

Dirk Felton's FEM Correction: an Iowa Example

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Motivation

The Air Quality system has two classifications (parameter codes) for PM2.5 data: suitable NAAQS compliance and Air Quality Index AQI reporting (88101) and suitable for AQI only (parameter code 88502). As of 11/23/21, the AQS system did not allow T640 data to be coded to parameter code 88502. The only option for SLAMs T640 data that exhibits poor comparability with the NAAQS (i.e. outside the Comparability box) is to remove it from AQS. Dirk has suggested that T640 data that fails the comparability requirement be post-processed by a specific method ("the Felton Method") and reloaded to AQS as parameter code 88101.

Dirk's spreadsheet was a little difficult for me to use, because it required setting a lot of ranges, so I reworked it using some excel macros. I wanted a different method that to compare with Dirk's, so I put together another spreadsheet that corrected the data using the data from each calendar quarter.

Postscript: On 11/24/21 AQS was configured to allow T640 data to be coded to parameter code 88502:

"Method code 236 with parameter code 88502 has been set up in AQS. This is for "Teledyne T640 at 5.0 LPM, Broadband spectroscopy, EQPM-0516-236 PM2.5 continuous FEM". This is intended solely for cases where the Region has approved that the data are not to be used in NAAQS due to comparability issues".

Explanation of Correction Methods

Objective: Transform an annual data set that does not meet equivalency criteria into one that does meet the criteria. Examine the effect on metrics used to compute the design values (annual average and 98th percentiles).

Linear Regression:

Calibration Equation:

$$e=m*f+b$$

Correction Equation:

$$f=(e-b)/m$$

Calibration Range:

The time-period used to generate the calibration equation.

Correction Range:

The time-period over which the correction equation is applied.

Note: Each **f** data value has a corresponding **e** data value in the calibration range. But the correction equation will be applied to all **e** data values in the correction range, and not just those that have a corresponding **f** data value.

If we use braces to indicate the calibration date range and the correction date range, i.e.,

{Calibration Range, Correction Range}

it helps to describe the two correction algorithms.

Prescription for Quarterly Correction:

Divide the year into four (calendar) quarters. calibrate over each quarter and correct over the corresponding quarter.

{{Q₁, Q₁}, {Q₂, Q₂}, {Q₃, Q₃}, {Q₄, Q₄}}

Or {...{Q_i, Q_i}...}, where i = 1,2, ... 4.

Prescription for Felton Correction:

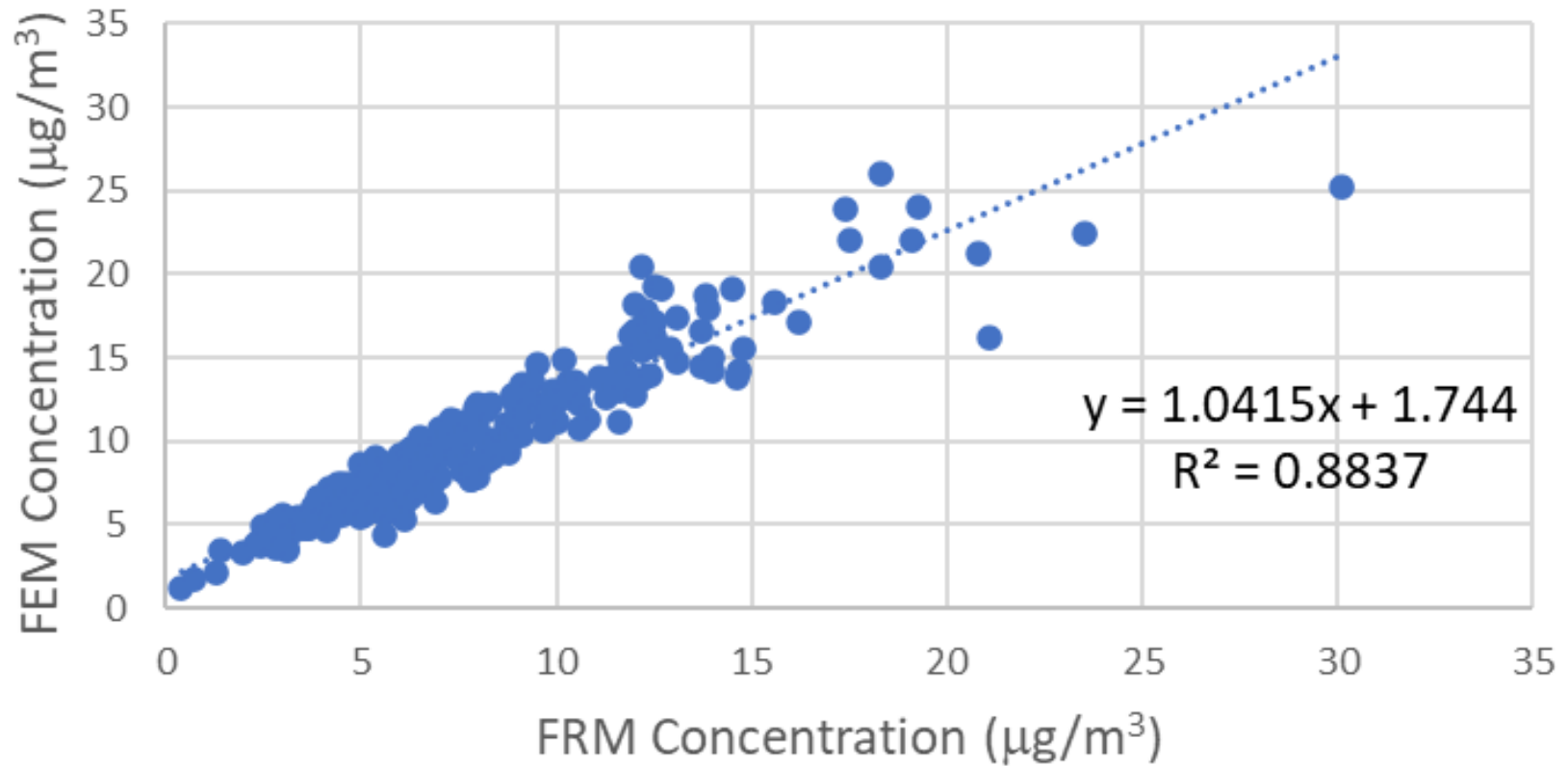
Divide the year into 12 (calendar) months. Correct each month by calibrating over that month, the previous month, and the following month:

$\{...{\{m_{i-1}, m_i, m_{i+1}\}, \{m_i\}}...\}$, where $i = 1, 2, \dots, 12$.

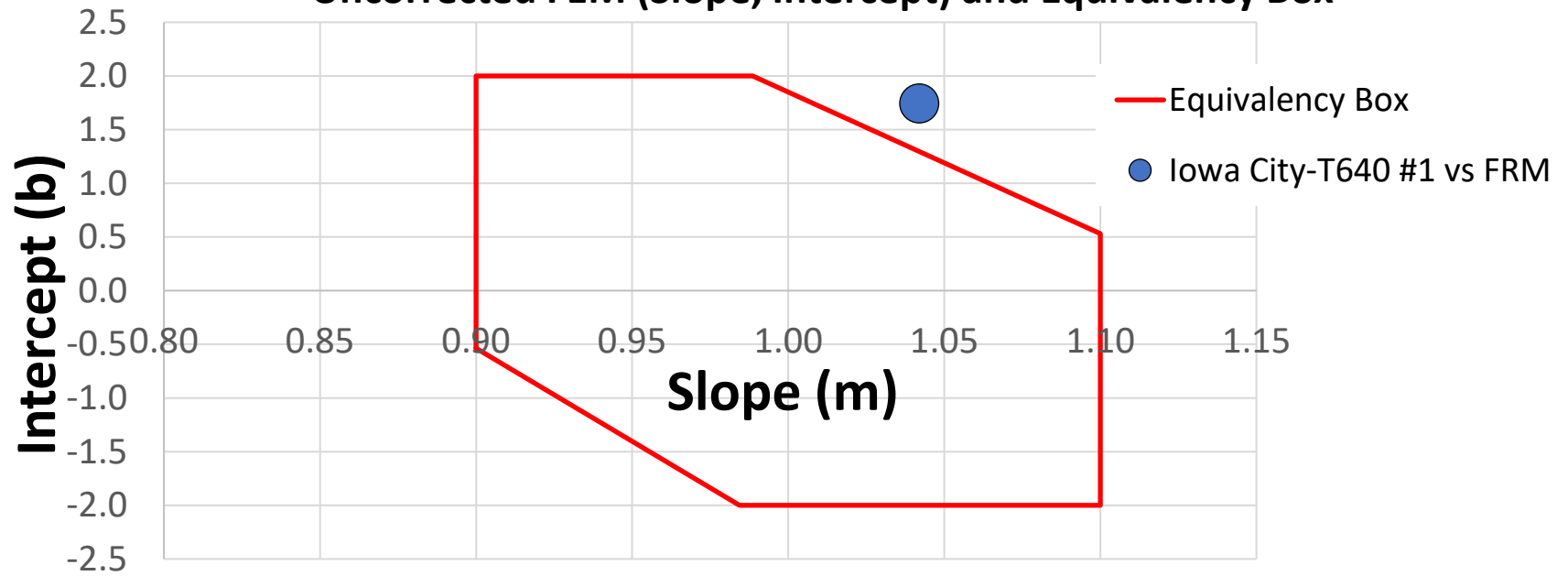
Note: It takes 14 months of calibration data to correct one year of monitoring data.

Example

Iowa City T640 #1 vs BAM



Uncorrected FEM (Slope, Intercept) and Equivalency Box



Example: Felton Correction and Quarterly Correction

| Year | Monitor Type | Monitor Location-Model | AQS ID |
|------|--------------|------------------------|-----------------|
| 2021 | FRM | Iowa City-2025i | 191032001-POC 1 |
| 2021 | FEM | Iowa City-T640 #1 | 191032001-POC 3 |

| Parameter/Monitor | FRM | FEM | FEM with Felton Correction | FEM with Quarterly Correction |
|---|------|-----------------|----------------------------|-------------------------------|
| Annual Average ($\mu\text{g}/\text{m}^3$) | 7.65 | 9.72 (2.07/27%) | 7.69 (0.04/1%) | 7.78 (0.13/2%) |
| 98th %-tile ($\mu\text{g}/\text{m}^3$) | 19.1 | 22.1 (3.0/14%) | 20.3 (1.2/6%) | 19.4 (0.3/2%) |

Note: Differences and Percent Differences Relative the FRM are noted in parenthesis.

| Regression Results | FEM vs FRM | FEM with Felton Correction vs FRM | FEM with Quarterly Correction vs FRM |
|--------------------|------------|-----------------------------------|--------------------------------------|
| Count | 264 | 264 | 264 |
| R2 | 0.88 | 0.93 | 0.93 |
| Slope | 1.04 | 1.00 | 1.00 |
| Intercept | 1.74 | -0.03 | 0.00 |