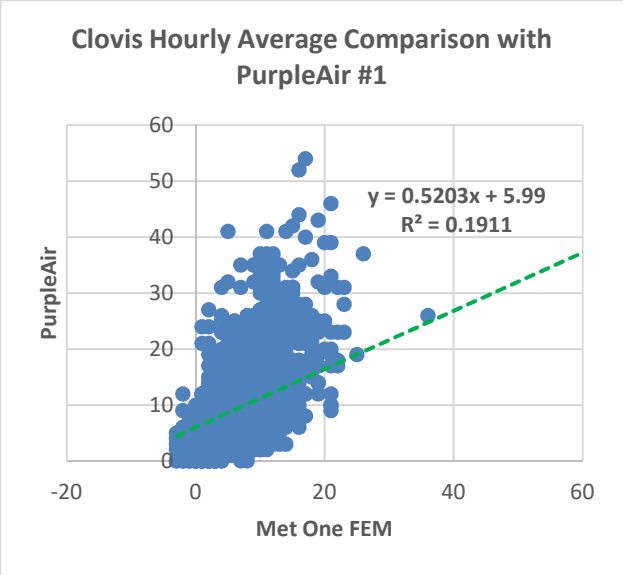


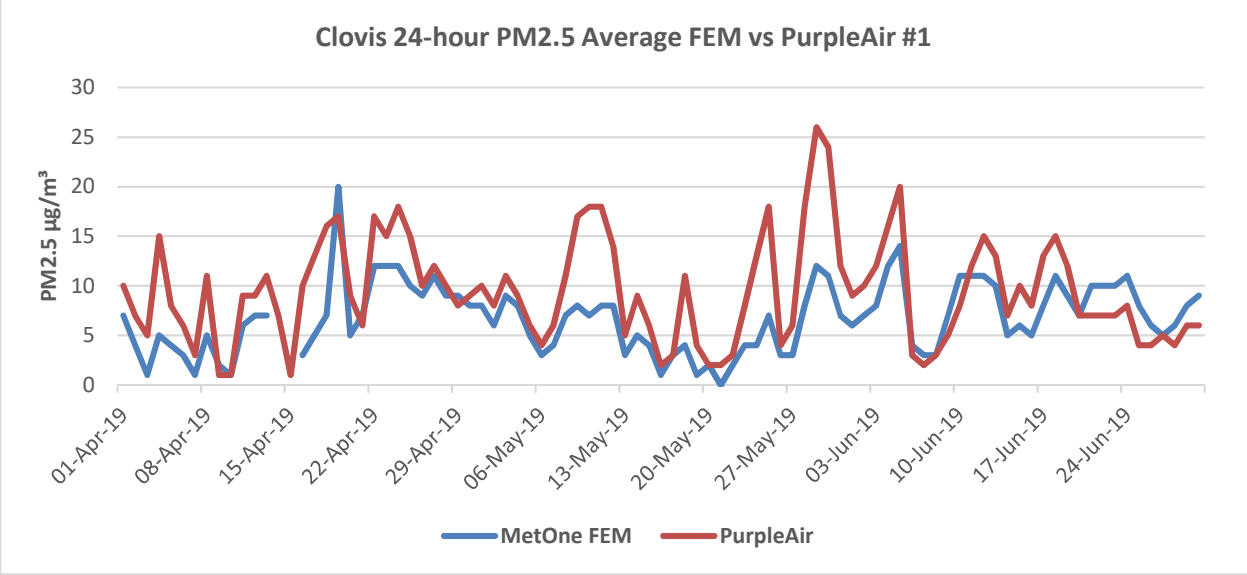


Clovis-Villa #1

For the 24-hour average, PurpleAir data had a 2.1 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 2.8 µg/m^3 over the same period.

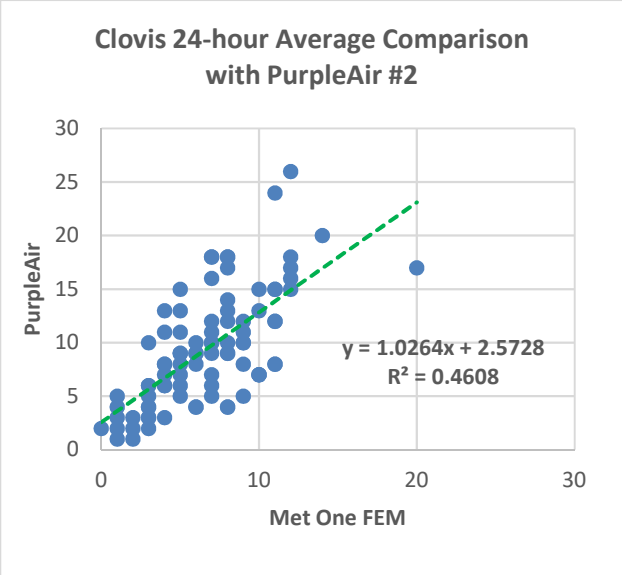


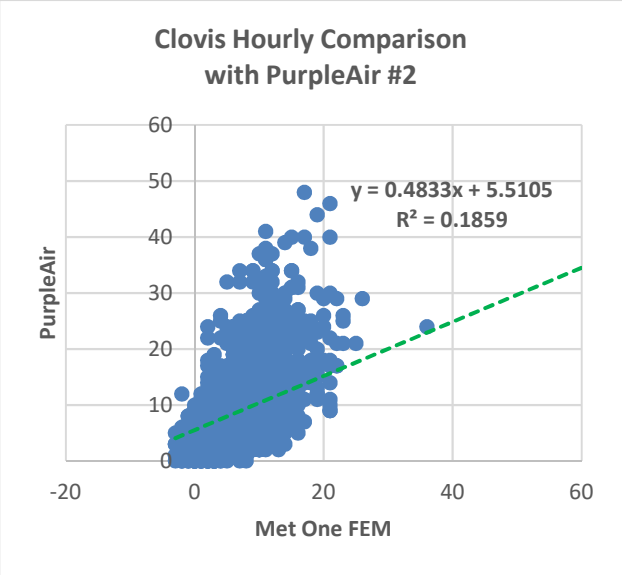


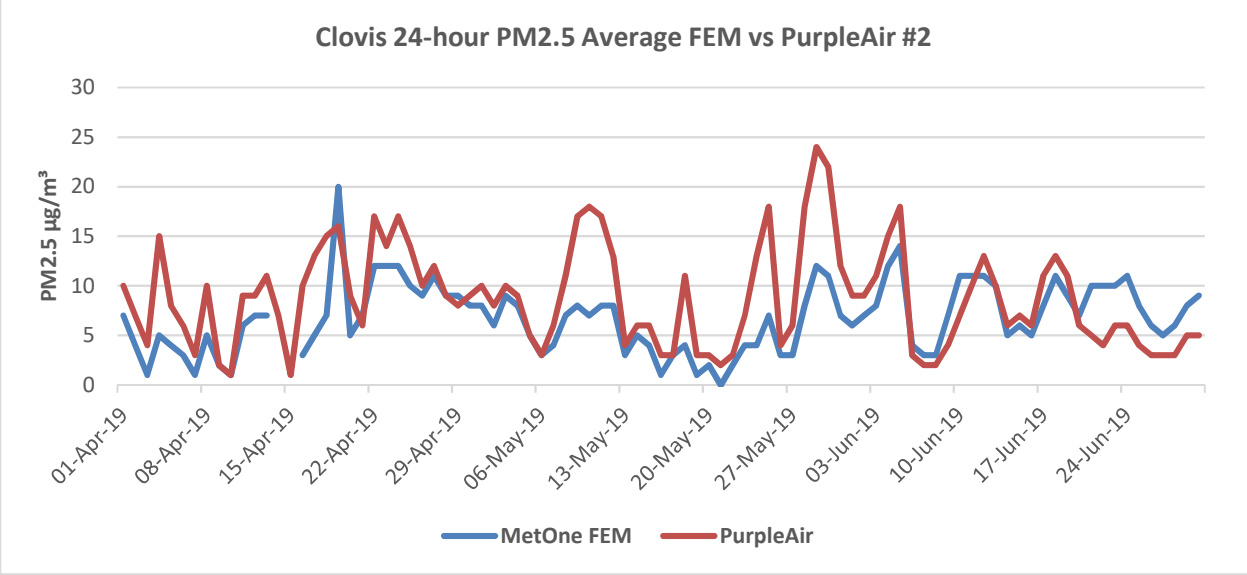


Clovis-Villa #2

For the 24-hour average, PurpleAir data had a 2.8 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 2.1 µg/m^3 over the same period.

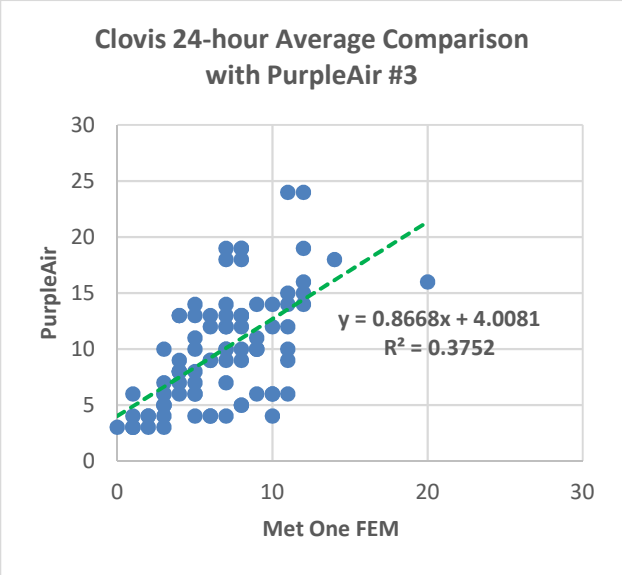


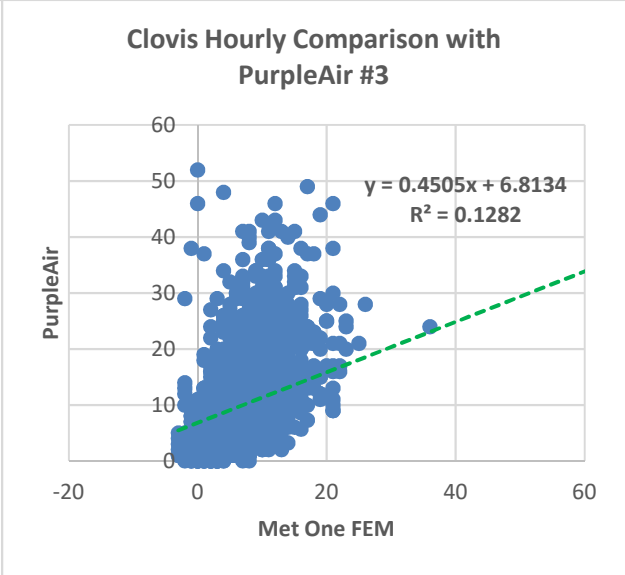


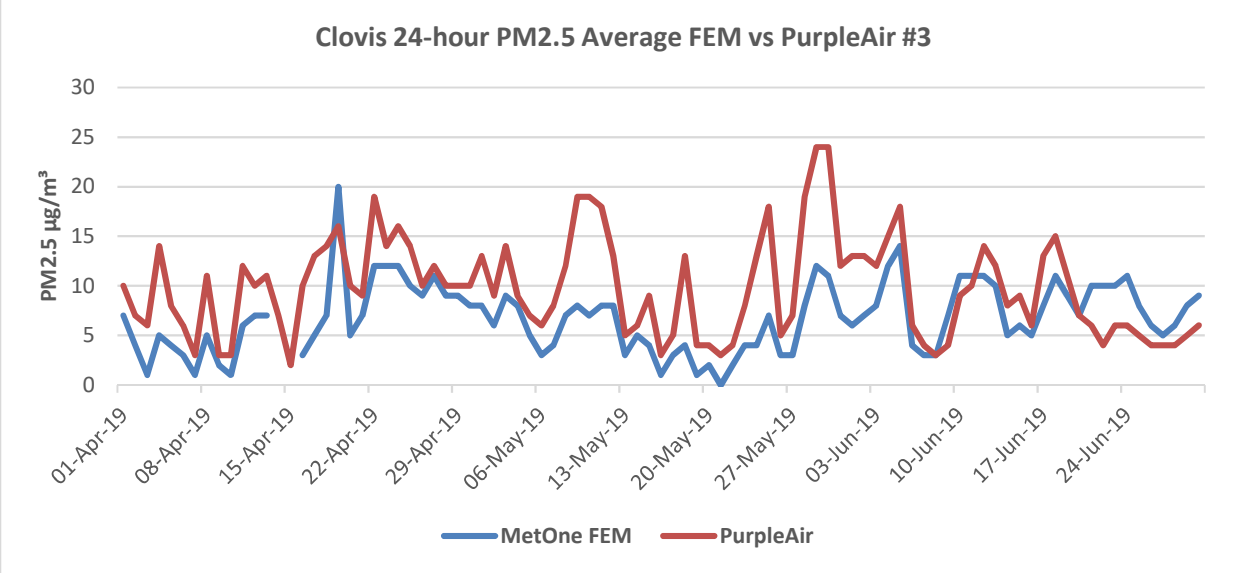


Clovis-Villa #3

For the 24-hour average, PurpleAir data had a 3.1 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 3.2 µg/m^3 over the same period.

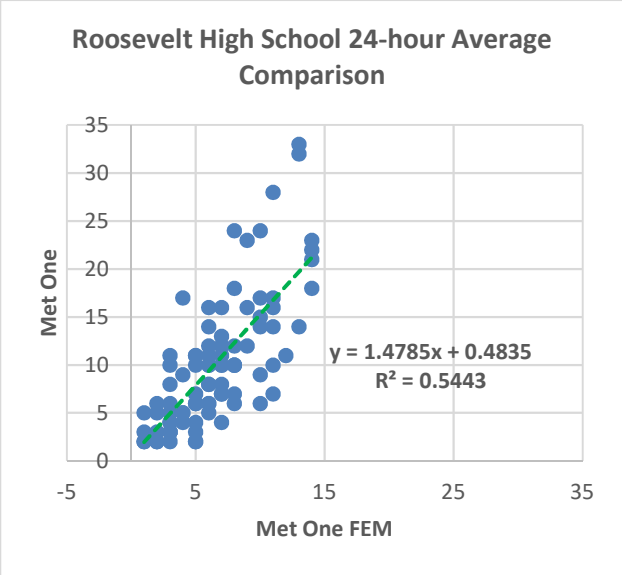


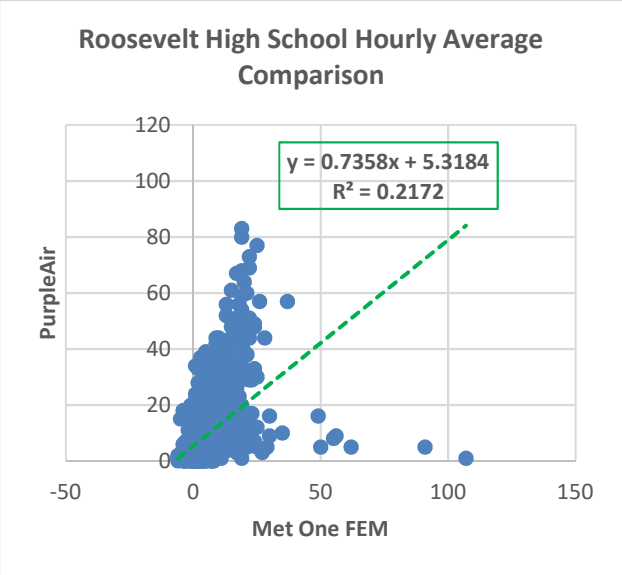


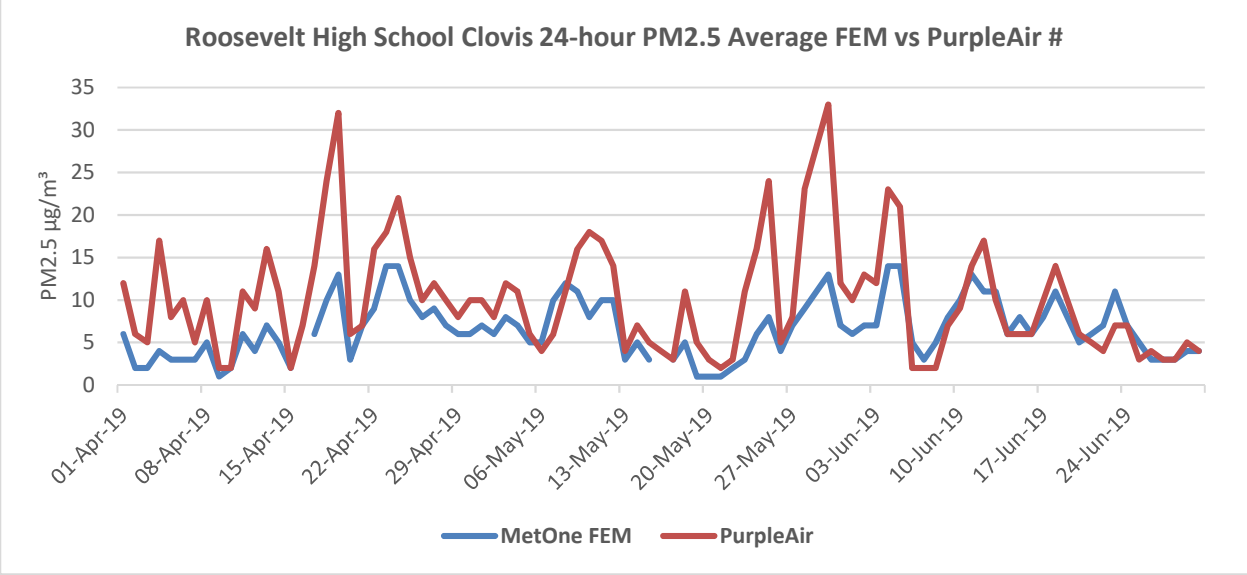


South Central Fresno – Roosevelt High School

For the 24-hour average, PurpleAir data had a 3.7 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 3.6 µg/m^3 over the same period.

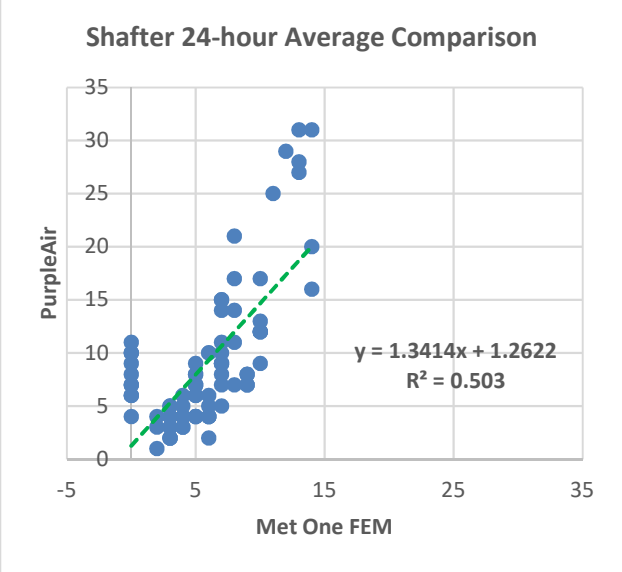


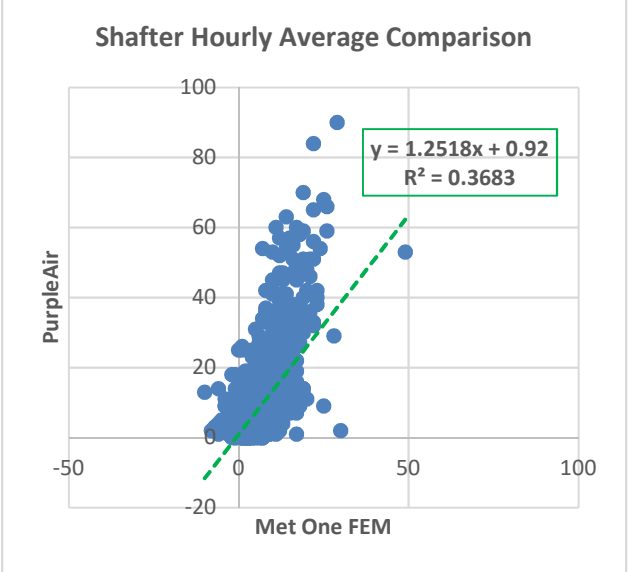


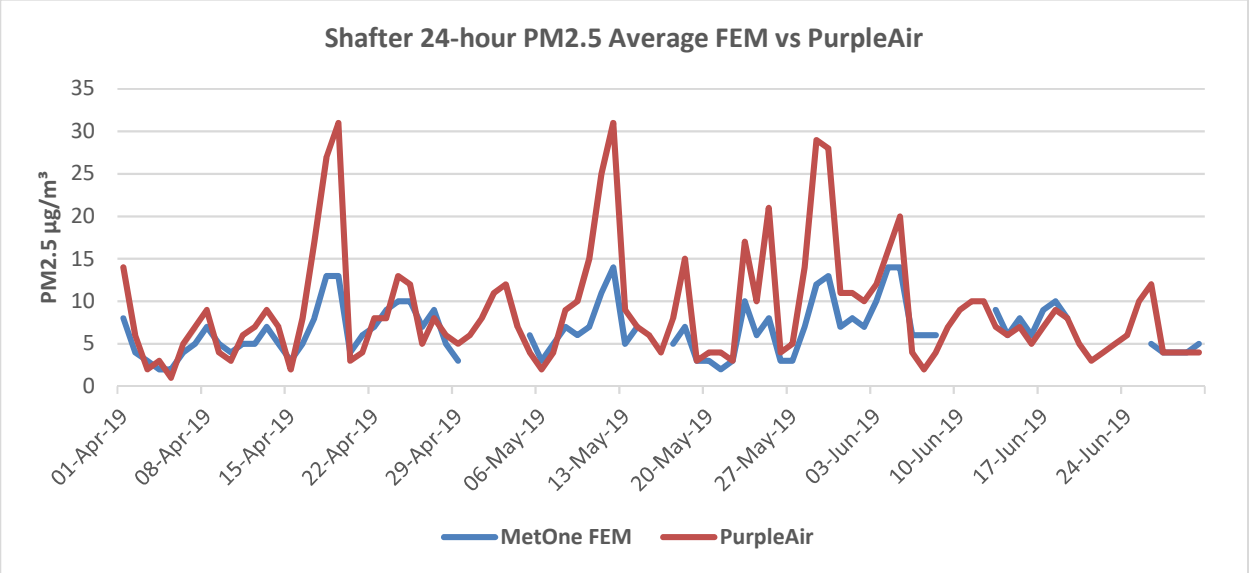


Shafter

For the 24-hour average, PurpleAir data had a 3.3 µg/m^3 high bias during the April 1st, 2019 through June 30th, 2019 period. For the hourly average, PurpleAir data had a high bias of 2.6 µg/m^3 over the same period.







Statistical Summary

The following tables provides a statistical summary of the 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	7.4	9.7	8.1	4.8
Sensor Avg 24-hr	9.5	12.4	7.6	6.6
FEM Max 1-hr	30	40	8.0	70
Sensor Max 1-hr	63	91	7.7	112
FEM Max 24-hr	16	18	15	11
Sensor Max 24-hr	28	37	28	22
1-hr R^2	0.52	0.55	0.47	0.30
1-hr Slope	1.26	1.55	1.03	0.86
1-hr Intercept	0.02	-2.45	2.59	2.47
24-hr R^2	0.70	0.71	0.62	0.47
24-hr Slope	1.46	1.76	1.37	1.03
24-hr Intercept	-1.29	-4.55	3.43	1.64

Table B – Clovis-Villa Site

Statistic	Clovis-Villa PurpleAir #1	Clovis-Villa PurpleAir #2	Clovis-Villa PurpleAir #3
FEM Avg 24-hr	6.7	6.7	6.7
Sensor Avg 24-hr	8.8	9.5	9.8
FEM Max 1-hr	212	212	212
Sensor Max 1-hr	54	48	78
FEM Max 24-hr	20	20	20
Sensor Max 24-hr	24	26	24
1-hr R^2	0.19	0.19	0.13
1-hr Slope	0.52	0.48	0.45
1-hr Intercept	5.99	5.51	6.81
24-hr R^2	0.41	0.46	0.38
24-hr Slope	0.92	1.03	0.87
24-hr Intercept	2.63	2.57	4.01

Table C – South Central Fresno and Shafter Sites

Statistic	South Central Fresno – Roosevelt HS	Shafter
FEM Avg 24-hr	6.6	5.9
Sensor Avg 24-hr	10.3	9.1
FEM Max 1-hr	107	49
Sensor Max 1-hr	83	90
FEM Max 24-hr	14	14
Sensor Max 24-hr	33	31
1-hr R^2	0.54	0.50
1-hr Slope	1.48	1.34
1-hr Intercept	0.48	1.26
24-hr R^2	0.22	0.37
24-hr Slope	0.74	1.25
24-hr Intercept	5.32	0.92