“Variability in BAM1020 Zero Background Tests”

Causes and Implications

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St. Louis, MO
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Louisville Metro Air Pollution Control District

Objective

- Provide a summary of an analysis of zero background test results performed by the Louisville Metro Air Pollution Control District
- Compare our results with previous analyses
- Follow up on topics discussed at 2012 and 2014 National Monitoring Conferences
- Discuss best practices / implications of zero test variability

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Disclaimer

- I am not a field technician
- I am a data analyst with some knowledge of instrument operations and field conditions
- Presentation is a compilation of data analyses and observations made by several monitoring staff in Louisville
- Data analysis is based on a somewhat limited dataset
- APCD monitoring staff relatively new
  - Still catching up on knowledge base

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Analysis & Methodology

- Evaluated up to four years of PM2.5 FEM BAM 1020 Zero Background tests for four sites in Louisville, KY
  - Approximately 20 zero background tests analyzed
- Zero Background tests performed using zero filter outside of the shelter (i.e. in ambient conditions)
- Goal → Determine potential causes for variability in zero background tests

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Summary of Results

- Strongest indicator / predictor of zero background averages was the ambient dew point temperature
- Three of the four sites showed a strong inverse relationship between the zero average and the ambient dew point temperature
- Remains unclear why the fourth site did not show a relationship with dew point temperature

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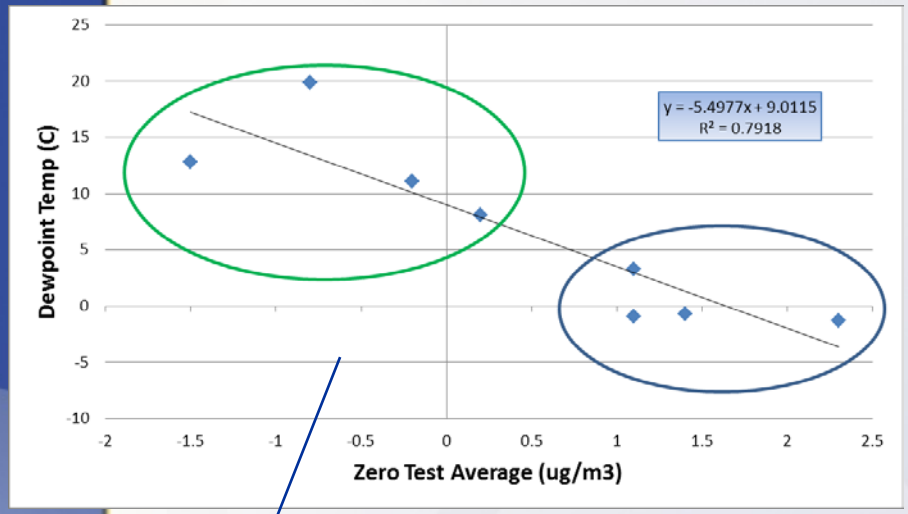
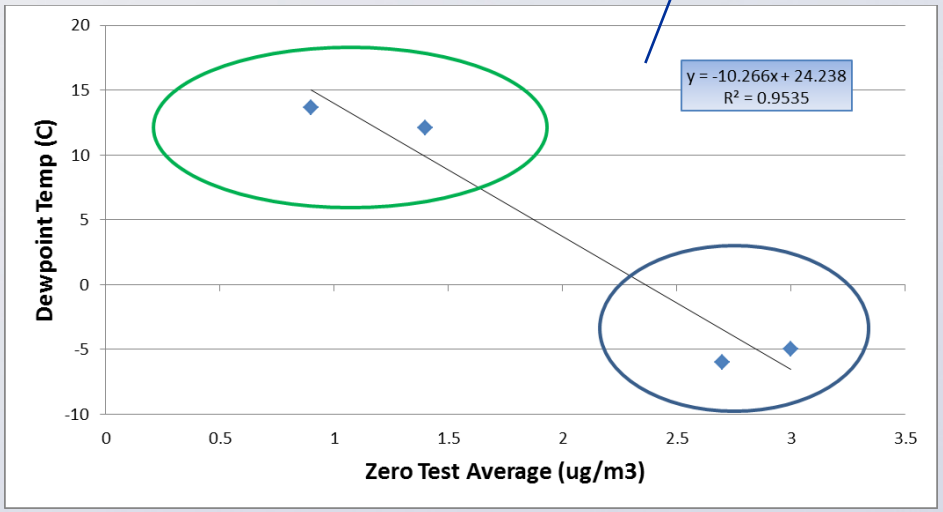
Summary of Results

Variation of ~2 µg/m^3

Site A

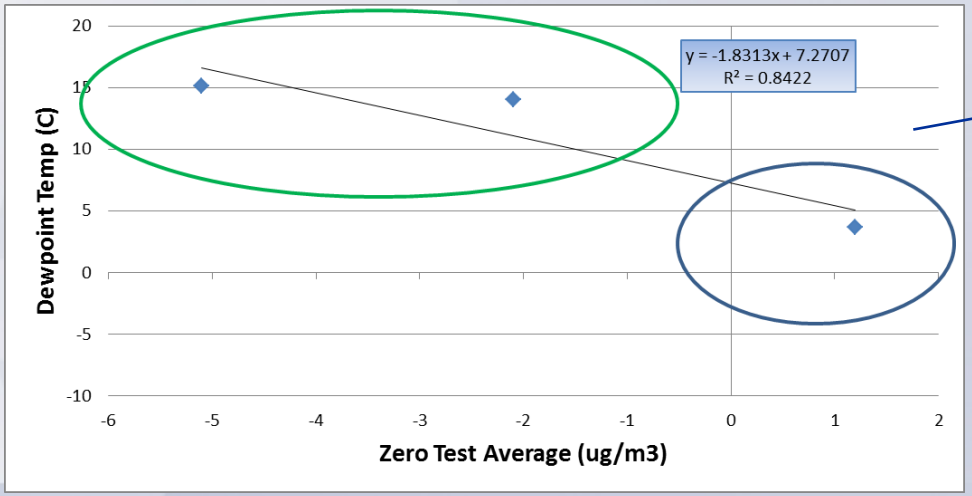


Site B



Variation of ~4 µg/m^3

Site C



Variation of ~6 µg/m^3

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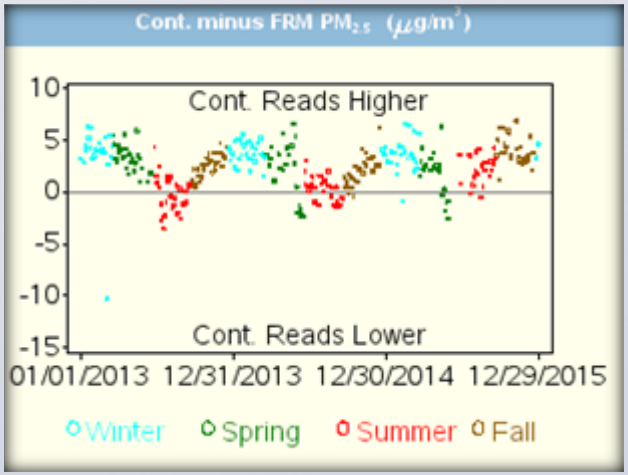
Comparison with Previous Studies

- APCD results consistent with previous studies
  - Performance issues at high Temp & RH (Met One, 2012 Monitoring Conference)
  - Negative bias under high dew point conditions (Tim Hanley, Oct. 2012 Technical Memo)
  - Data from other agencies



- OK, so how can we mitigate this?

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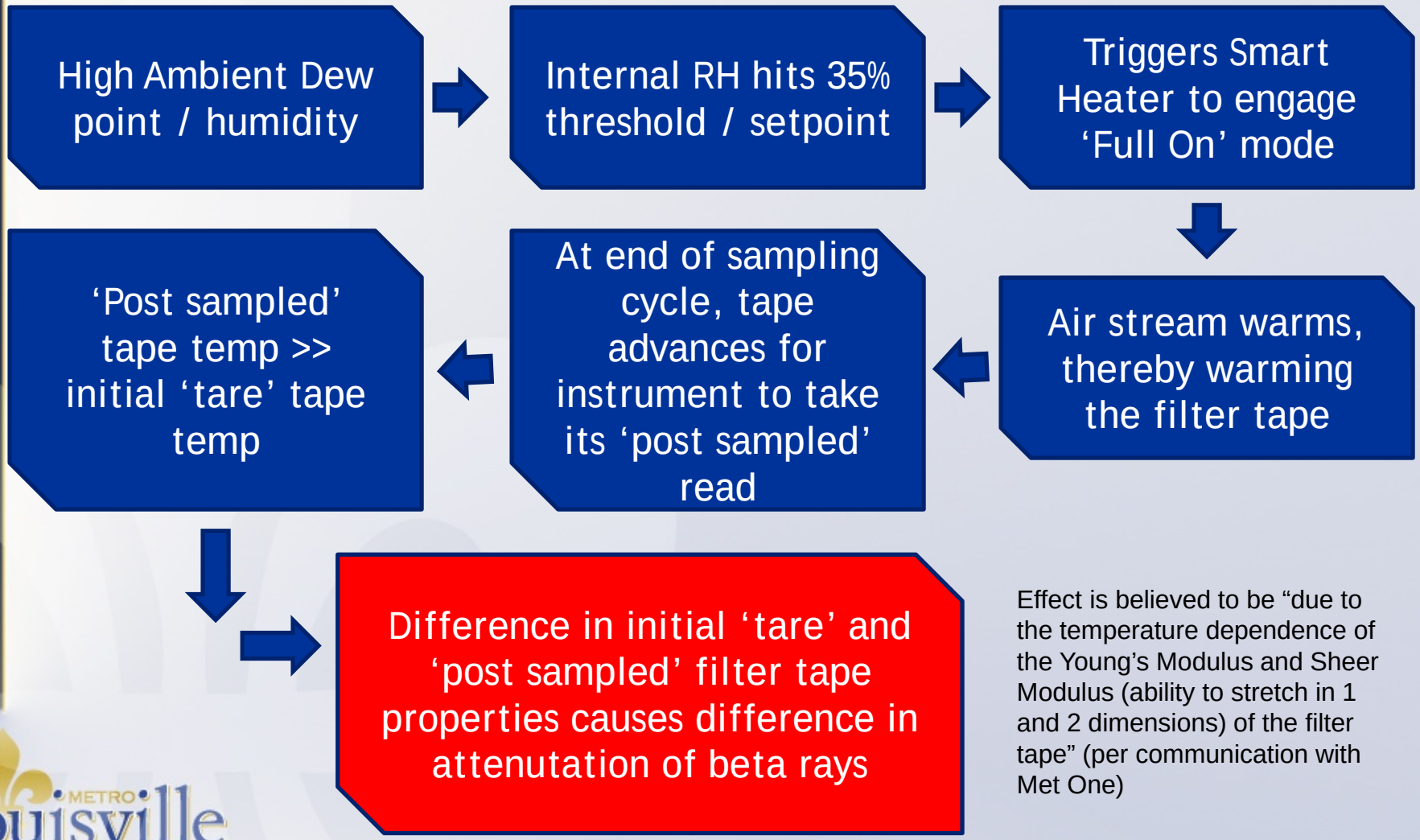
Why the Inverse Relationship?



Effect is believed to be "due to the temperature dependence of the Young's Modulus and Sheer Modulus (ability to stretch in 1 and 2 dimensions) of the filter tape" (per communication with Met One)

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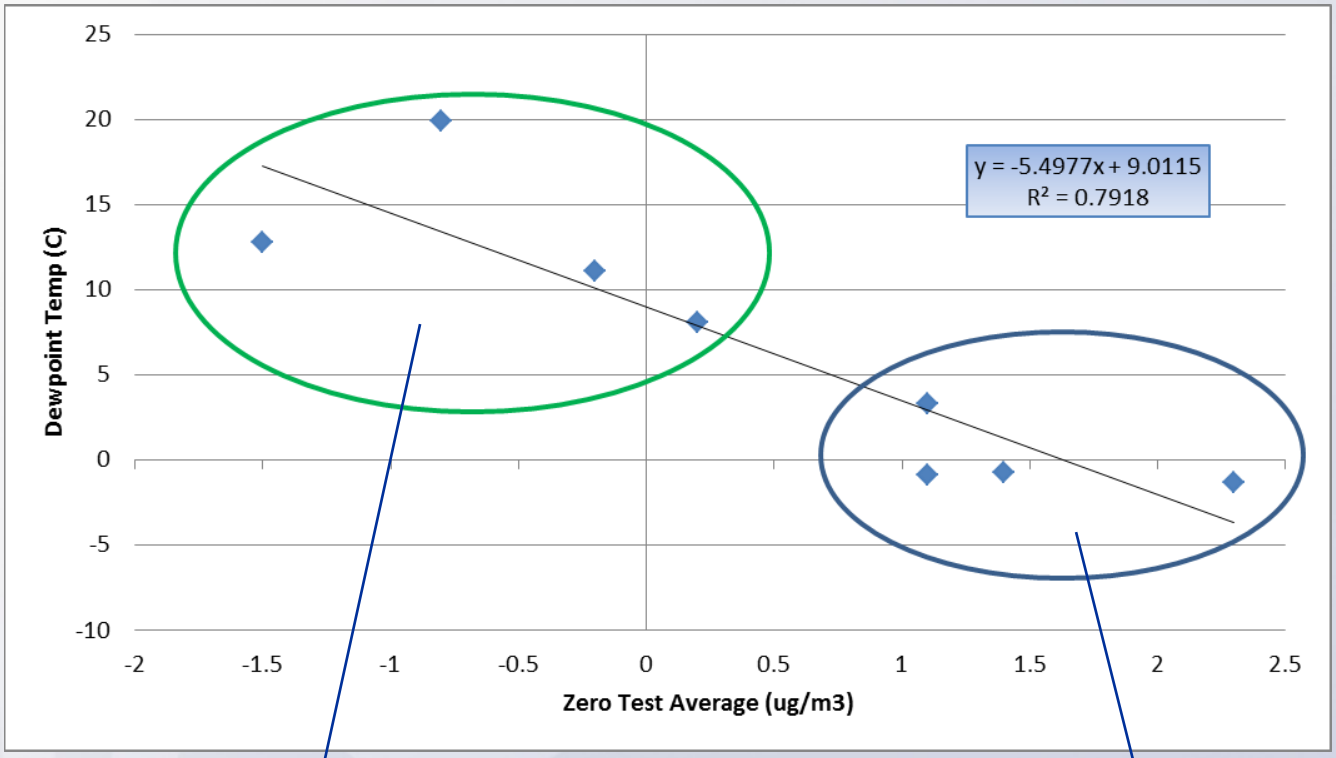
Why the Inverse Relationship?



Warm, humid ambient conditions

Cool / dry ambient conditions

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Significance?

- The zero background test corrects for this variability, right?
- Sort of…

- If performing zero background test once per year, the test does not capture the seasonal variation, so you'll only be 'accurate' for the season that the test was performed in.
- If zero background test performed seasonally, the annual variation is minimized…
  - As long as you perform the test at the right time

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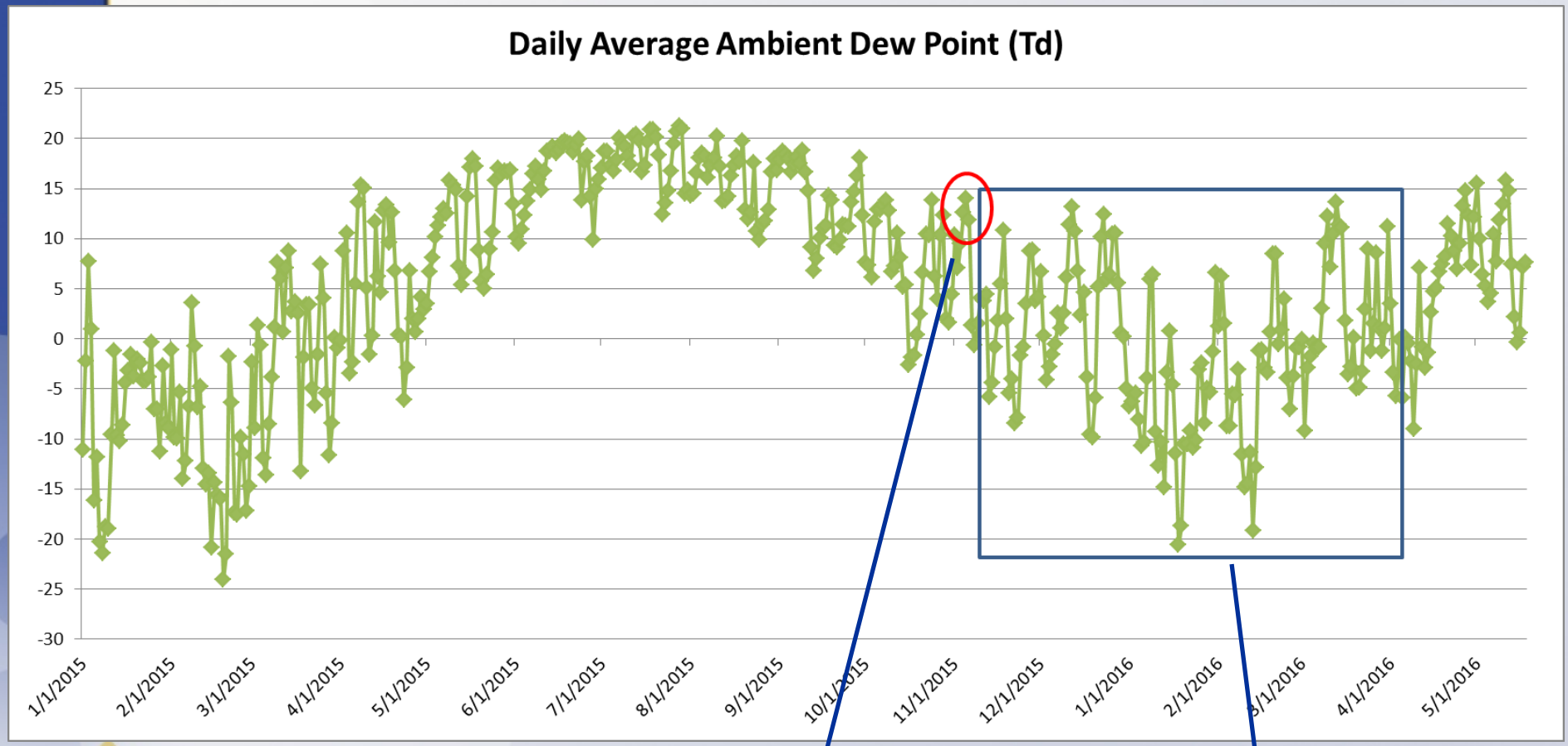
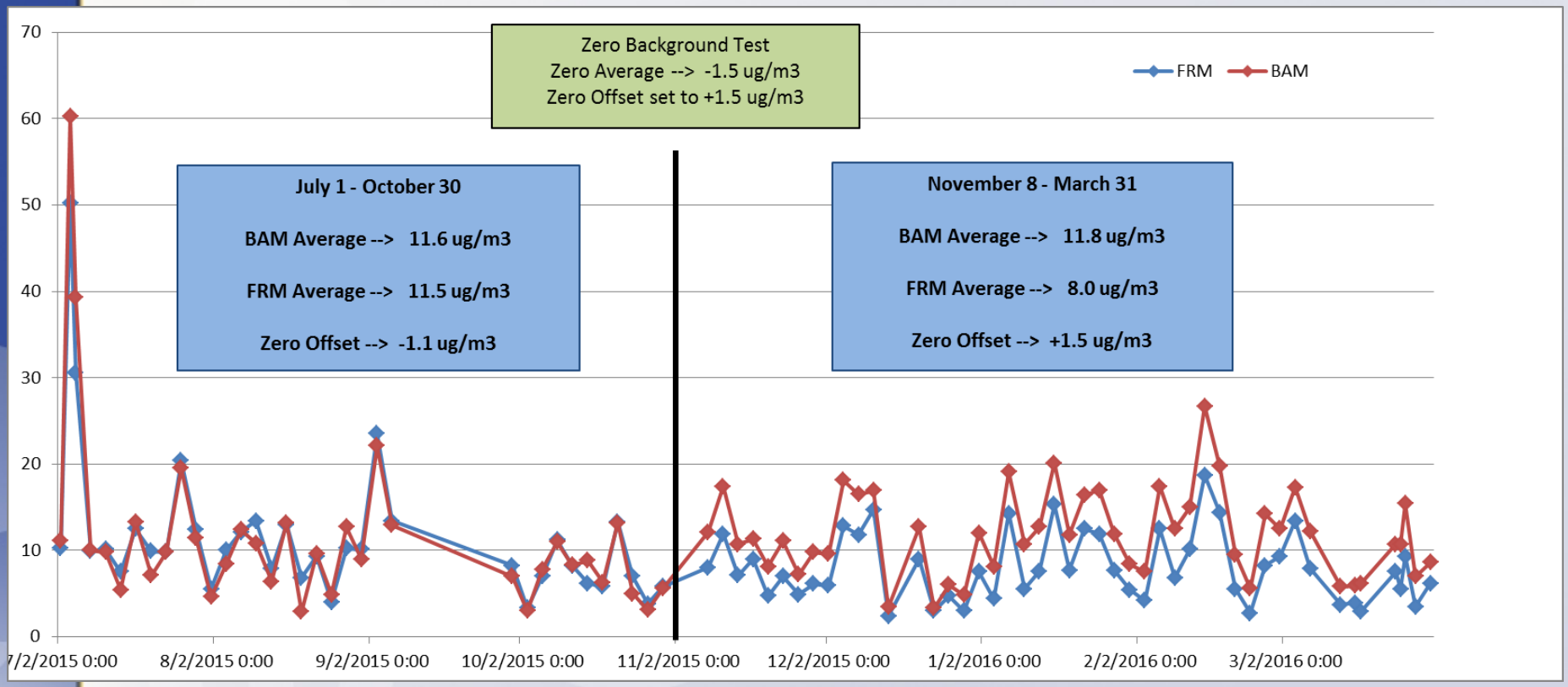
Timing of Zero Background Tests



Zero background Avg dew point → +11.0 C

Winter Season Avg dew point → -0.8 C

Significance?



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Considerations / Challenges

- Trying to find the 'right time' to perform the zero background test can be challenging and resource intensive
  - Must know dew point climatology for your area
  - Must pay close attention to the weather and weather forecasts
  - Must factor in technician schedules in addition to weather conditions
- Be particularly careful when performing zero background tests during spring and fall when weather conditions can vary widely from one week to the next
  - If performing background tests for sites at different times, different weather conditions can result in biases between sites
- Stable weather conditions are not always representative of seasonal norms (e.g. dry drought conditions, cool / dry conditions after frontal passages)
  - Particularly true of the eastern U.S.
- Should background tests be performed inside shelter or outside shelter?
  - Guidance has fluctuated, but Met One's most recent guidance appears to be 'inside shelter'
  - In fact, recent Met One guidance cautions that the Smart Heater should not be 'full on' when performing zero background tests
  - While conducting tests inside shelter will likely produce cleaner looking zero tests, it will not incorporate offsets due to ambient conditions (i.e. dew point)

Considerations / Challenges

- Keep Shelter Temps warm (in summer) to minimize differences in tape temperature between initial 'tare' read and final 'post sampled' read
  - May be impractical for shelters that house gaseous analyzers (20 – 30 C range)
  - Note that Manual states shelter operating range of 0 – 50 C
- Ultimately, several factors to consider, but agencies need to determine what's more important…
  - Obtaining PM results that are most accurate and comparable to FRMs or
  - Minimizing logistical challenges
  - Note: the FEM designation does not go into much detail about the zero background test… but does reference the BAM1020 manual, which can sometimes be a moving target.
- If conducting zero background tests annually, the timing of the zero background test can impact your annual averages
  - A 2-4 $\mu g/m^3$ deviation may not seem significant, but it can make the difference between attainment and nonattainment.

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Other Factors / Interferences

- Bad batch of filter tape?
- Zero filter life span?
- Shelter conditions

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Acknowledgements

- It's been a team effort…
  - Tom Lobb
  - Lajos 'Louie' Kurucz
  - Josh Tennen
  - Billy DeWitt

- Dr. Gobeli & Met One
- Tim Hanley

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Questions?

- Bryan.paris@louisvilleky.gov

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Additional Slides

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Various BAM1020 Zero Background Test Guidance

- *Perform zero background test seasonally for areas with high dew point (Tim Hanley Memo, 2012)*
- *Perform zero background tests upon unit deployment and periodically thereafter (BAM1020 Revision K Manual)*
- *Perform background test with zero filter outside in ambient conditions (Tim Hanley Memo, 2012 and BAM 1020 Revision K Manual)*
- *Perform background test with zero filter inside the shelter (Recent guidance from MetOne)*
- *Shelter Temperature should be within specified range, which is 0°C to 50°C, but stable within ±2°C per hour (BAM1020 Manual Revision K)*
- *Shelter Temperature should be as warm as possible during humid ambient conditions (Recent guidance from MetOne)*

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Service Bulletin **BAM-1020**
BAM-1020 BACKGROUND TESTS **23SEP2011**
and the EFFECTS OF MOISTURE

The Met One Service department has fielded a number of calls regarding bad data, normally when running the initial zero background test of the instrument in the field.

There are two main causes of bad background test data resulting from moisture:

1. **Water or humidity collected inside the zero-filter from rain or dew point changes in the ambient air will cause bad data. The purpose of the background test is to compensate for minor variations in local site conditions, such as grounding, radon, or RFI characteristics. This results in optimum accuracy at lower concentrations typical of PM2.5 levels, but will not give you the compensation value required if moisture is part of the sampled air.**
2. **Humidity inside the shelter as a result of condensation will cause bad background test data. In cases where the shelter temperature meets the dew point temperature, there will be condensation in the tape path area and moisture will cause a higher than normal sample average. If this moisture evaporates between the Io count and the I3 count, the result will show up as a negative concentration.**

It is recommended that the zero-filter be placed inside the shelter in adverse weather conditions and the shelter temperature be kept approximately 10 to 15 degrees Fahrenheit above the dew point temperature of the area where the shelter is located. This will avoid condensation effects.
It is also recommended that insulation should be installed on the inlet tube, covering the entire length from the top of the BAM-1020 to the roof.

If you have any questions regarding this bulletin, please contact the Met One Service Department with one of the contact methods below.

service@metone.com

Ph. 541-471-7111
Fax 541-471-7116

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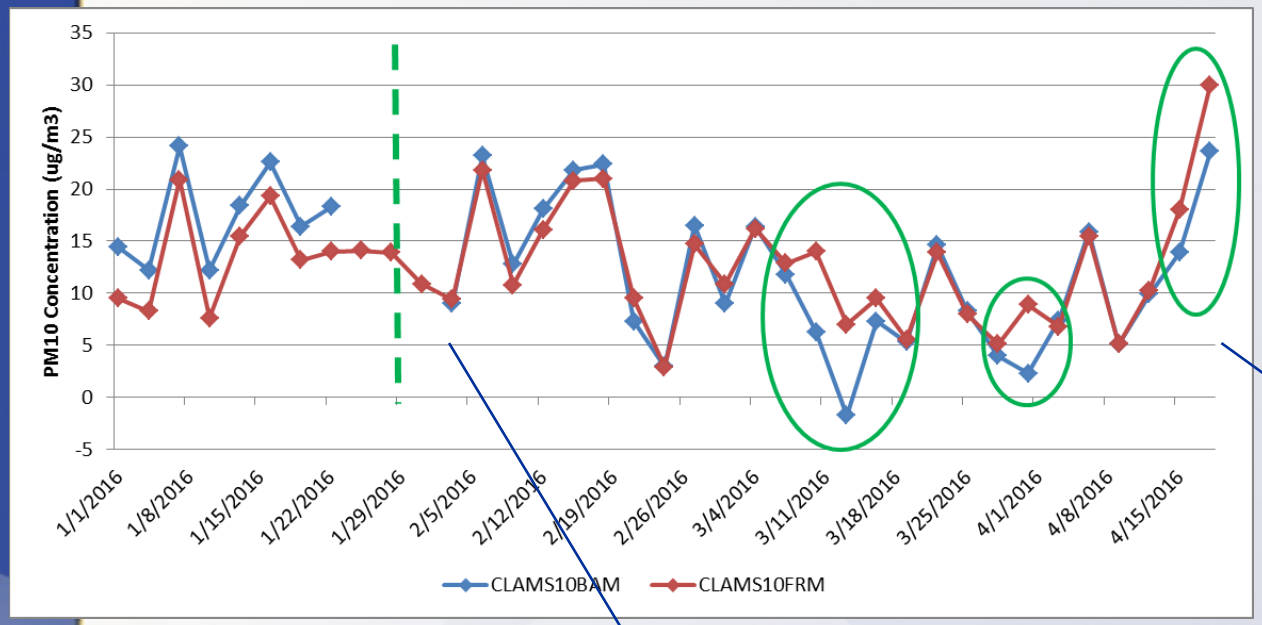
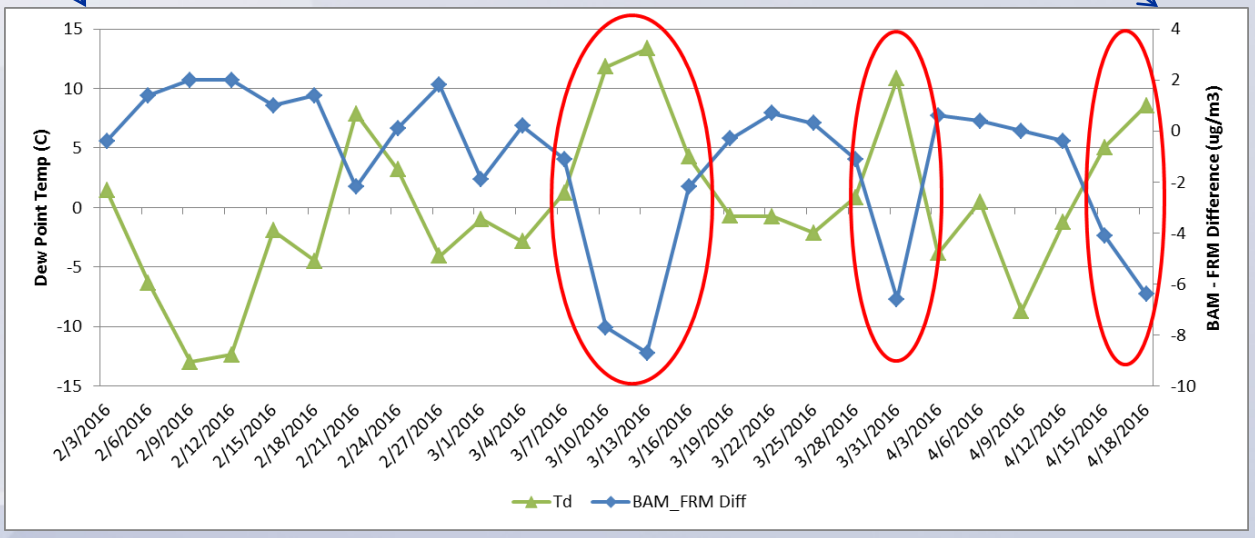


Extreme Example – beta source hot spot or bad tape?



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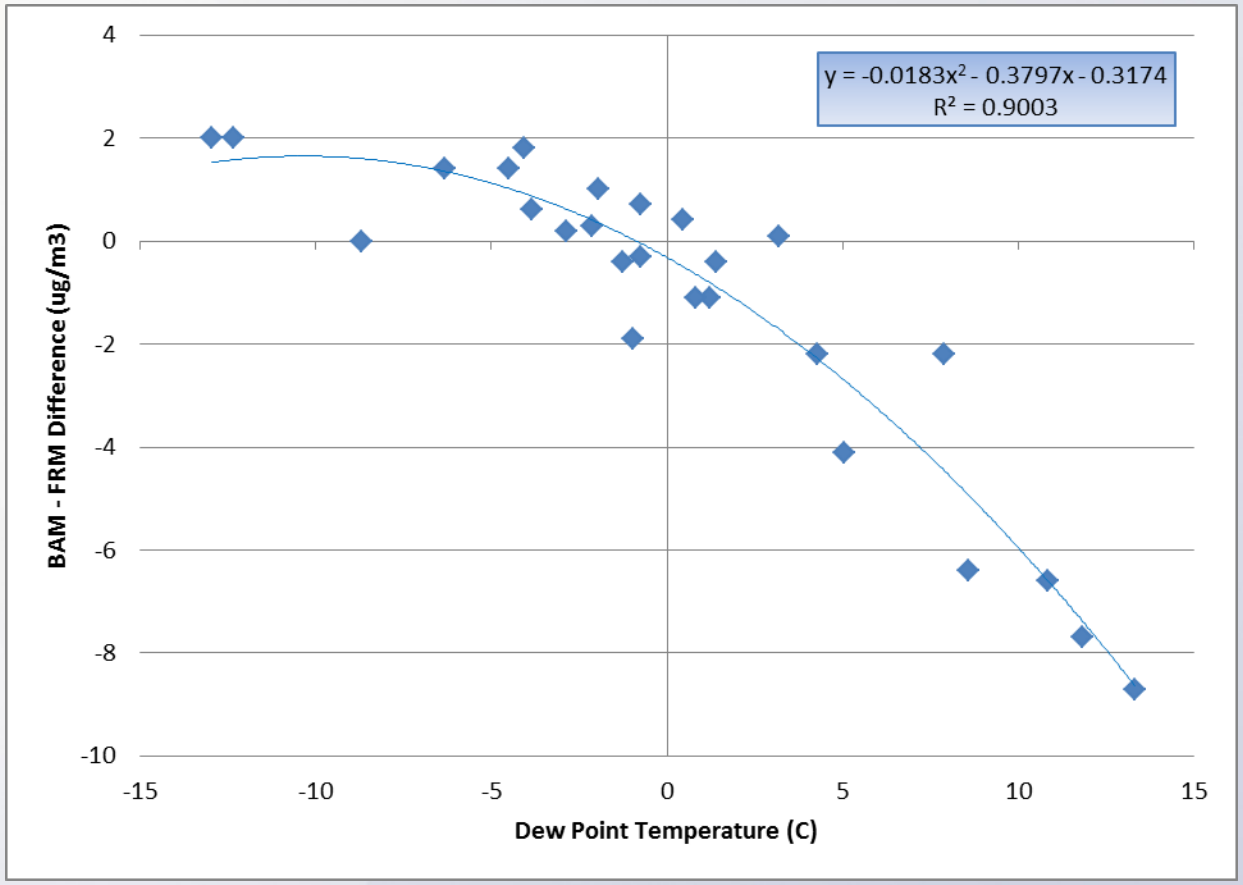

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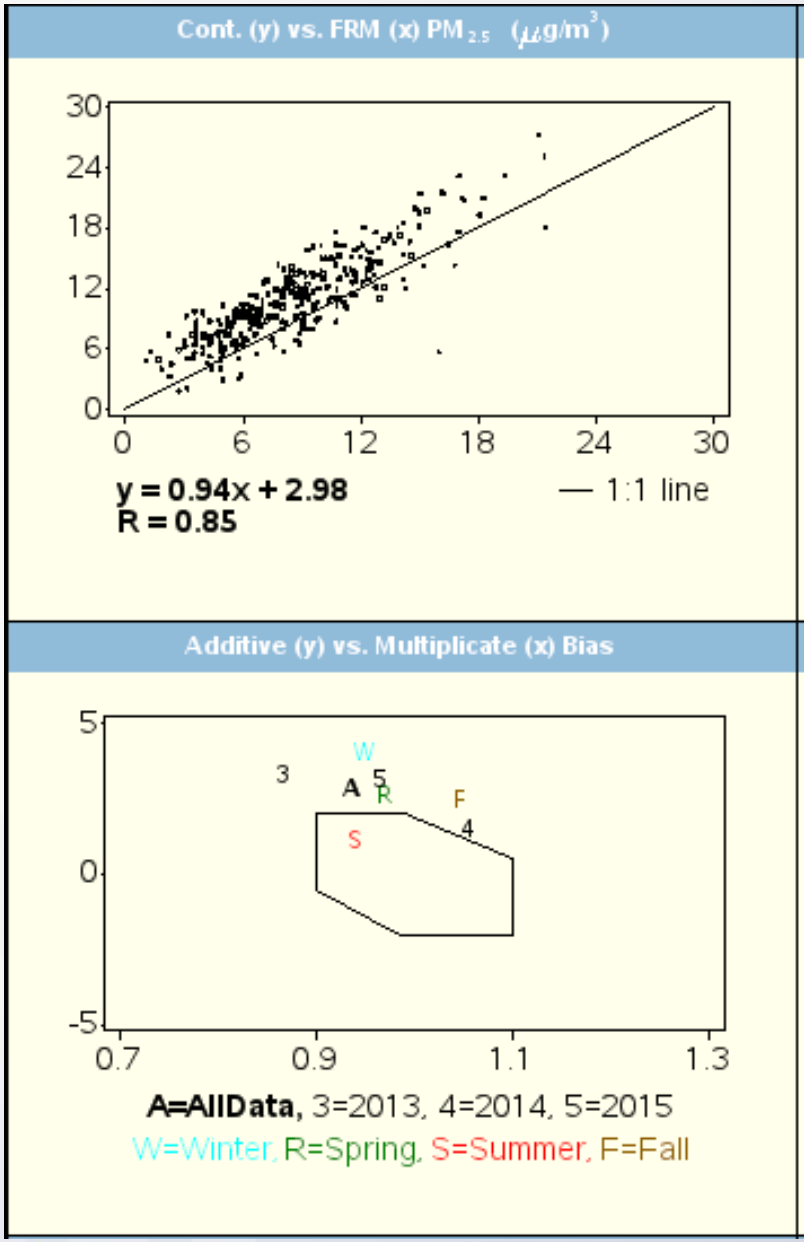
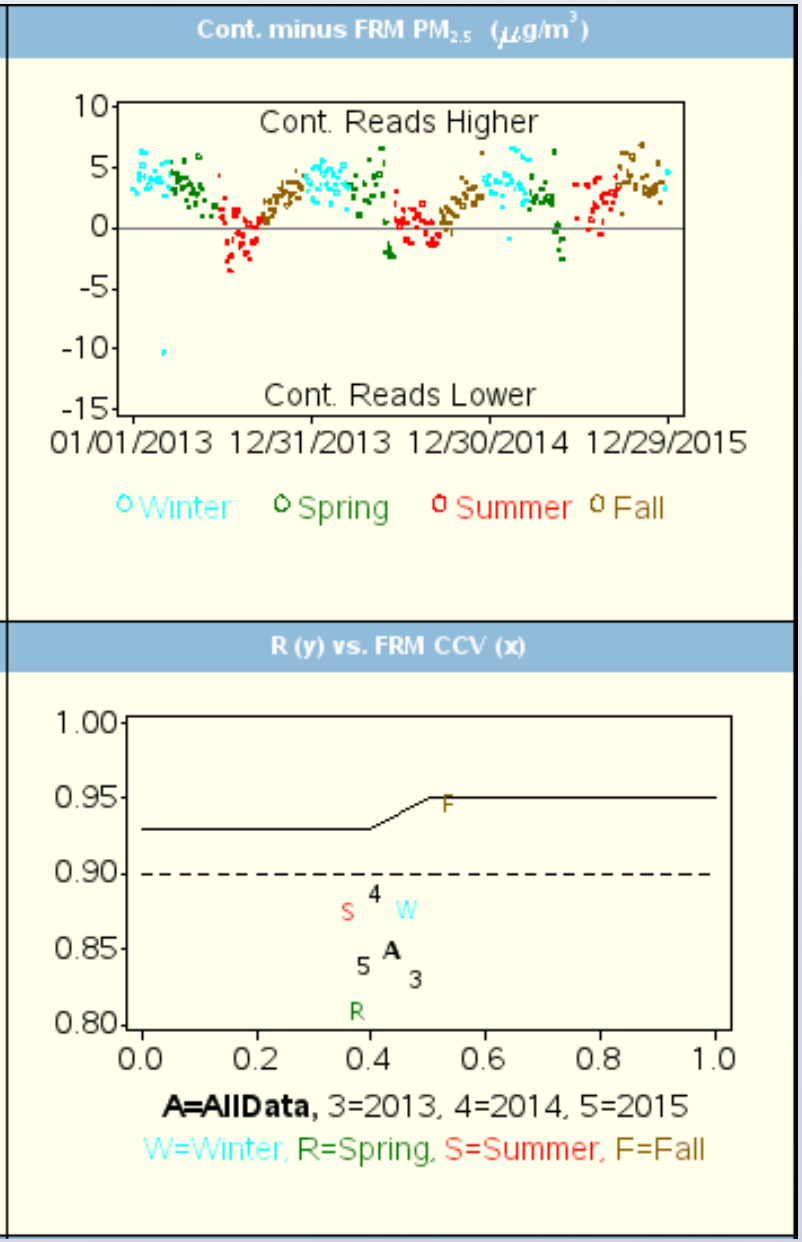
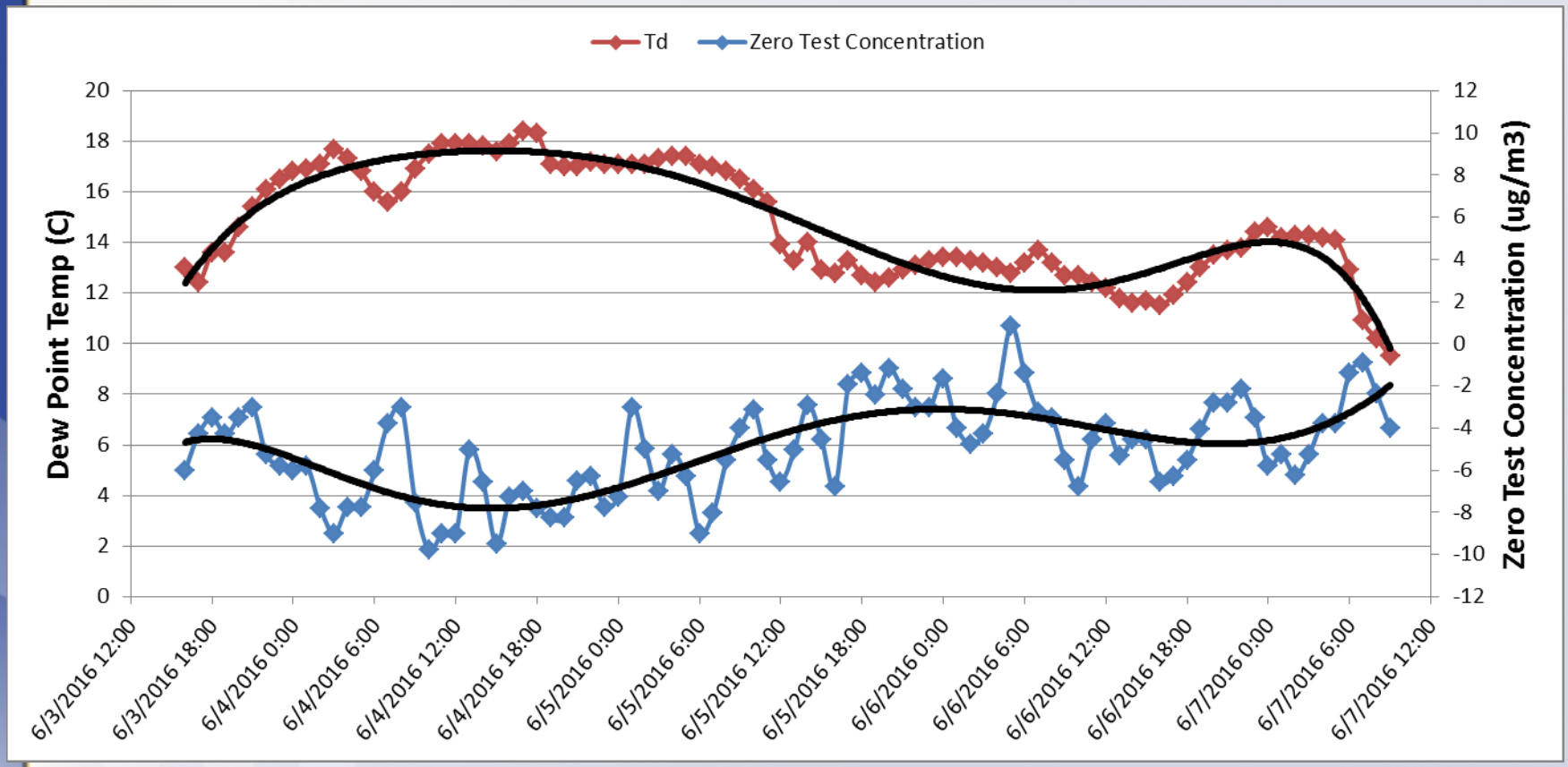




Source: EPA PM2.5 Continuous Monitor Comparability Assessment Tool
https://www3.epa.gov/airquality/airdata/ad_rep_frmvfem.html



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