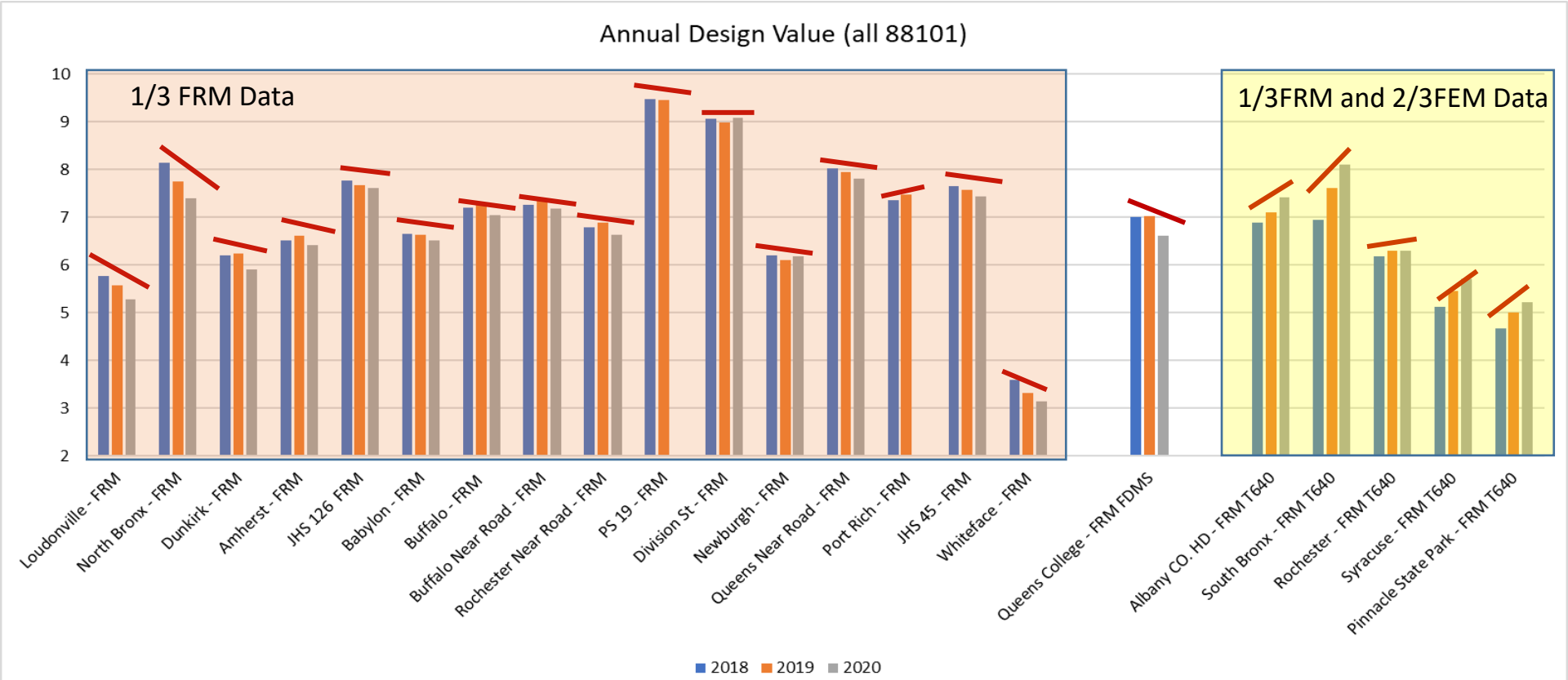
NEW YORK STATE | Department of Environmental Conservation

PM-2.5 FEM Data Optimization

Approach to Adjust (Any and All) Class III FEM Data to more closely match Filter Based FRM Data

NACAA Monitoring Committee Meeting
Dirk Felton
August 19, 2021

PM-2.5 Method Issues: Ability to Detect a Trend



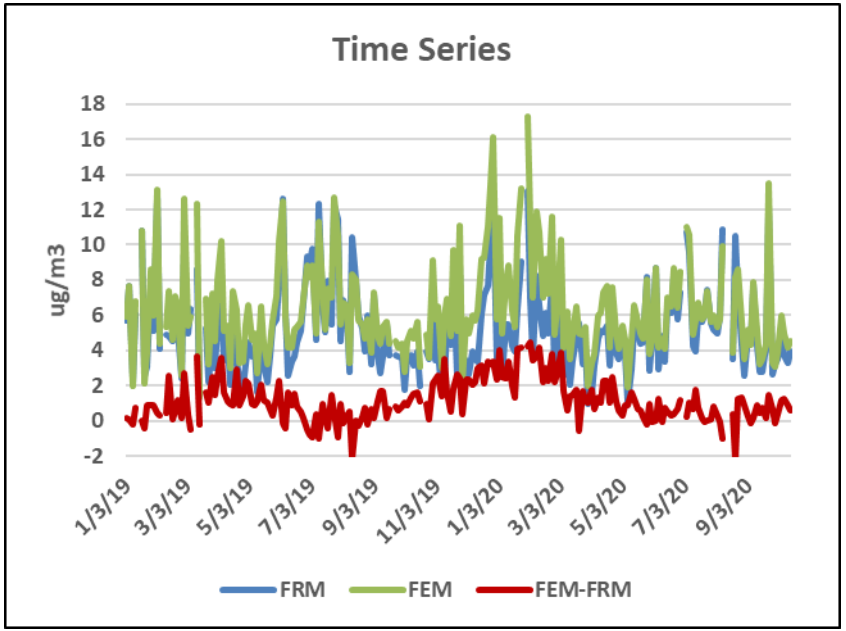
Why is this Necessary?

American Rescue Plan Funds – S&Ls encouraged to expand deployment of FEMs in EJ neighborhoods

The PM-2.5 FEM Class III Equivalency criteria are too loose.
- FEMs run in triplicate (eliminates noise issue)
- FEM winter and summer bias averaged together
- PM-2.5 levels were higher when criteria established

Normalizing FEM data to FRM data on a MSA basis will permit seamless integration of the continuous and filter-based datasets and will eliminate concern over inaccurate attainment designations

Bias Assessment



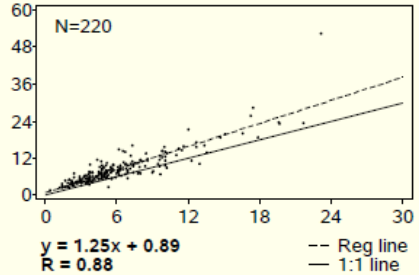
- Bias is generally seasonal due to environmental factors as well as changes in PM composition and size
- FRM data are subtracted from FEM 24-Hr averages
- The difference (Red Data) is the daily bias
- FEMs can be biased high (> zero) or low (< zero)

$PM_{2.5}$ Continuous Monitor Comparability Assessment

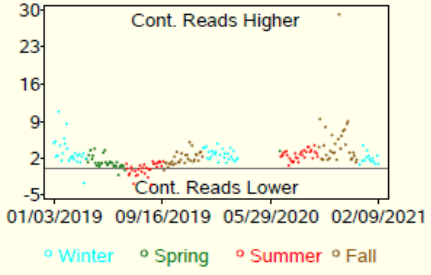
Site 36-001-0005: Albany, NY

FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric (118,145), PM2.5 - Local Conditions (88101), POC=1,2
Cont: Teledyne T640 at 5.0 LPM - Broadband spectroscopy (236), PM2.5 - Local Conditions (88101), POC=3

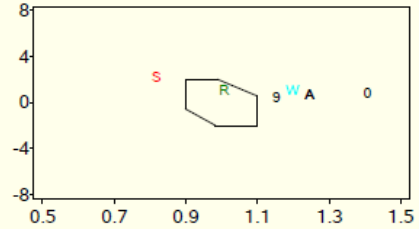
Cont. (y) vs. FRM (x) ($\mu g/m^3$)



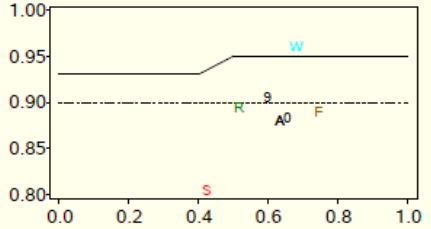
Cont. minus FRM ($\mu g/m^3$)



Additive (y) vs. Multiplicative (x) Bias



R (y) vs. FRM CCV (x)



Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	220	6.1	8.4	1.39

Appendix A Statistics

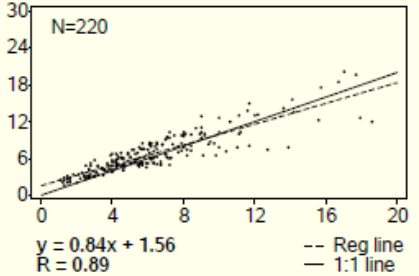
Dataset	N	Bias (all observations)	N (only >= 3 ug/m^3)	Bias (only >= 3 ug/m^3)
AllData	220	49.1	183	41.0

$PM_{2.5}$ Continuous Monitor Comparability Assessment

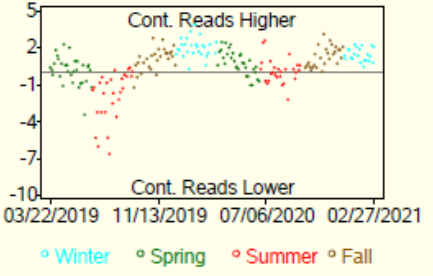
Site 36-055-1007: Rochester, NY

FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric (118,145), PM2.5 - Local Conditions (88101), POC=1
Cont: Teledyne T640 at 5.0 LPM - Broadband spectroscopy (236), PM2.5 - Local Conditions (88101), POC=4

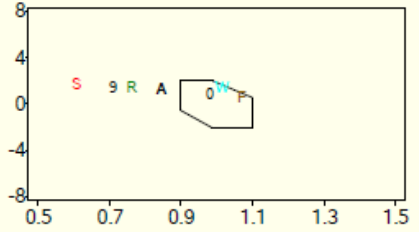
Cont. (y) vs. FRM (x) ($\mu g/m^3$)



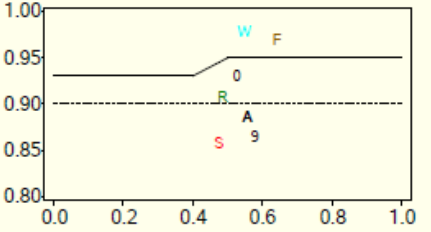
Cont. minus FRM ($\mu g/m^3$)



Additive (y) vs. Multiplicative (x) Bias



R (y) vs. FRM CCV (x)



Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	220	6.1	6.7	1.10

Appendix A Statistics

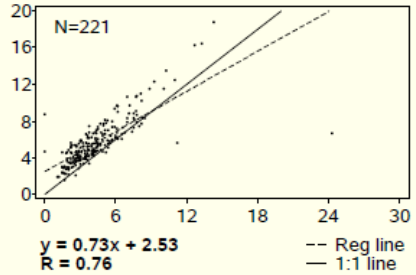
Dataset	N	Bias (all observations)	N (only >= 3 ug/m^3)	Bias (only >= 3 ug/m^3)
AllData	220	18.4	188	12.1

$PM_{2.5}$ Continuous Monitor Comparability Assessment

Site 36-101-0003: Not in a City, NY

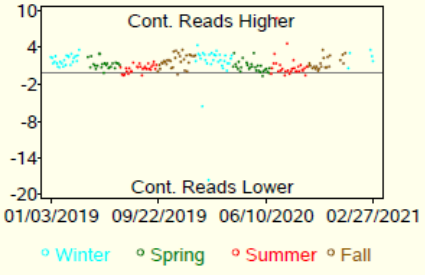
FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric (118,145), PM2.5 - Local Conditions (88101), POC=1
Cont: Teledyne T640 at 5.0 LPM - Broadband spectroscopy (236), PM2.5 - Local Conditions (88101), POC=4

Cont. (y) vs. FRM (x) ($\mu g/m^3$)



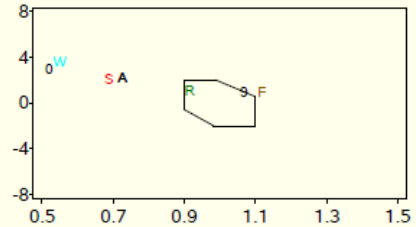
y = 0.73x + 2.53
R = 0.76
-- Reg line
— 1:1 line

Cont. minus FRM ($\mu g/m^3$)



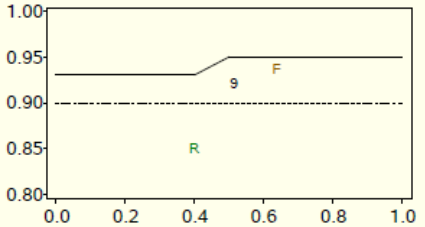
° Winter ° Spring ° Summer ° Fall

Additive (y) vs. Multiplicative (x) Bias



A=AllData, 9=2019, 0=2020, 1=2021
W=Winter, R=Spring, S=Summer, F=Fall

R (y) vs. FRM CCV (x)



A=AllData, 9=2019, 0=2020, 1=2021
W=Winter, R=Spring, S=Summer, F=Fall

Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	221	4.4	5.7	1.30

Appendix A Statistics

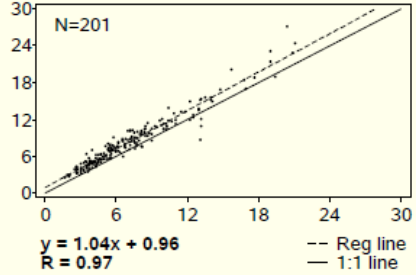
Dataset	N	Bias (all observations)	N	Bias (only >= 3 ug/m^3)
AllData	221	40.2	152	27.5

$PM_{2.5}$ Continuous Monitor Comparability Assessment

Site 36-005-0110: New York, NY

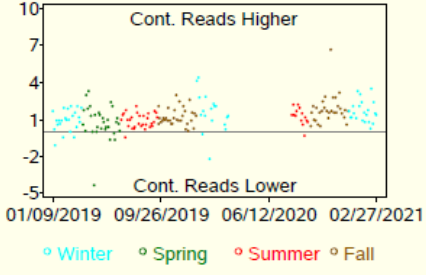
FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric (118,145), PM2.5 - Local Conditions (88101), POC=1,2
Cont: Teledyne T640 at 5.0 LPM - Broadband spectroscopy (236), PM2.5 - Local Conditions (88101), POC=4

Cont. (y) vs. FRM (x) ($\mu g/m^3$)



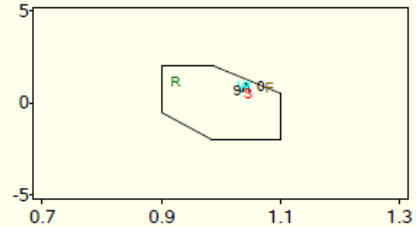
y = 1.04x + 0.96
R = 0.97
-- Reg line
— 1:1 line

Cont. minus FRM ($\mu g/m^3$)



° Winter ° Spring ° Summer ° Fall

Additive (y) vs. Multiplicative (x) Bias



A=AllData, 9=2019, 0=2020, 1=2021
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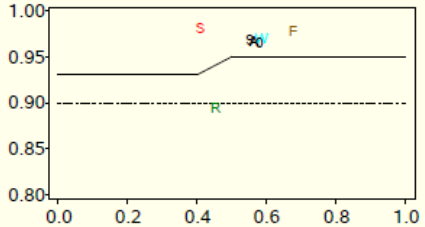
R (y) vs. FRM CCV (x)



A=AllData, 9=2019, 0=2020, 1=2021
W=Winter, R=Spring, S=Summer, F=Fall

Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	201	7.1	8.4	1.18

Appendix A Statistics

Dataset	N	Bias (all observations)	N	Bias (only >= 3 ug/m^3)
AllData	201	22.3	185	20.2

Observations and Requirements

- Every FEM (vendor and model) requires a different adjustment
- Every MSA requires a different adjustment
- The adjustment must account for seasonal changes in bias
- The adjustment should utilize 1-in-6 day FRM data, otherwise, you would have two collocated NAAQS quality measurements which is not cost effective
- The adjustment should be simple, easy to explain, scientifically justified and easy to calculate
- The adjustment must produce FEM_{adj} data that result in Annual and Daily Design Values indistinguishable from FRM data

Solution

Linear Regressions are simple and account for bias

They have to be done repeatedly to account for temporal changes in bias (1 month at a time)

They must use enough data points to be robust and to accommodate missing values (>10 FRM:FEM data pairs)

For 1-in-6 datasets, 3 months of paired FRM:FEM data are utilized for each month of adjusted data

Example: To determine a Regression Equation for February, data from January through March are used. For March, data from February through April are used and so on

Procedure

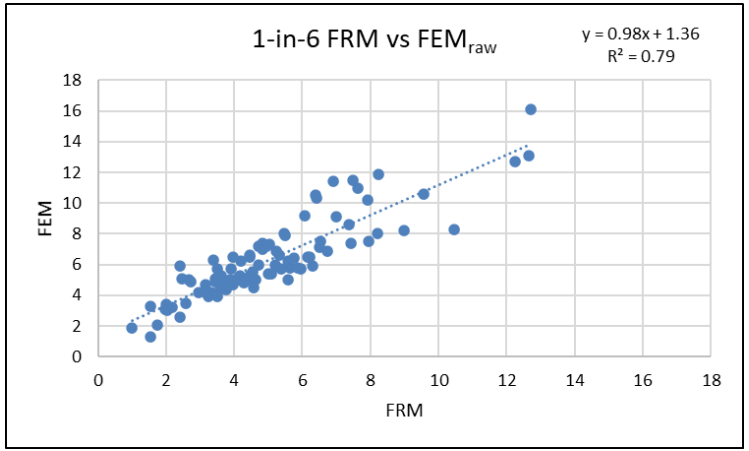
Use 3 months of data and calculate a slope and intercept

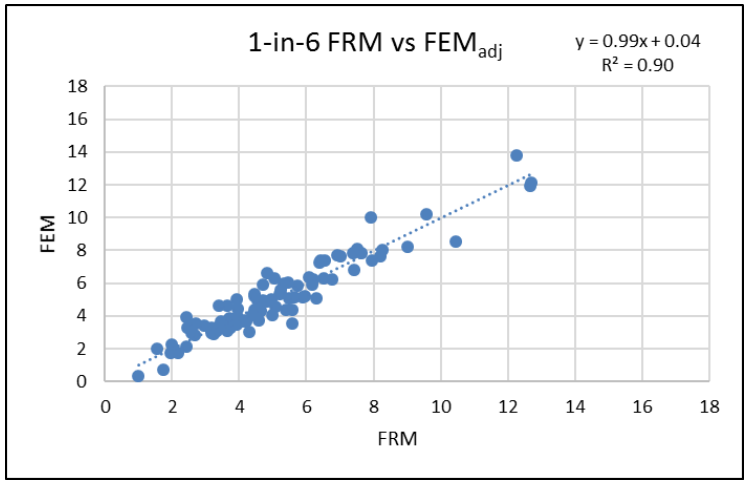
Use the slope and intercept to adjust the FEM data for each FEM value for the center month of data

$$FEM_{adj} = (FEM_{raw} – (\pm)intercept)/slope$$

This equation can be applied to other like method FEMs within the MSA for the same month

The equation can be used to adjust (post process) the hourly as well as daily average FEM data



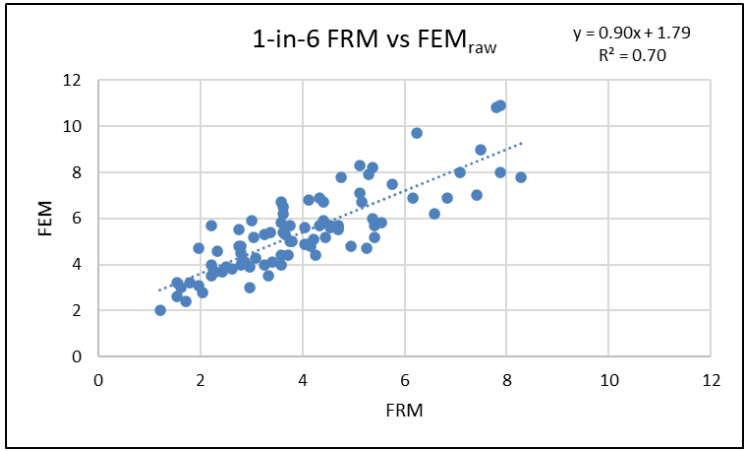


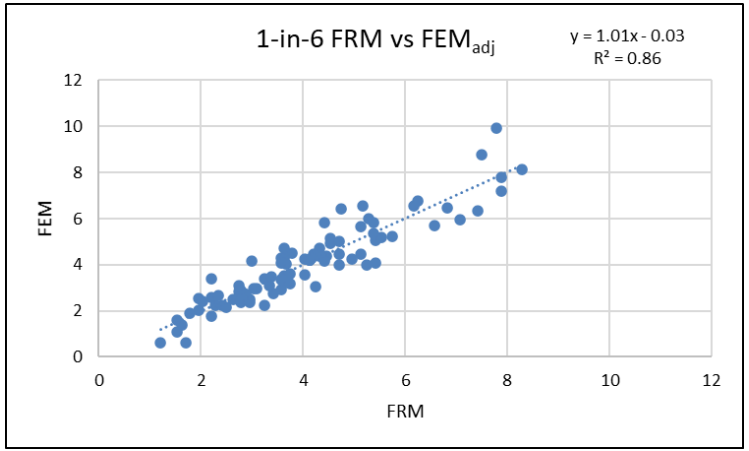
Result: Feb 2019 – Aug 2020

Syracuse, NY: Thermo 2025 & T640

The accuracy and variability are improved and the estimated DVs are comparable

PM-2.5 ug/m^3	**FRM**	**FEM$_{raw}$**	**FEM$_{Adj}$**
18 Month Average	5.02	6.29	5.01
18 Month 3rd Max	12.25	12.70	12.11
18 Month Range	Slope 0.68 to 1.55	Intercept -0.57 to 2.17	R^2 0.65 to 0.96





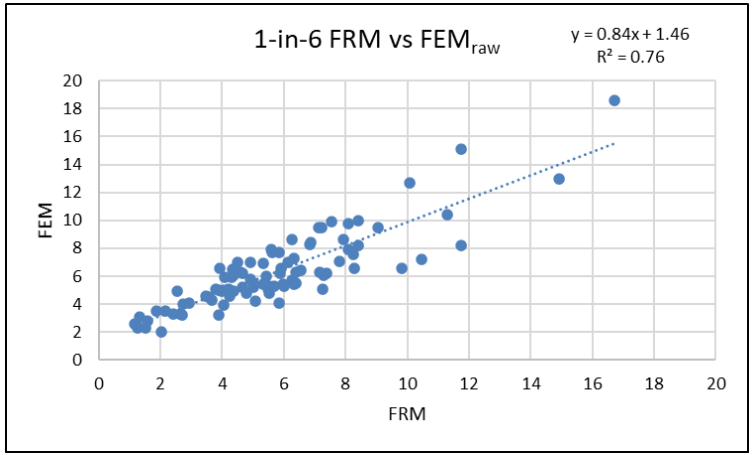
Result: Feb 2019 – Aug 2020

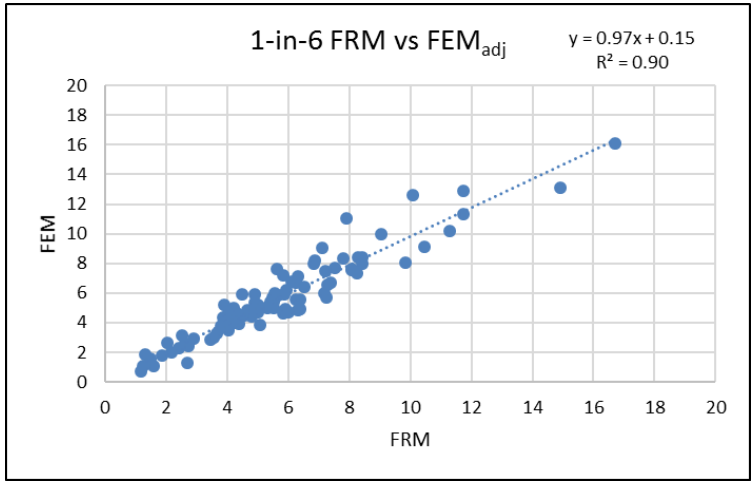
Rural NCore Site: Pinnacle State Park

Thermo 2025 & T640

The accuracy and variability are improved and the estimated DVs are comparable

PM-2.5 ug/m^3	**FRM**	**FEM$_{raw}$**	**FEM$_{Adj}$**
18 Month Average	4.04	5.43	4.04
18 Month 3rd Max	7.88	9.70	8.76
18 Month Range	Slope 0.69 to 1.26	Intercept 0.15 to 2.19	R^2 0.70 to 0.96





Result: Feb 2019 – Aug 2020

Urban NCore Site: Rochester, NY

Thermo 2025 & T640

The accuracy and variability are improved and the estimated DVs are comparable

PM-2.5 ug/m^3	**FRM**	**FEM$_{raw}$**	**FEM$_{Adj}$**
18 Month Average	5.72	6.28	5.69
18 Month 3rd Max	11.75	13.00	12.86
18 Month Range	Slope 0.51 to 1.13	Intercept -0.75 to 2.55	R^2 0.71 to 0.99

Conclusions

The adjustments were determined with NY data and sites but the method can be applied to any FEM FRM dataset

The adjustments are derived from 24-Hr data but can and should be applied to 1-Hr data (not in real time)

The calculations could be performed by S&Ls or within AQS to produce FRM quality FEM data

Adjusted FEM data will simplify future health and area-wide PM studies as data from neighboring S&L air agencies will be comparable

The “CASAC” IPMRP Panel recommended this approach

Independent Recommendation

Page B-9 of the IPMRP PM review: (Former CASAC PM Panel)

> “There are approaches that could be implemented to make nearly all the existing FEM data of acceptable quality for comparison to the NAAQS based on data collected from co-located FRM and FEM PM-2.5 monitors over the last several years, since nearly all FEMs produce 24-hour average PM-2.5 concentrations that are well-correlated with FRM samples.”

Next Steps

S&L: Do not submit FEM data as 88101 if it does not meet Class III Equivalency at each site

S&L: Use April 15, 2013 EPA Document:
"Instructions and Template for Requesting that data from PM2.5 Continuous FEMs are not compared to the NAAQS"

(Exclude the 4th Qtr of 2021 – Next NAAQS attainment demonstration can use prior years data)

EPA: In the next revision of the PM NAAQS, require 88101 FEM data to be adjusted to emulate local FRM data on a MSA specific basis

Thank You

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