



**San Joaquin Valley**  
AIR POLLUTION CONTROL DISTRICT

## Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor  
2022 – 4<sup>th</sup> 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-14<sup>th</sup> 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, 2022, through December 31, 2022 (2022 – 4<sup>th</sup> 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.

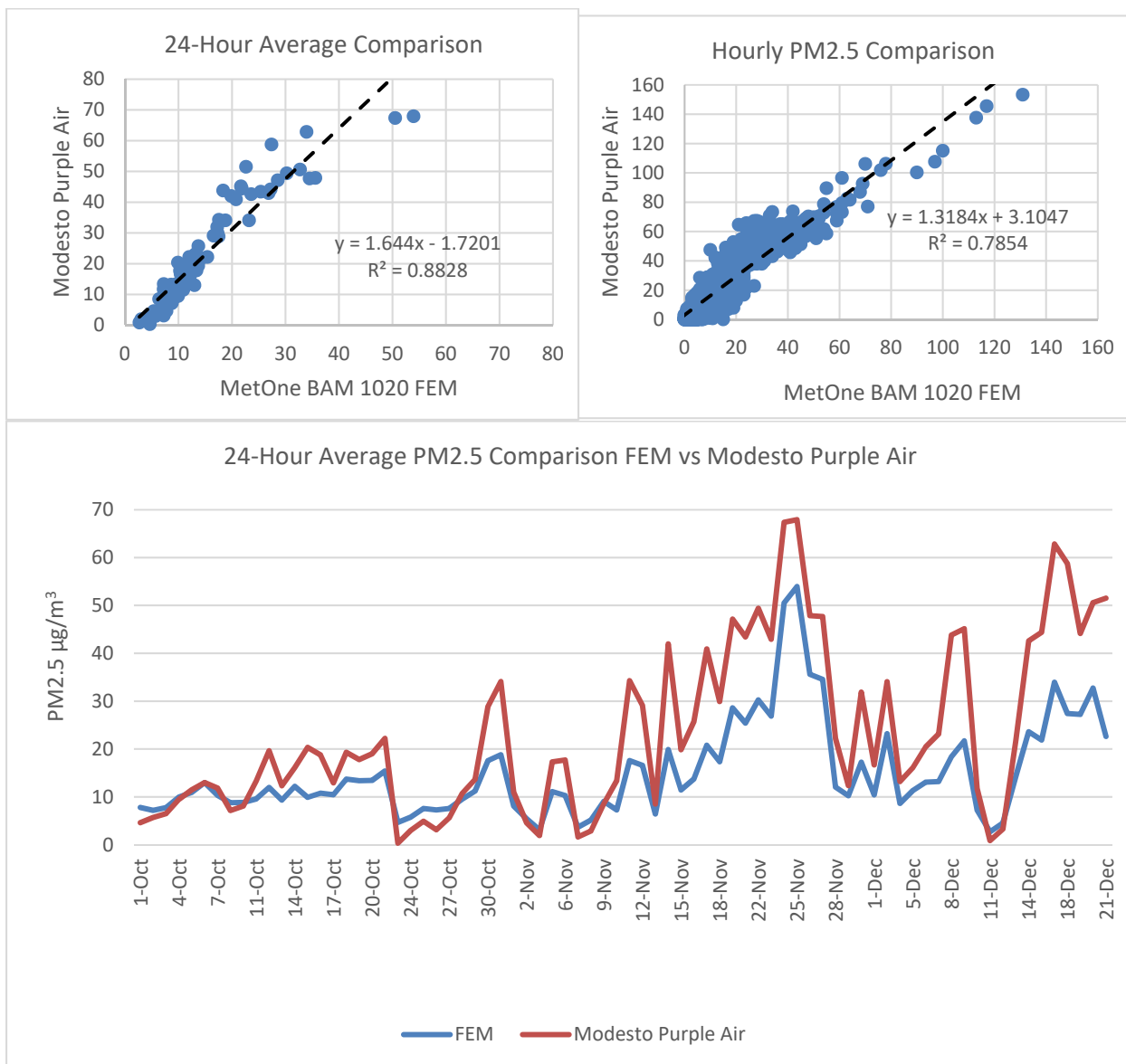
Seasonally, PM2.5 is typically highest during the winter months and lowest during the summer months. Weather systems influence PM2.5 levels by either trapping pollutants near the surface or dispersing them. Generally, California’s experiences weather patterns that alternate between high pressure systems and low pressure systems that move through the region every two to four days. As such, this alternating pattern was present during the 2022 4<sup>th</sup> Quarter, however prolonged periods of high pressure also occurred. Indeed most of October was governed by high pressure and stability as were mid-November and mid-December and PM2.5 concentrations remained elevated during those periods. Additionally, low pressure systems that were weak or tracked away from the Valley also contributed to periods of elevated PM2.5 concentrations. The beginning and end of November and December were characterized by very good dispersive low pressure systems that helped PM2.5 concentrations decrease Valley-wide.

During the 2022 4<sup>th</sup> quarter, the PurpleAir sensors and the MetOne BAM 1020 FEM monitors responded similarly to the fluctuations in concentrations, however the Purple Air sensors tended to measure higher compared to the FEM monitors.

**Site Specific Analysis of PurpleAir PA-II Sensor Performance**

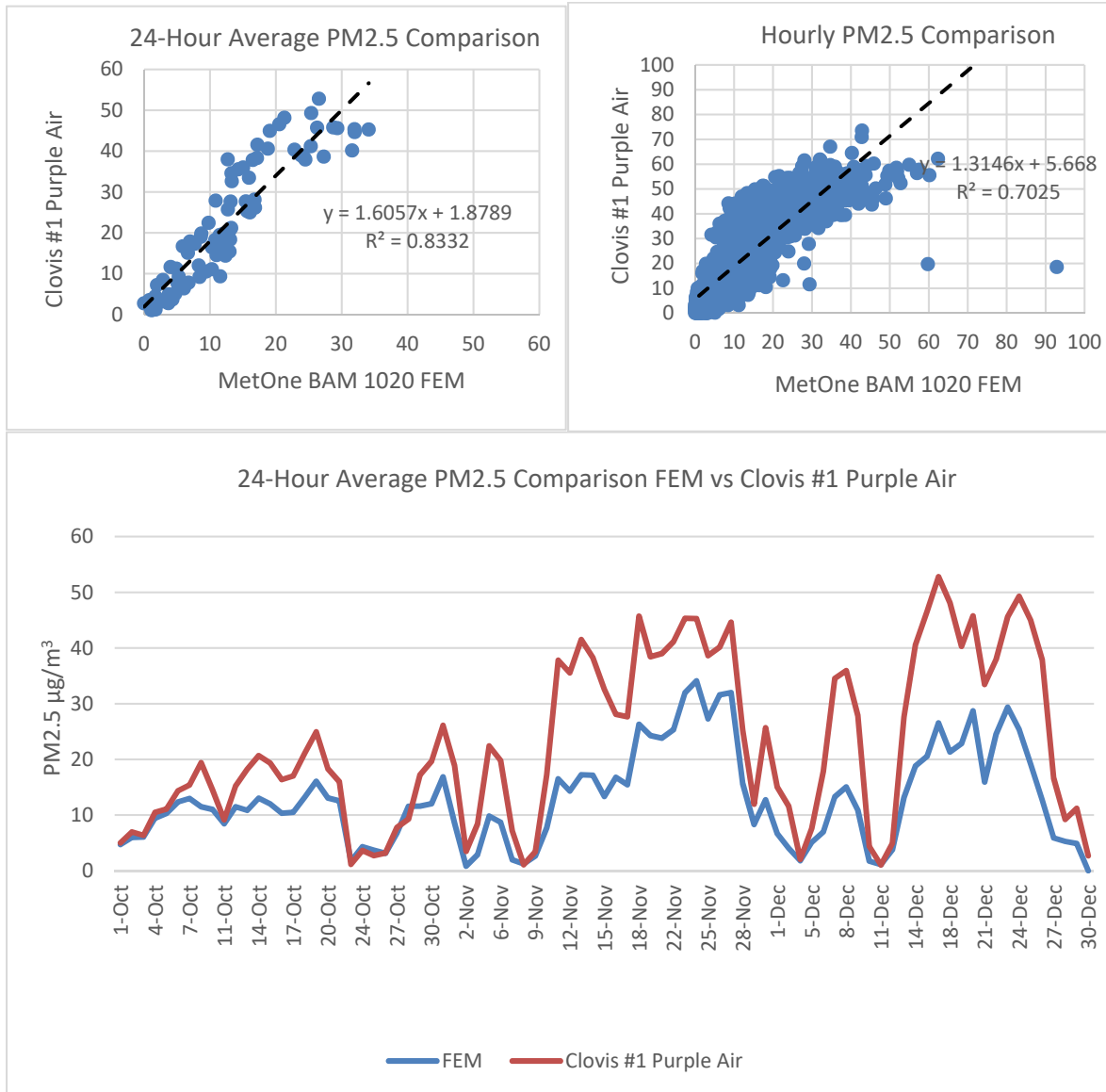
**Modesto-14<sup>th</sup> St.**

For the 24-hour average, PurpleAir data had an 8.1 µg/m<sup>3</sup> high bias during the October 1, 2022, through December 31, 2022, period. For the hourly average, PurpleAir data had a high bias of 7.9 µg/m<sup>3</sup> over the same period.



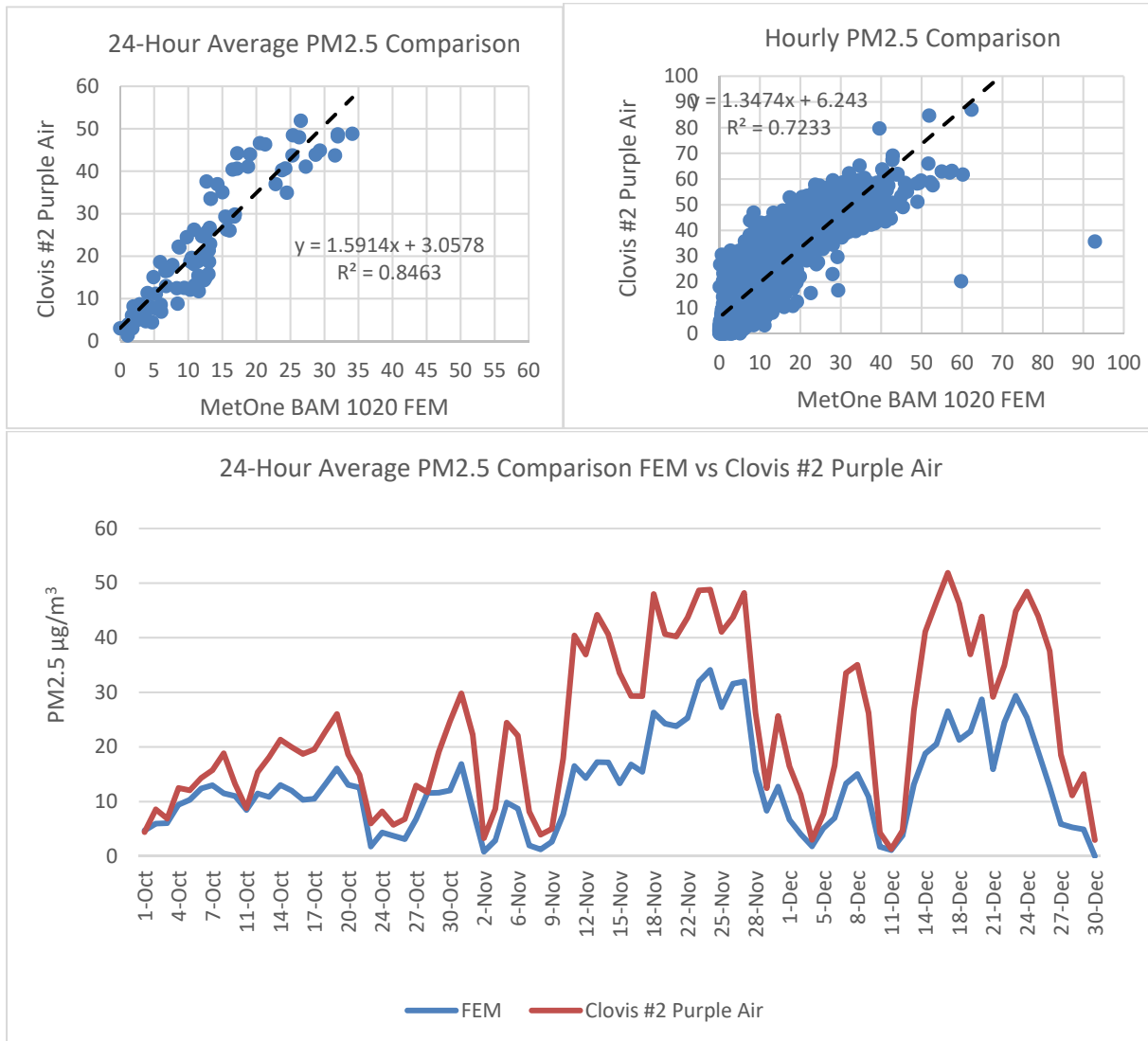
**Clovis-Villa #1**

For the 24-hour average, PurpleAir data had a 9.7  $\mu\text{g}/\text{m}^3$  high bias during the October 1, 2022, through December 31, 2022, period. For the hourly average, PurpleAir data had a high bias of 9.8  $\mu\text{g}/\text{m}^3$  over the same period.



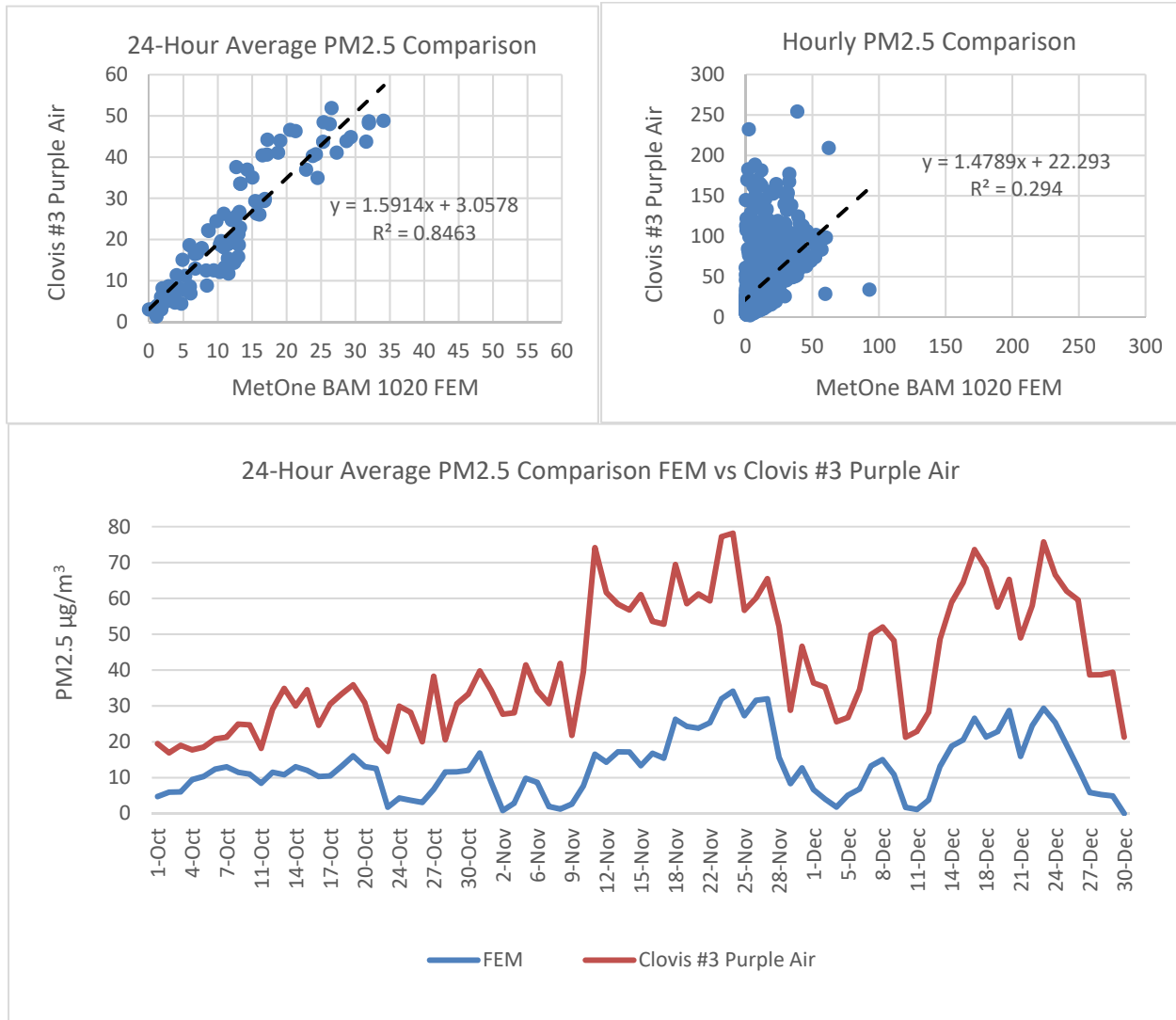
**Clovis-Villa #2**

For the 24-hour average, PurpleAir data had a 10.7  $\mu\text{g}/\text{m}^3$  high bias during October 1, 2022, through December 31, 2022, period. For the hourly average, PurpleAir data had a high bias of 10.8  $\mu\text{g}/\text{m}^3$  over the same period.



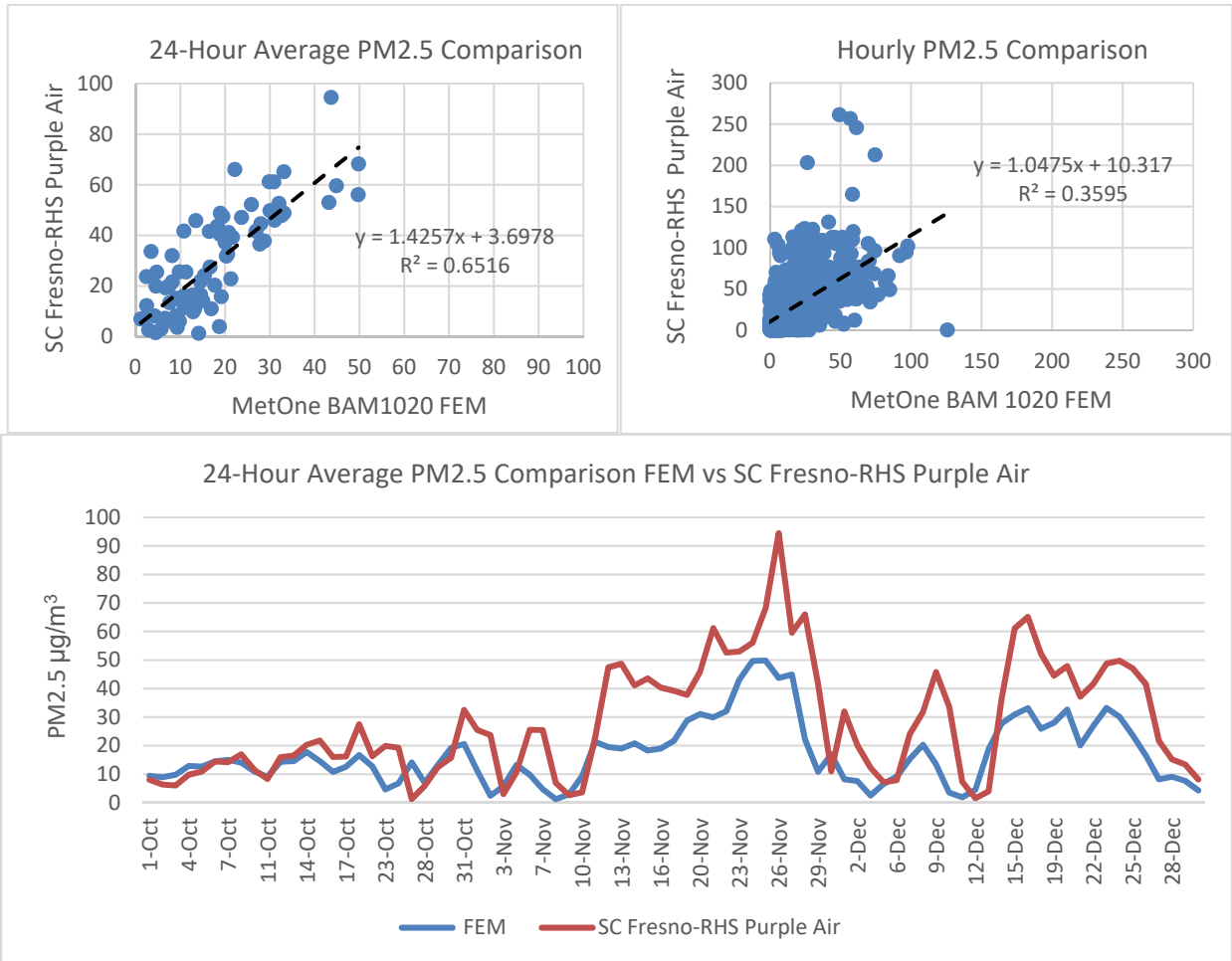
**Clovis-Villa #3**

For the 24-hour average, PurpleAir data had a 28.5  $\mu\text{g}/\text{m}^3$  high bias during the October 1, 2022, through December 31, 2022, period. For the hourly average, PurpleAir data had a high bias of 35.8  $\mu\text{g}/\text{m}^3$  over the same period.



**South Central Fresno – Roosevelt High School**

For the 24-hour average, PurpleAir data had an 11.0 µg/m<sup>3</sup> high bias during the October 1, 2022, through December 31, 2022, period. For the hourly average, PurpleAir data had a high bias of 11.1 µg/m<sup>3</sup> over the same period.



**Non-Reporting Sites**

**Bakersfield-California**

Data from this sensor was not available for the October 1, 2022, through December 31, 2022 period. This sensor will be included in future analysis reports if the data becomes available.

**Visalia-Church**

Data from this sensor was not available for the October 1, 2022, through December 31, 2022 period. This sensor will be included in future analysis reports if the data becomes available.

**Shafter #2**

Data from this sensor was not available for the October 1, 2022, through December 31, 2022 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, 2022, through December 31, 2022 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-14<sup>th</sup> Sites**

Statistic	Fresno-Garland	Visalia-Church	Bakersfield-CA	Modesto-14 <sup>th</sup>
FEM Avg. 24-hr	PurpleAir sensor at this site did not report during this period	PurpleAir sensor at this site did not report during this period	PurpleAir sensor at this site did not report during this period	15.2
Sensor Avg. 24-hr				23.3
FEM Max 1-hr				274
Sensor Max 1-hr				173.8
FEM Max 24-hr				54
Sensor Max 24-hr				67.9
1-hr R <sup>2</sup>				0.7854
1-hr Slope				1.3184
1-hr Intercept				+3.1047
24-hr R <sup>2</sup>				0.8828
24-hr Slope				1.644
24-hr Intercept				-1.7201



**Table B – Clovis-Villa Site**

Statistic	Clovis-Villa PurpleAir #1	Clovis-Villa PurpleAir #2	Clovis-Villa PurpleAir #3
FEM Avg. 24-hr	13.0	13.0	13.0
Sensor Avg. 24-hr	22.7	23.7	41.4
FEM Max 1-hr	92.9	92.9	92.9
Sensor Max 1-hr	73.5	86.9	297.2
FEM Max 24-hr	34.1	34.1	34.1
Sensor Max 24-hr	52.8	51.9	78.2
1-hr R <sup>2</sup>	0.7025	0.7233	0.294
1-hr Slope	1.3146	1.3474	1.4789
1-hr Intercept	+5.668	+6.243	+22.293
24-hr R <sup>2</sup>	0.8332	0.8463	0.6687
24-hr Slope	1.6057	1.5914	1.6878
24-hr Intercept	+1.8789	+3.0578	+19.567

**Table C – South Central Fresno and Shafter Sites**

Statistic	South Central Fresno	Shafter
FEM Avg. 24-hr	17.2	PurpleAir sensor at this site did not report during this period
Sensor Avg. 24-hr	28.2	
FEM Max 1-hr	125.8	
Sensor Max 1-hr	261.3	
FEM Max 24-hr	49.8	
Sensor Max 24-hr	94.5	
1-hr R <sup>2</sup>	0.3595	
1-hr Slope	1.0475	
1-hr Intercept	+10.317	
24-hr R <sup>2</sup>	0.6516	
24-hr Slope	1.4257	
24-hr Intercept	+3.6978	