San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

PurpleAir PA-II Sensor
2021 – 3rd 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

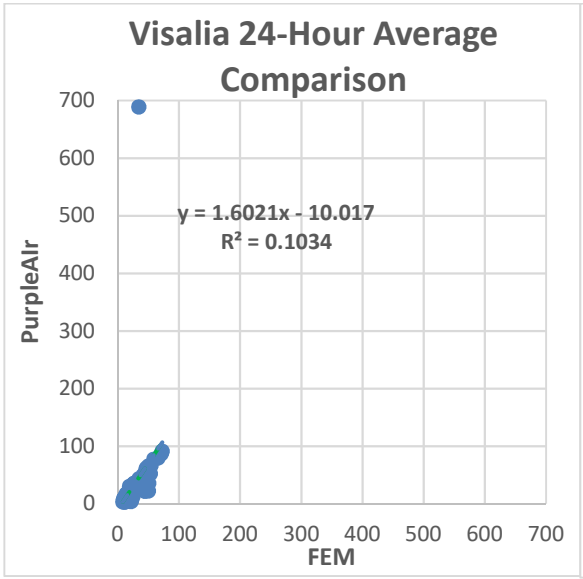
The analysis for this report covers the time period of July 1, 2021, through September 30, 2021 (2021 – 3rd quarter). During this period, hourly data was removed from the calculation of bias when either the PurpleAir sensor or regulatory monitor did not have a valid hourly sample. For the 24-hour averages, only days with 18 or more valid hourly samples (75% or greater completeness) are included.

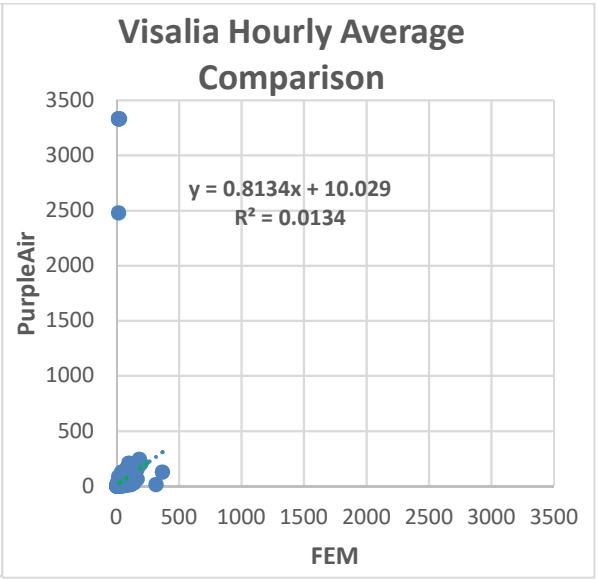
The 3rd quarter of 2021 was essentially dominated by high pressure systems that produced numerous days of triple digit temperatures, and poor dispersion across the Valley. Monsoonal moisture also streamed into California, producing thunderstorms that caused wildfires in the northern California and Sierra Nevada mountains. Wind flow patterns and strong temperature inversions associated with the high pressure systems exacerbated smoke impacts in the Valley. There were brief periods of cooling and improved dispersion conditions that infiltrated the Valley when low pressure systems moved through the Pacific Northwest during August and September. Overall, the 3rd quarter was characterized by poor dispersion and smoke impacts that led to elevated PM2.5 concentrations through the period.

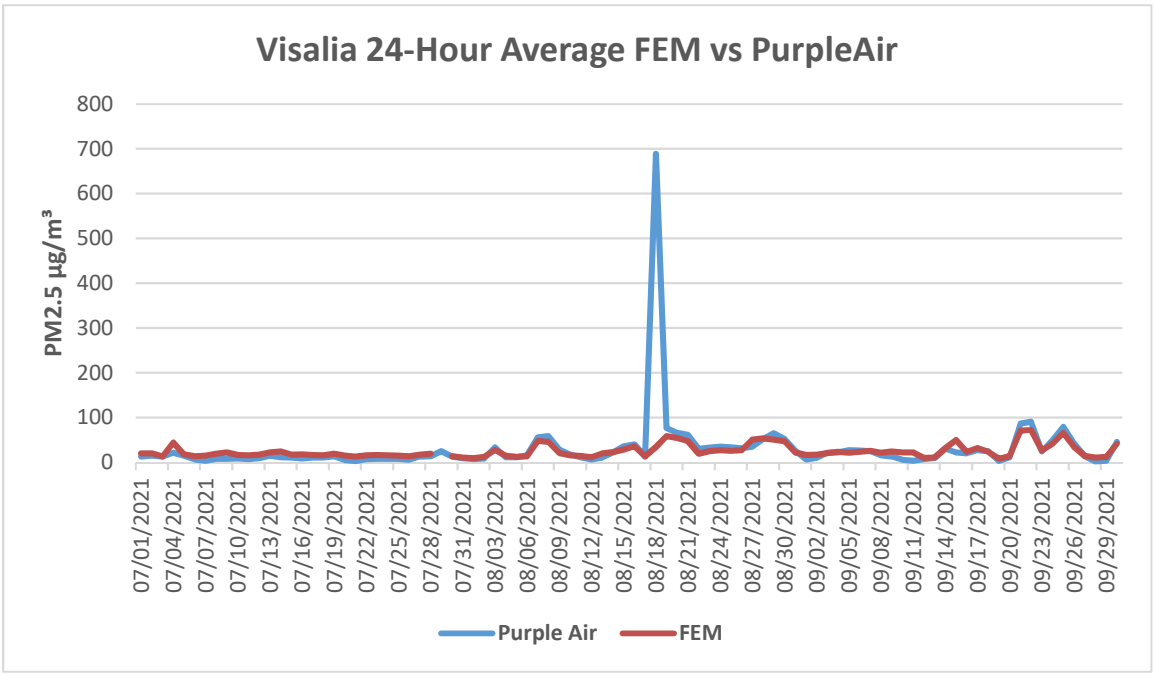
Site Specific Analysis of PurpleAir PA-II Sensor Performance

Visalia-Church

For the 24-hour average, PurpleAir data had a 5.1 µg/m^3 high bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 5.3 µg/m^3 over the same period.

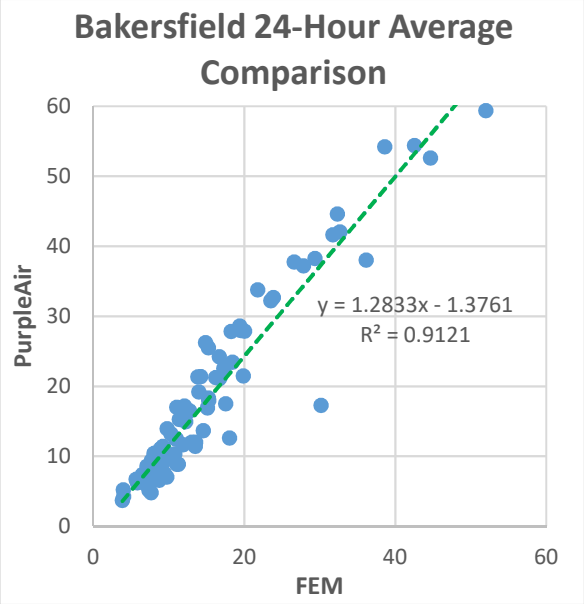


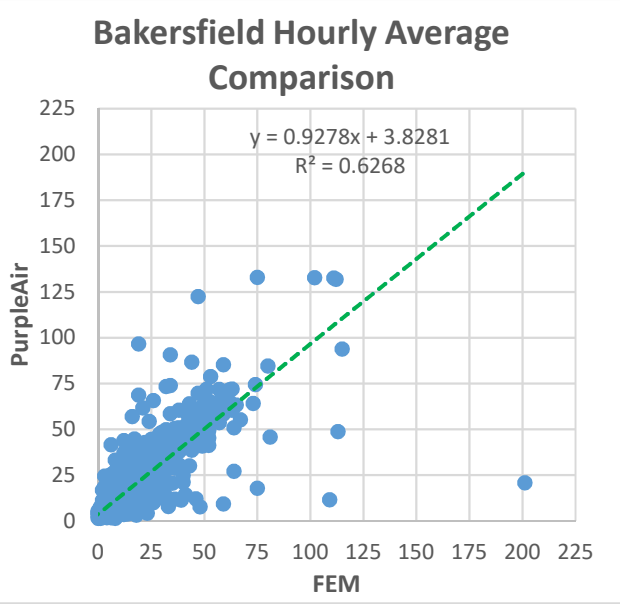


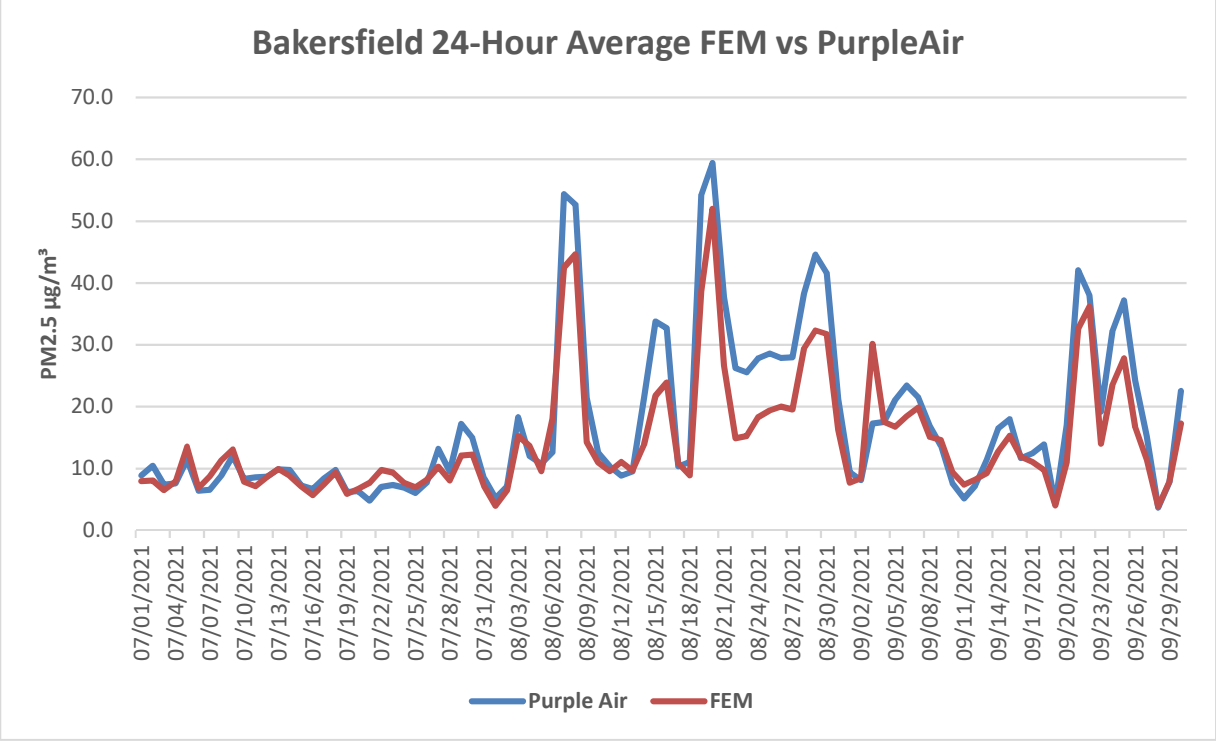


Bakersfield-California

For the 24-hour average, PurpleAir data had a 2.8 µg/m^3 high bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 2.8 µg/m^3 over the same period.

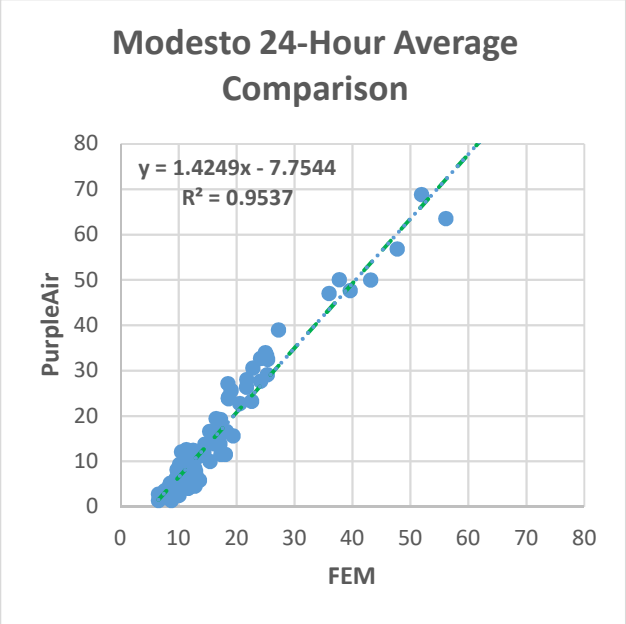


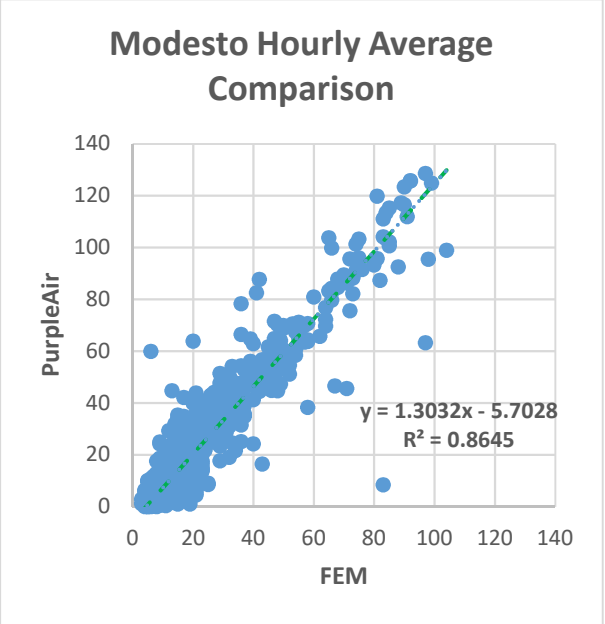


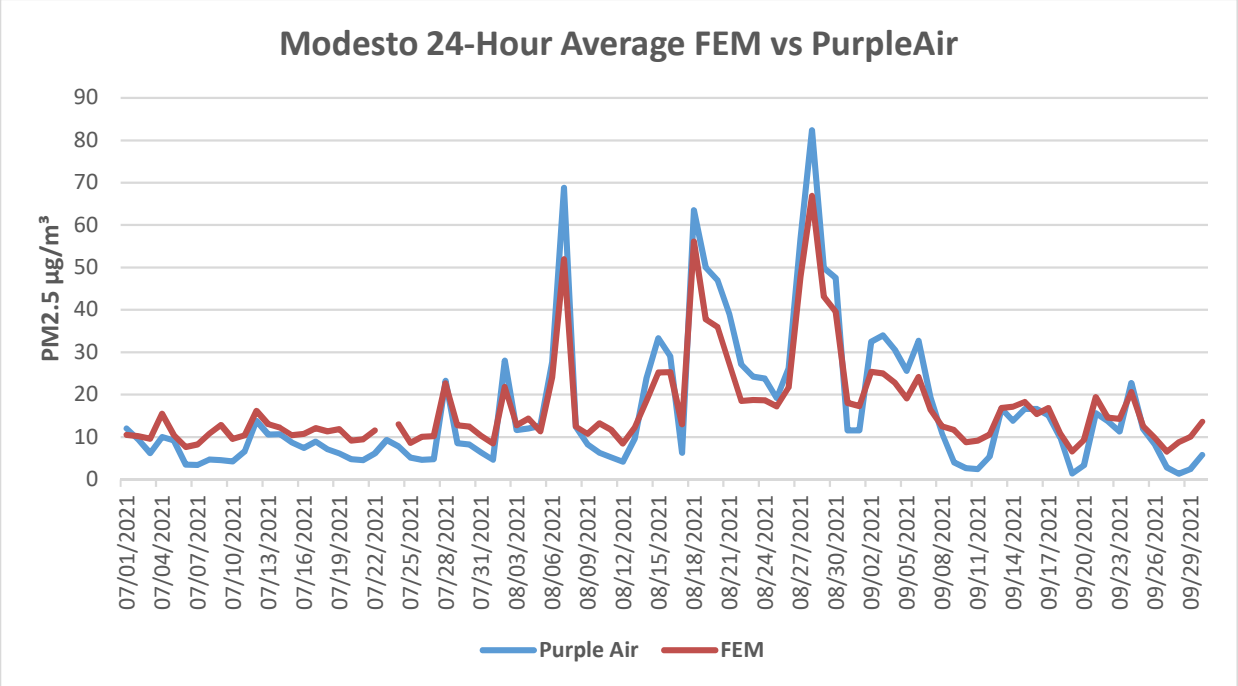


Modesto-14th St.

For the 24-hour average, PurpleAir data had a 0.6 µg/m^3 low bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 0.5 µg/m^3 over the same period.

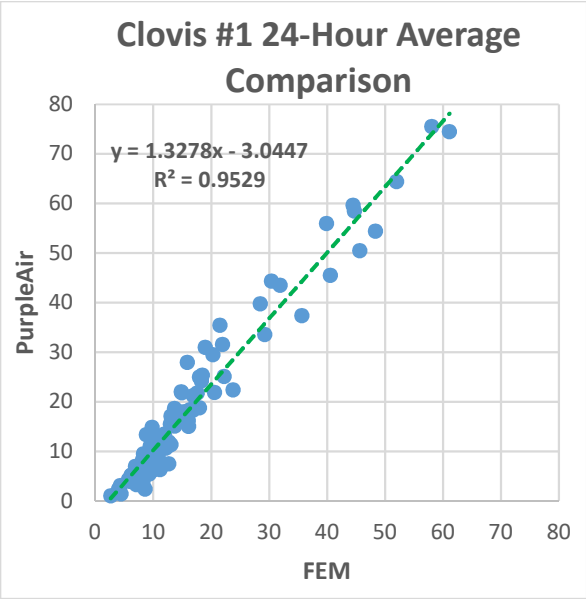


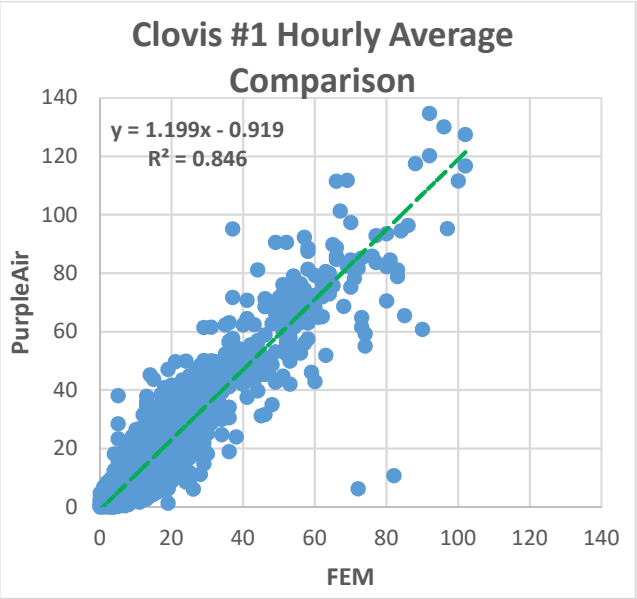


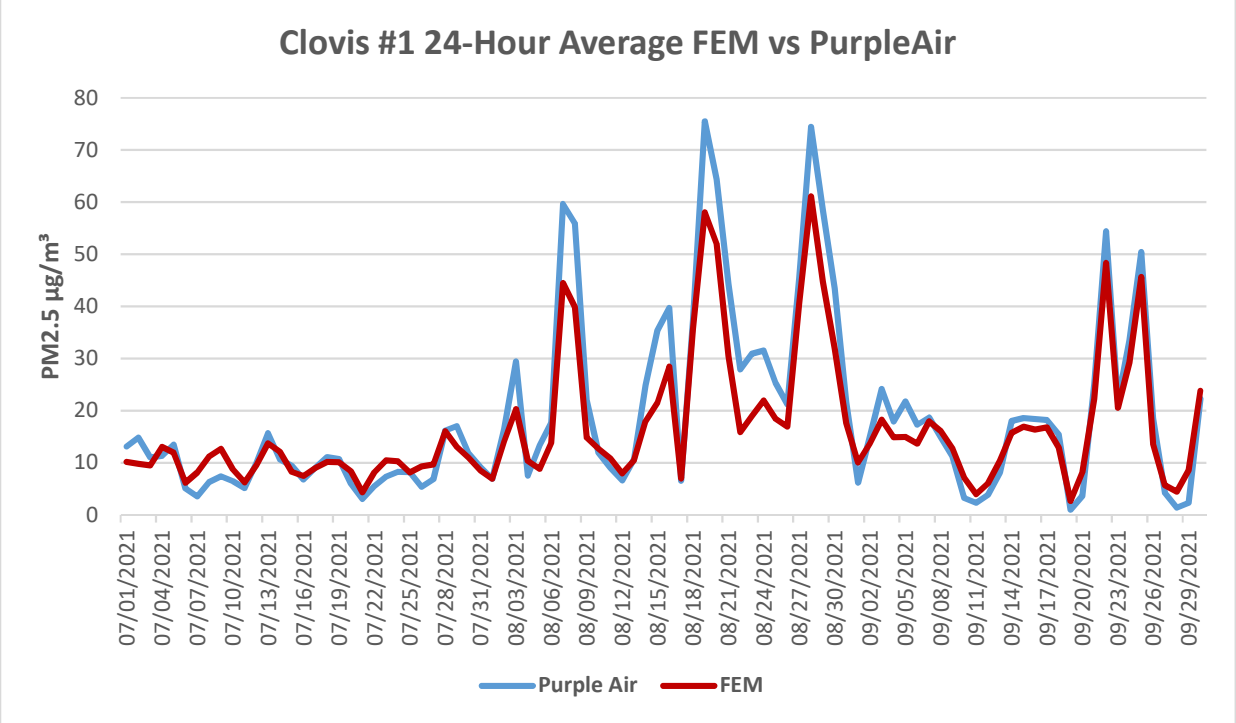


Clovis-Villa #1

For the 24-hour average, PurpleAir data had a 2.4 µg/m^3 high bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 2.6 µg/m^3 over the same period.

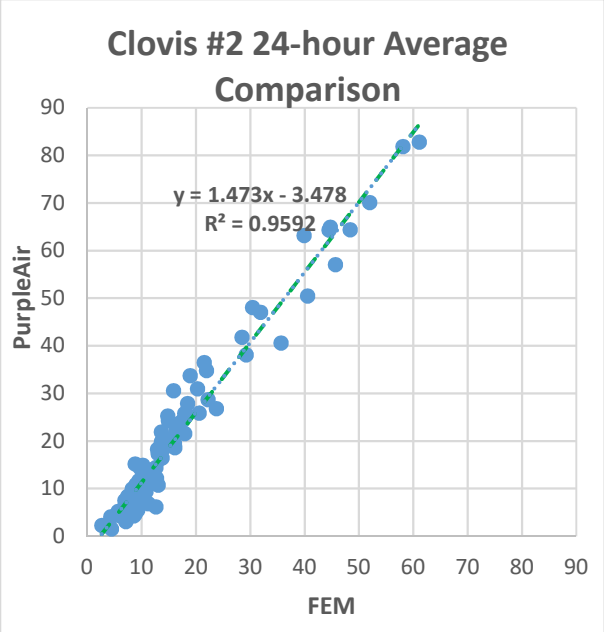


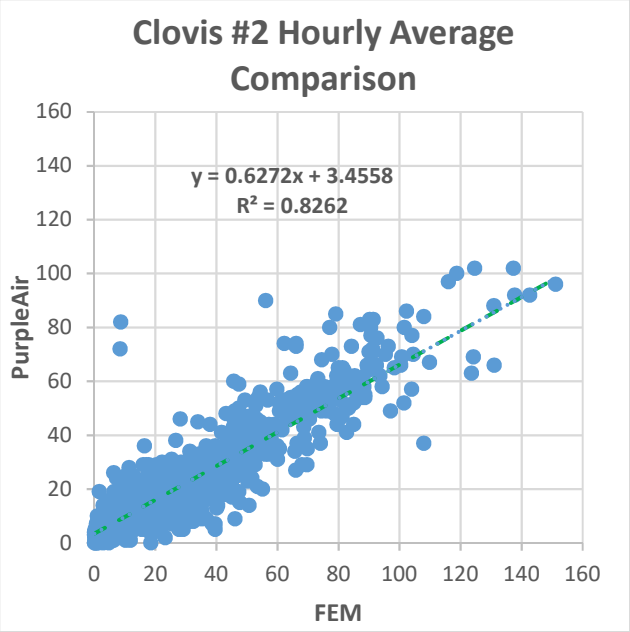


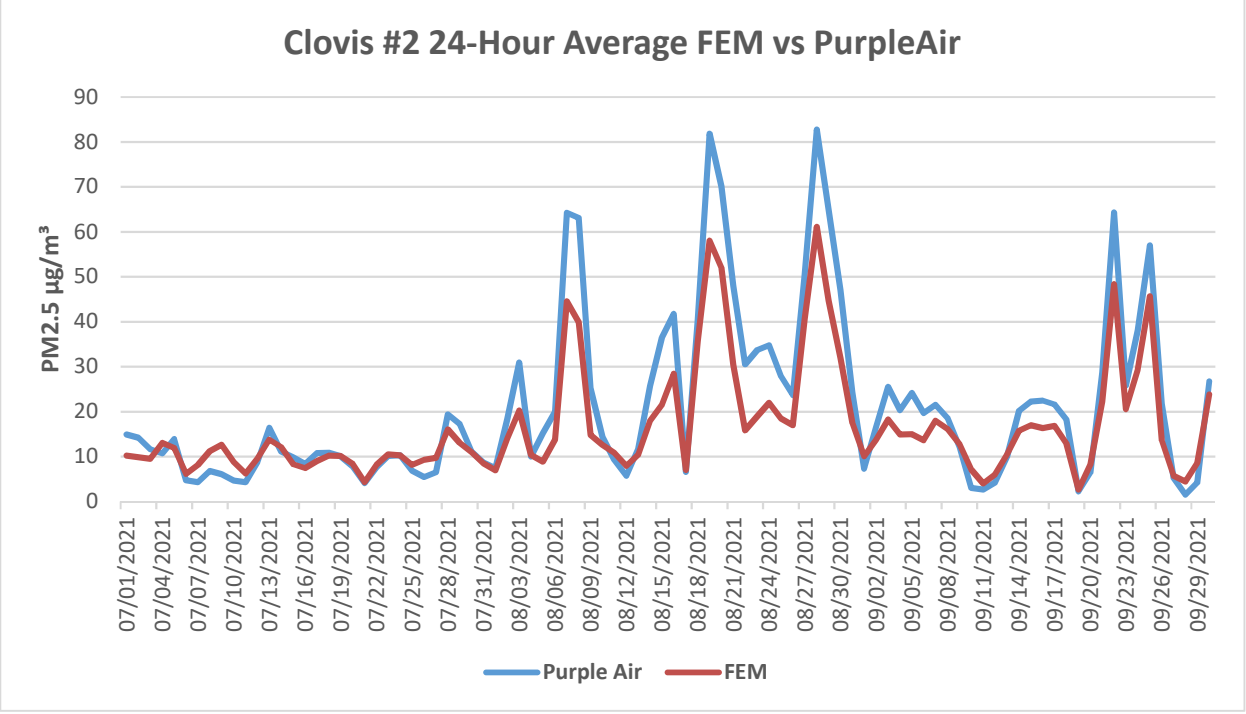


Clovis-Villa #2

For the 24-hour average, PurpleAir data had a 4.4 µg/m^3 high bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 4.5 µg/m^3 over the same period.

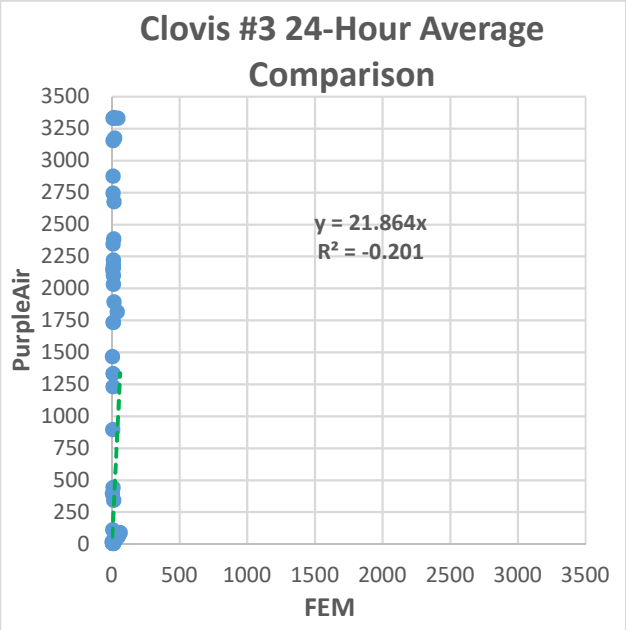


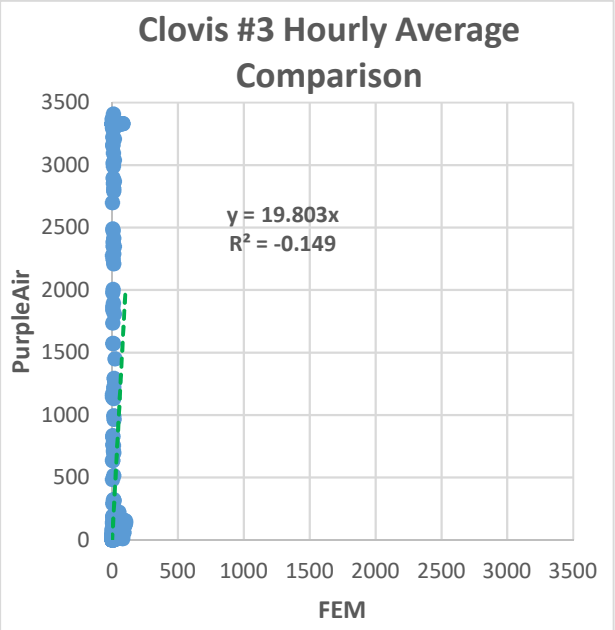


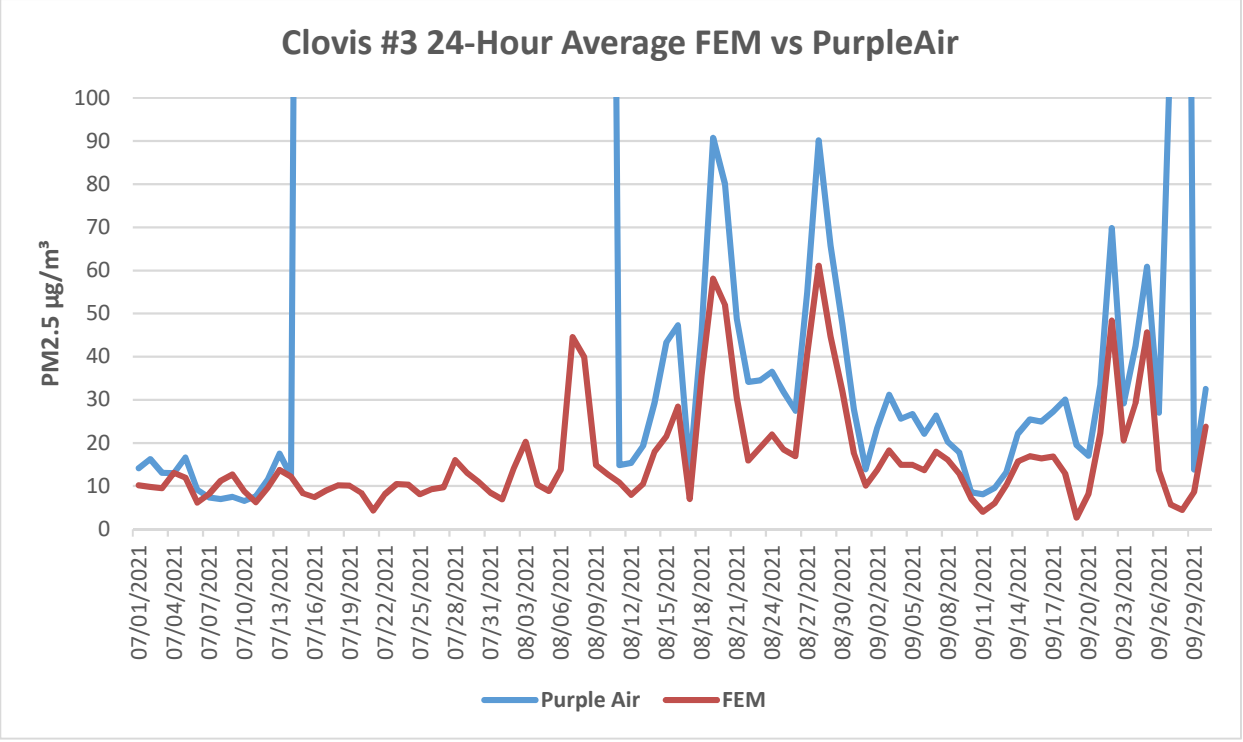


Clovis-Villa #3

For the 24-hour average, PurpleAir data had a 643.9 µg/m^3 high bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 658.1 µg/m^3 over the same period.

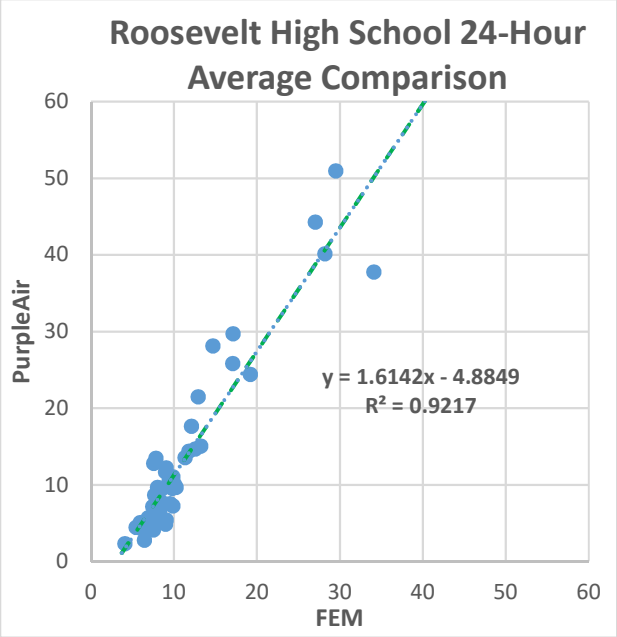


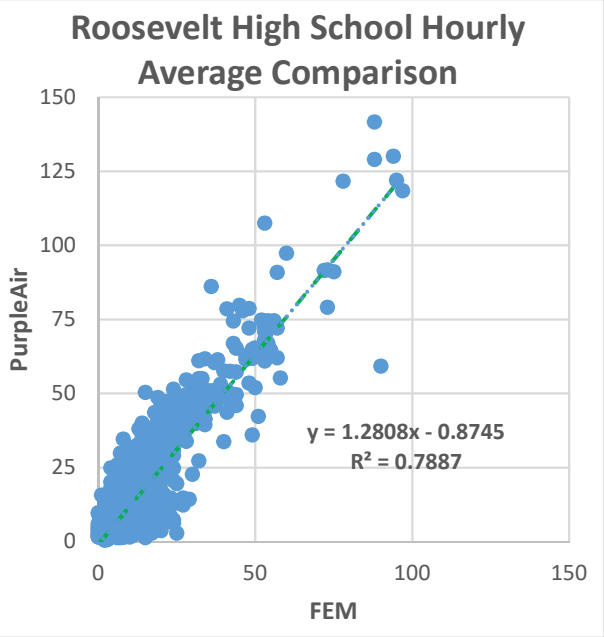


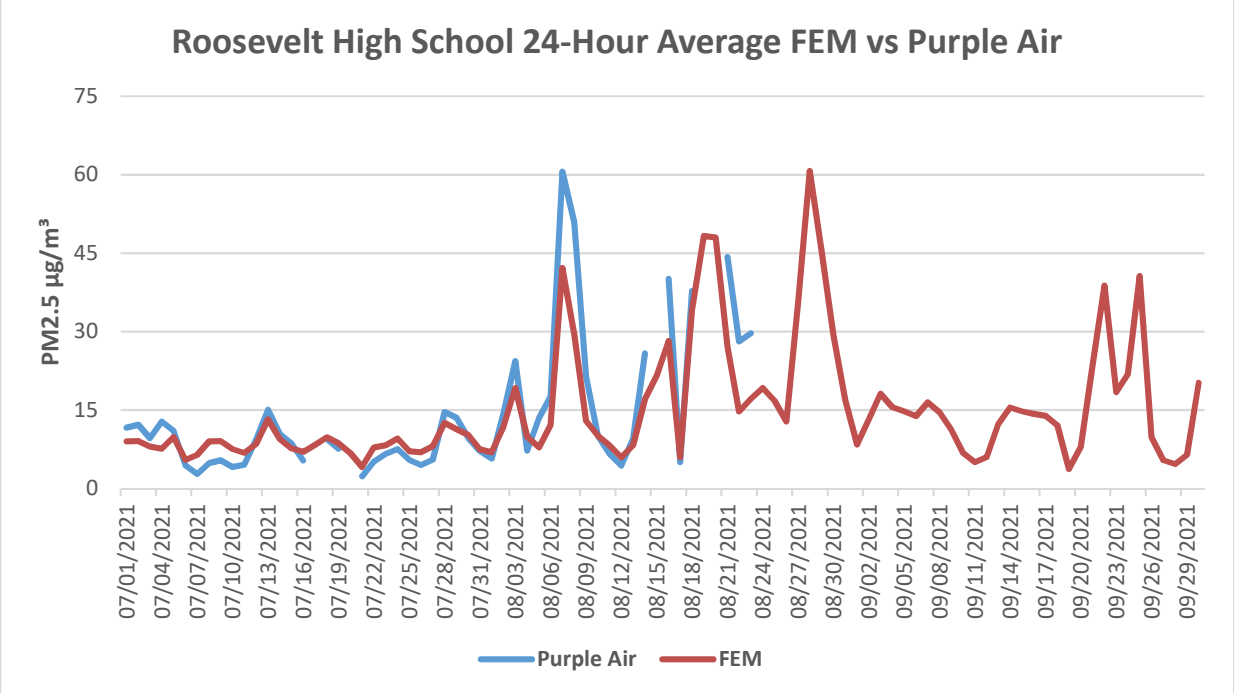


South Central Fresno – Roosevelt High School

For the 24-hour average, PurpleAir data had a 0.9 µg/m^3 low bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 0.4 µg/m^3 over the same period.

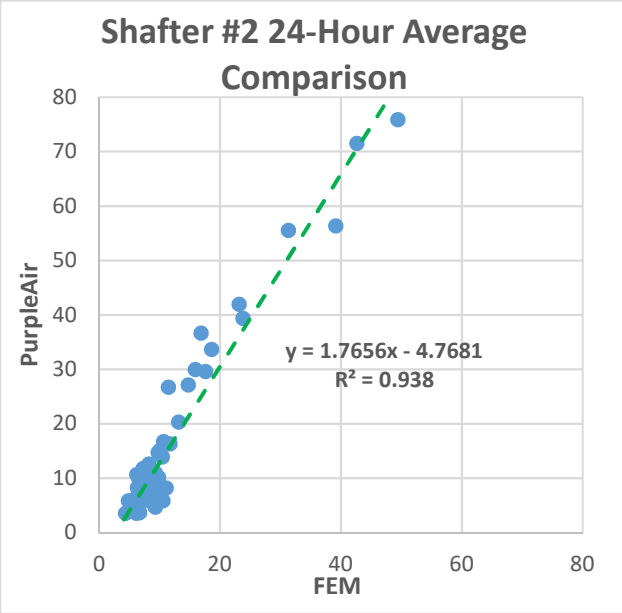


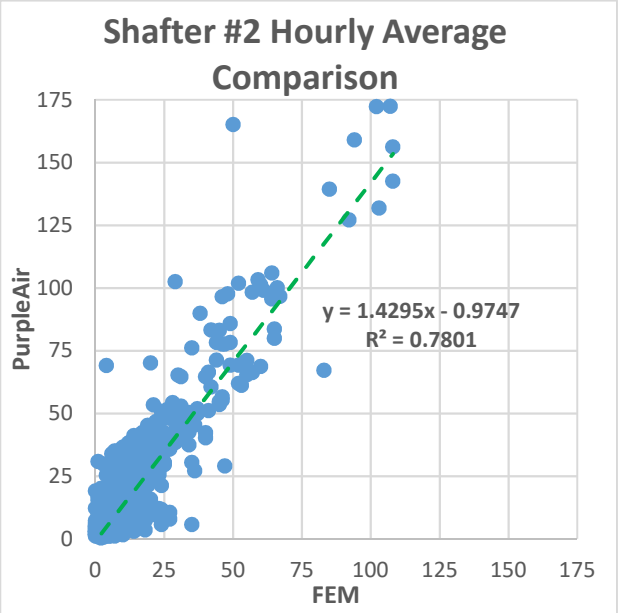


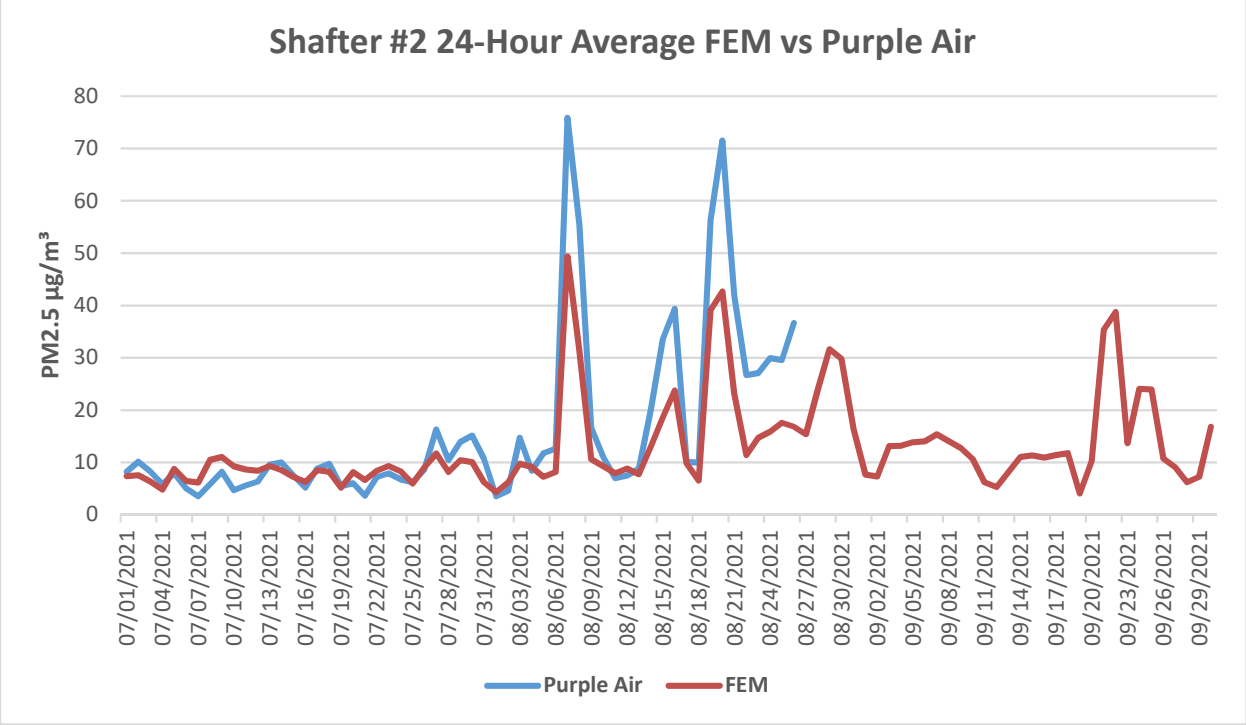


Shafter #2

For the 24-hour average, PurpleAir data had a 3.2 µg/m^3 high bias during the July 1, 2021, through September 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 3.0 µg/m^3 over the same period.







Non-Reporting Sites

Fresno-Garland
Data from this sensor was not available for the July 1, 2021, through September 30, 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-14th
FEM Avg. 24-hr	PurpleAir sensor at this site did not report during this period	25.3	14.6	17.0
Sensor Avg. 24-hr		30.4	17.3	16.4
FEM Max 1-hr		369	201.0	104
Sensor Max 1-hr		3332.49	132.9	128.55
FEM Max 24-hr		72.8	52.0	66.9
Sensor Max 24-hr		688.9	59.4	82.4
1-hr R^2		0.0134	0.6268	0.8645
1-hr Slope		0.8134	0.9278	1.3032
1-hr Intercept		10.029	3.8281	-5.7028
24-hr R^2		0.1034	0.9121	0.9530
24-hr Slope		1.6024	1.2833	1.4257
24-hr Intercept		-10.058	-1.3761	-7.8140

Table B – Clovis-Villa Site

Statistic	Clovis-Villa PurpleAir #1	Clovis-Villa PurpleAir #2	Clovis-Villa PurpleAir #3
FEM Avg. 24-hr	16.7	16.7	16.7
Sensor Avg. 24-hr	19.1	21.1	660.6
FEM Max 1-hr	102.0	102.0	102.0
Sensor Max 1-hr	134.7	151.18	3409.48
FEM Max 24-hr	61.1	61.1	61.1
Sensor Max 24-hr	75.5	82.8	3338.0
1-hr R^2	0.8460	0.8262	-0.149
1-hr Slope	1.1990	0.6272	19.803
1-hr Intercept	-0.9190	3.4558	-
24-hr R^2	0.9529	0.9592	-0.201
24-hr Slope	1.3278	1.4730	21.864
24-hr Intercept	-3.0447	-3.4780	-

Table C – South Central Fresno and Shafter Sites

Statistic	South Central Fresno	Shafter
FEM Avg. 24-hr	14.9	12.9
Sensor Avg. 24-hr	14.0	16.2
FEM Max 1-hr	97.0	108.00
Sensor Max 1-hr	141.63	172.34
FEM Max 24-hr	60.8	49.4
Sensor Max 24-hr	60.6	75.9
1-hr R^2	0.7887	0.7801
1-hr Slope	1.2808	1.430
1-hr Intercept	-0.8745	-0.975
24-hr R^2	0.9217	0.9380
24-hr Slope	1.6142	1.7656
24-hr Intercept	-4.8849	-4.7681