$PM_{2.5}$ Monitoring in the U.S.

For AWMA-OS Real-time PM Monitoring Workshop
October 20, 2011
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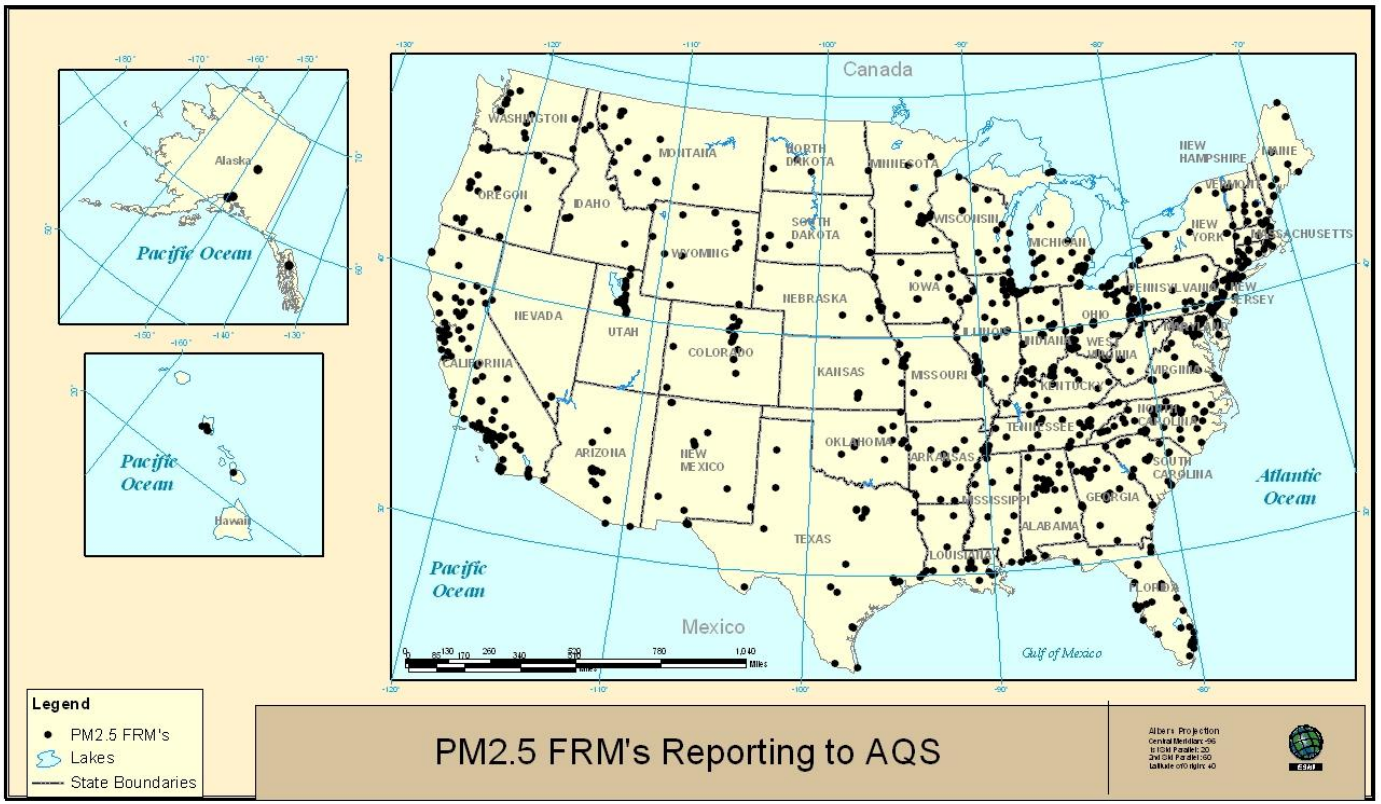
U.S. $PM_{2.5}$ Networks

Networks include three categories of methods:

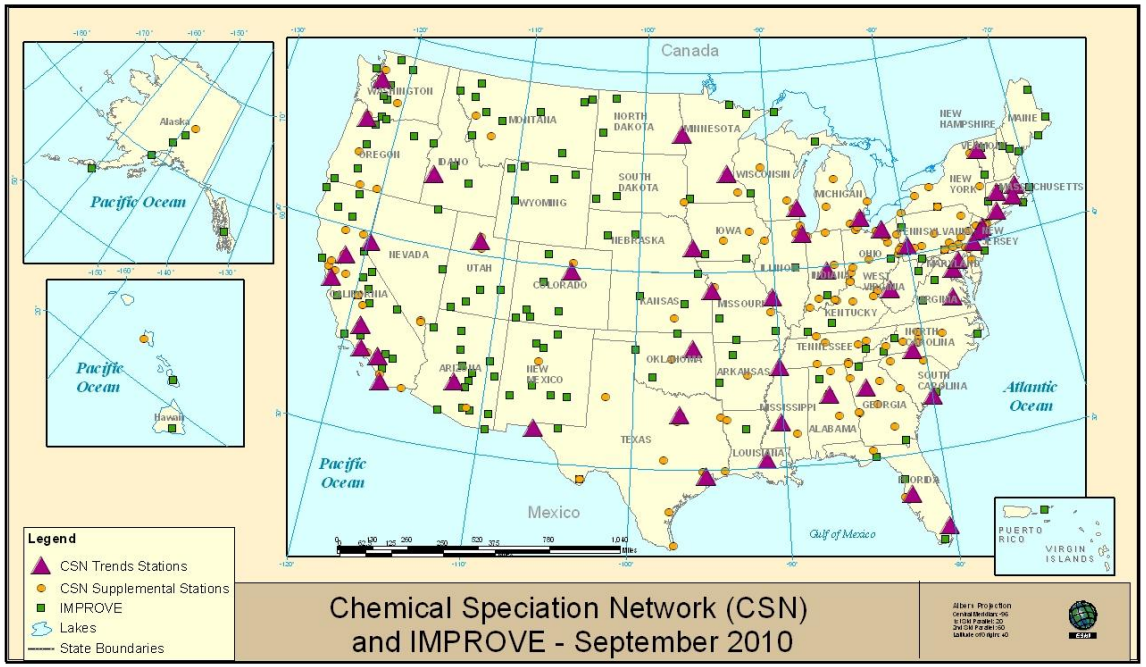
1. Federal Reference Methods (FRMs)
2. Chemical Speciation Networks
    1. CSN (largely urban)
    2. IMPROVE (largely rural and National Parks)
3. **Continuous Monitors**

$PM_{2.5}$ Federal Reference Methods



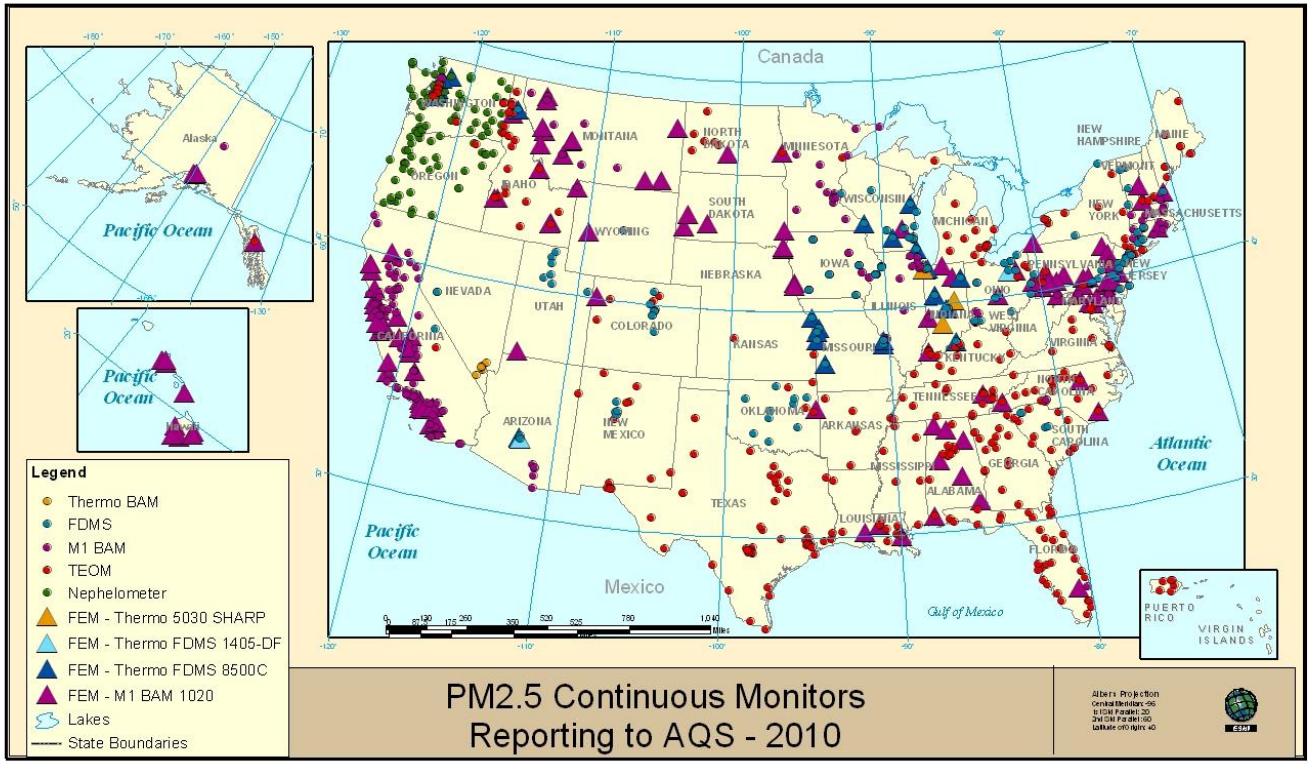
- FRMs are filter-based methods
- Operating at about 900 sites nationally
- Primary objective is to compare to the National Ambient Air Quality Standards (NAAQS); also used in trends analyses
- Typically operate every third or sixth day on a consistent national schedule; some sites operate daily

$PM_{2.5}$ Chemical Speciation Networks
(CSN and IMPROVE)



- Both networks employ similar sampling and analysis methods
  - Three channels: one each for carbon, ions, and elements
- Primary objectives – source apportionment, accountability of control strategies, input to health studies
- CSN is largely urban with ~200 operating sites
  - About 60 sites operate every third day
  - Balance operates every sixth day
- IMPROVE (largely rural and National Parks) ~160 operating sites
  - All operate every third day

$PM_{2.5}$ Continuous Monitoring Sites



- Near-real time data logged in hourly averages
- Operate at about 800 sites nationally
- Primary objective is to support reporting and forecasting of the Air Quality Index (AQI).
- Newly designated FEMs can be compared to the NAAQS

Background – $PM_{2.5}$ Continuous Monitors

- In U.S., monitoring agencies are required to have at least half of their minimally required network operating with a $PM_{2.5}$ continuous monitor; however, not required to be a continuous FEM
- $PM_{2.5}$ continuous monitoring data are primarily used in reporting and forecasting the AQI.

- In the U.S., we have an Ambient Air Monitoring Strategy for State, Local, and Tribal Air Agencies. One of the primary objectives of that strategy is to:

  "Encourage the use of continuous …methods…to provide easy access to timely, high-quality, high-resolution air quality data."
- Monitoring Final Rule in 2006 included new performance criteria and testing requirements for approval of $PM_{2.5}$ Class III continuous Methods
- Six $PM_{2.5}$ continuous methods have been approved as Class III FEMs.

Approved $PM_{2.5}$ Class III FEMs

- Met One:
  - BAM-1020 Monitor – EQPM-0308-**170**

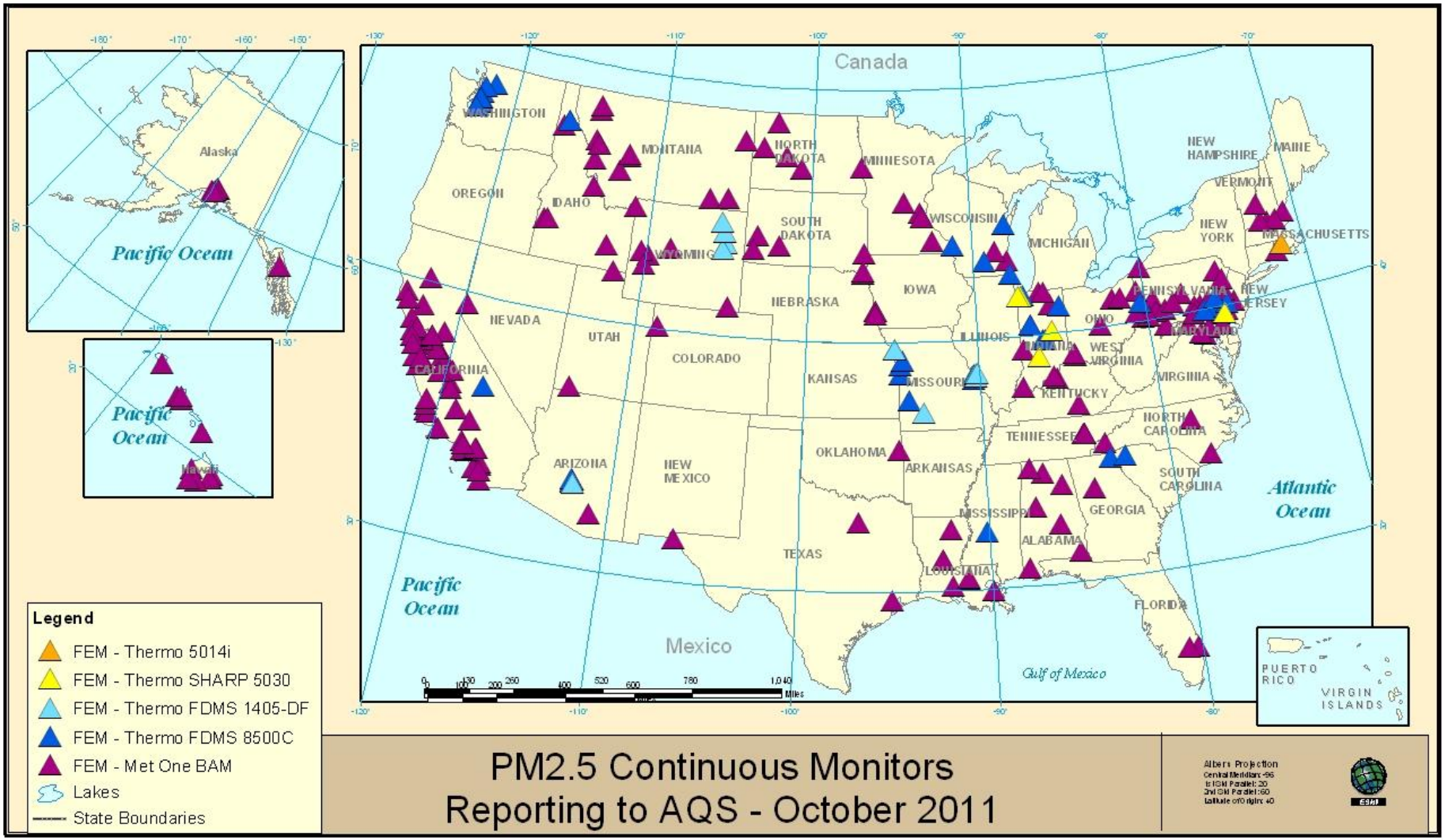
- Thermo Scientific:
  - Series 8500C FDMS – EQPM-0609-**181**
  - 1405-DF FDMS – EQPM-0609-**182**

  - Model 5014i or FH62C14-DHS – EQPM-0609-**183**
  - Model 5030 SHARP – EQPM-0609-**184**

- GRIMM:
  - Model EDM 180 $PM_{2.5}$ Monitor – EQPM-0311-**195**

Summary of $PM_{2.5}$ FEMs in the United States reporting to our database:

Method Description	Method Code	Monitors Reporting to AQS – Oct. '11
Met One BAM-1020	170	195
Thermo 8500C FDMS	181	36
Thermo 1405-DF FDMS	182	10
Thermo 5014i or FH62C14-DHS	183	1
Thermo 5030 SHARP	184	5
GRIMM EDM 180	195	0
Totals		247



Only continuous FEMs are mapped

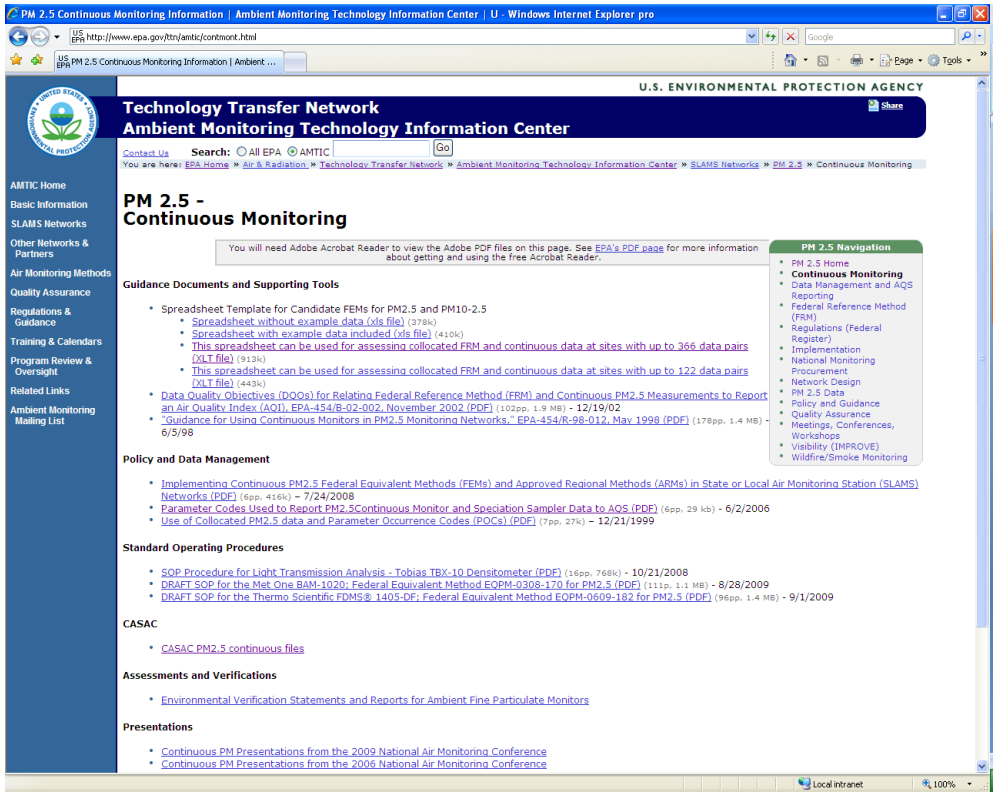
What considerations are monitoring agencies making when selecting a $PM_{2.5}$ continuous FEM for their network?

- Is the FEM data sufficiently comparable to a collocated FRM when operated by the monitoring agency?
- Ease of use (e.g., maintenance)
- Support from the instrument company
- Experience with the technology
- Cost
  - Capital
  - On-going
- Noise of the hourly data
- Logistics (size of unit, inside versus outside shelter, special installation considerations…)

Our Web site has several tools and supporting documents available for monitoring agencies.

http://www.epa.gov/ttn/amtic/contmont.html

- **Assessment Spreadsheets**
- **Draft SOPs** -
  - Met One BAM 1020
  - Thermo 1405DF FDMS
  - Thermo 8500C FDMS – (Available soon)
- **Guidance and technical notes**



Activities to support optimizing operation of $PM_{2.5}$ continuous FEMs:

Completed:

- Reach out to instrument manufactures to inform them of mixed data quality and ask for input on how to best resolve issues that can be resolved.
- Consensus SOPs (draft) for most commonly used FEMs
- Reach out to users on their experiences with FEMs where there is little data (e.g., GRIMM)

In Progress:

- Need for quick assessment that an agency can initiate on the quality of their data compared to DQOs and Part 53 FEM criteria?
- Communicate results of assessments to monitoring agencies.
- Solicit detailed FEM operational information through questionnaire.

Future:

- **Development of a concise and straightforward document on what to do if your data quality is suspect or not acceptable?** This would be a best practices document, providing recommendations from instrument companies and key insights learned from monitoring agencies.
- **Longer term - develop instrument specific Technical Systems Audit (TSA) checklists.**
- Develop confidence interval around NAAQS decision given FEM data quality as found.
- Do we need to update our Technical Note on data reporting?
- Other?

Assessments

Assessments that follow are part of a memo to the PM NAAQS docket:

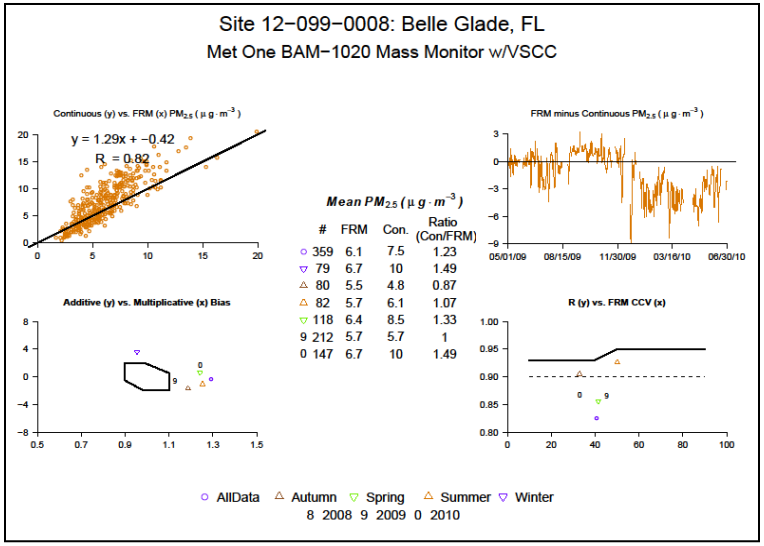
Assessment of $PM_{2.5}$ FEMs Compared to Collocated FRMs; Tim Hanley and Adam Reff, OAQPS; PM NAAQS Docket, EPA - HQ - OAR - 2007 - 0492

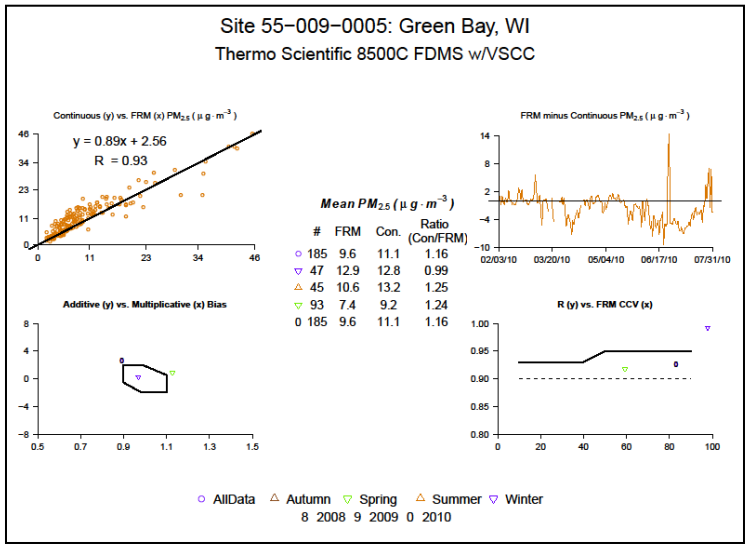
- Memo is available at: http://www.epa.gov/ttn/naaqs/standards/pm/data/HanleyandReff040711.pdf

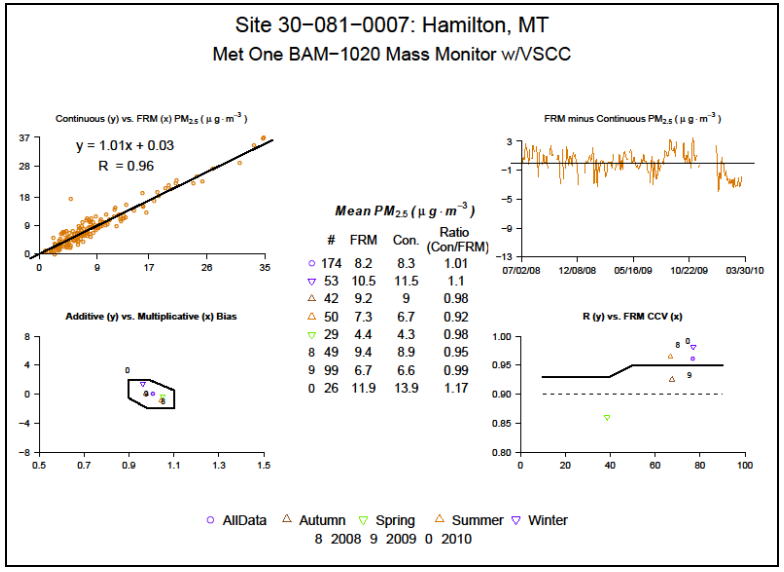
- Detailed one page assessments are available at: http://www.epa.gov/ttn/analysis/pm.htm
  - Met One BAM 1020 Assessments - 61 sites
  - Thermo Scientific Ambient Particulate Monitor with Series 8500C FDMS Assessments - 17 sites
  - Thermo Scientific Model 5030 SHARP Assessments - 2 sites

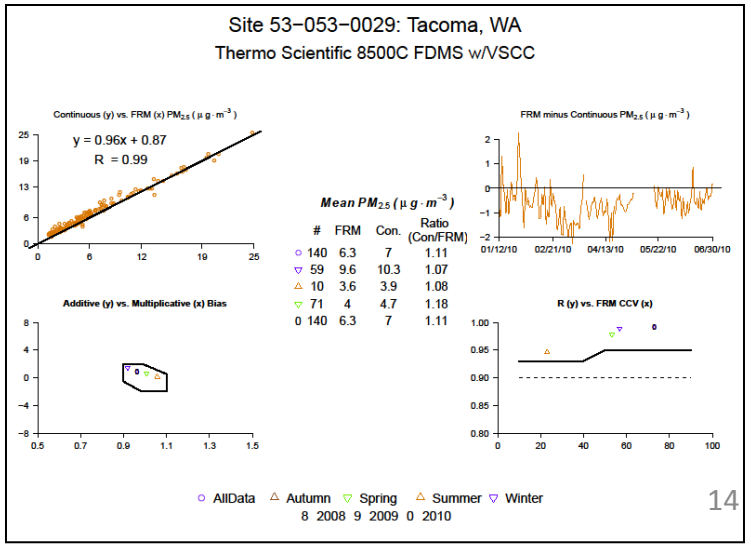
Also, new automated assessment tool is being developed.

Information is available to assess comparability of $PM_{2.5}$ FEM data to collocated FRMs









Example of using an assessment to troubleshoot a Met One BAM FEM

(initial thoughts; not an exhaustive list):

	Too High	Too Low
Slope	1. Verify flow rate 2. Check that smart heater is operating when RH is above 35% 3. Ensure that RH sensor is calibrated correctly (the RH sensor can be biased if calibrated with the monitor recently on)	1. Verify flow rate 2. Verify that beta source has not changed significantly
Intercept	1. Check and verify zero test; ensure entered correctly in instrument 2. Check data in instrument compared to central data logger (especially if using analog outputs)	Same Checks
Correlation	NA	1. Verify nozzle has been cleaned at regular intervals 2. Verify leak tests have been performed
Other Key Checks	1. Ensure downtube is grounded; 2. Ensure stability of shelter temperature; 3. Ensure shelter temp is not set too low. 4. Ensure time stamp is correct.	

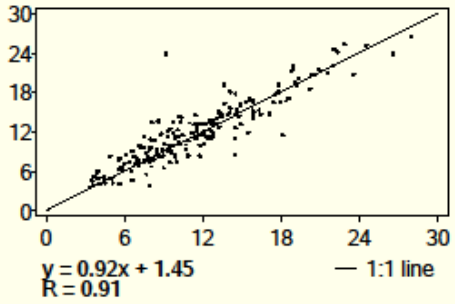
New automated assessment tool being developed

$PM_{2.5}$ Continous Monitor Comparability Assessment

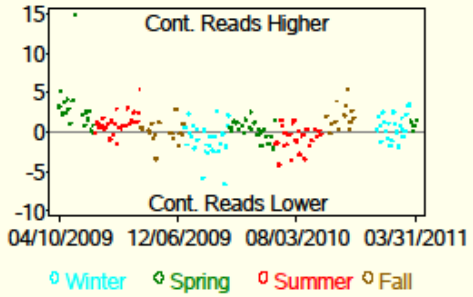
Site 18-105-0003: Bloomington, IN

FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC-Gravimetric (145), PM2.5 - Local Conditions (88101)
Cont: Thermo Scientific Model 5030 SHARP w/VSCC-Beta Attenuation (184), PM2.5 - Local Conditions (88101)

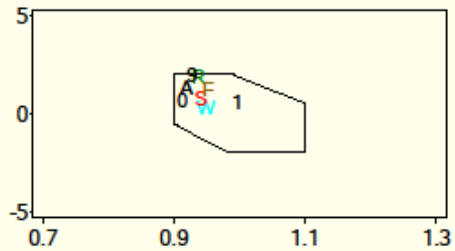
Cont. (y) vs. FRM (x) $PM_{2.5}$ ($\mu g/m^3$)



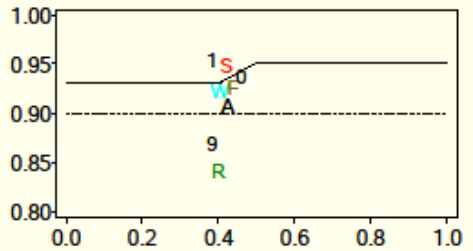
Cont. minus FRM $PM_{2.5}$ ($\mu g/m^3$)



Additive (y) vs. Multiplicate (x) Bias



R (y) vs. FRM CCV (x)



Mean $PM_{2.5}$ ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**193**	**11.6**	**12.2**	**1.04**
Winter	52	12.8	12.5	0.98
Spring	50	10.3	11.7	1.13
Summer	59	12.4	12.7	1.02
Fall	32	10.4	11.3	1.09
2009	73	11.1	12.5	1.12
2010	92	11.9	11.7	0.98
2011	28	12.0	12.8	1.06

Appendix A Statistics

Dataset	N (all observations)	Bias	N (only >= 3 ug/m^3)	Bias
AllData	**193**	**6.9**	**193**	**6.9**
Winter	52	-0.4	52	-0.4
Spring	50	15.9	50	15.9
Summer	59	3.3	59	3.3
Fall	32	11.3	32	11.3
2009	73	14.3	73	14.3
2010	92	0.7	92	0.7
2011	28	7.6	28	7.6

Data Source: EPA AQS Data Mart

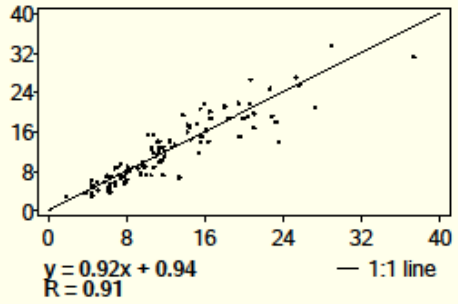
Generated on: October 18, 2011

$PM_{2.5}$ Continous Monitor Comparability Assessment

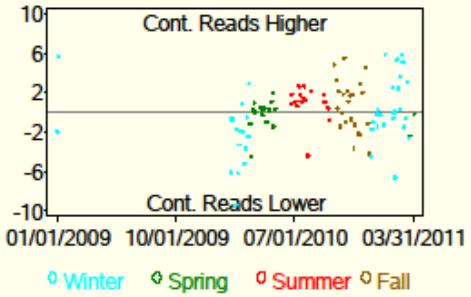
Site 18-089-2004: Hammond, IN

FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC-Gravimetric (145), PM2.5 - Local Conditions (88101)
Cont: Thermo Scientific Model 5030 SHARP w/VSCC-Beta Attenuation (184), PM2.5 - Local Conditions (88101)

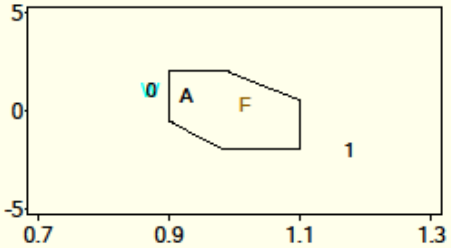
Cont. (y) vs. FRM (x) $PM_{2.5}$ ($\mu g/m^3$)



Cont. minus FRM $PM_{2.5}$ ($\mu g/m^3$)

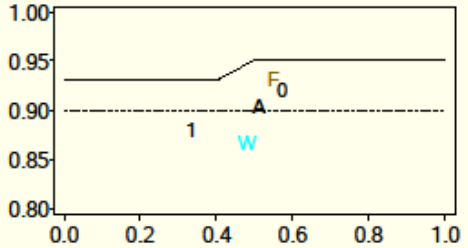


Additive (y) vs. Multiplicate (x) Bias



A=AllData, 9=2009, 0=2010, 1=2011
W=Winter, R=Spring, S=Summer, F=Fall

R (y) vs. FRM CCV (x)



A=AllData, 9=2009, 0=2010, 1=2011
W=Winter, R=Spring, S=Summer, F=Fall

Mean $PM_{2.5}$ ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**100**	**12.5**	**12.5**	**1.00**
Winter	42	14.4	13.8	0.96
Spring	18	9.1	8.7	0.96
Summer	17	11.8	12.7	1.08
Fall	23	12.4	13.1	1.05
2009	2	11.7	13.5	1.15
2010	74	12.1	11.8	0.98
2011	24	14.0	14.7	1.05

Appendix A Statistics

Dataset	N (all observations)	Bias	N (only >= 3 ug/m^3)	Bias
AllData	**100**	**1.1**	**99**	**0.5**
Winter	42	-4.0	42	-4.0
Spring	18	-2.1	17	-5.8
Summer	17	10.1	17	10.1
Fall	23	6.2	23	6.2
2009	2	9.8	2	9.8
2010	74	0.1	73	-0.7
2011	24	3.3	24	3.3

Data Source: EPA AQS Data Mart

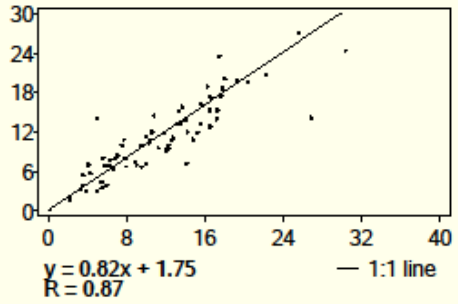
Generated on: October 18, 2011

$PM_{2.5}$ Continous Monitor Comparability Assessment

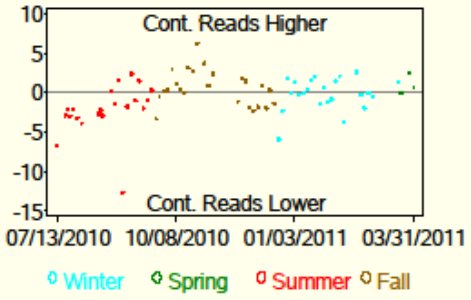
Site 18-095-0011: Anderson, IN

FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC-Gravimetric (145), PM2.5 - Local Conditions (88101)
Cont: Thermo Scientific Model 5030 SHARP w/VSCC-Beta Attenuation (184), PM2.5 - Local Conditions (88101)

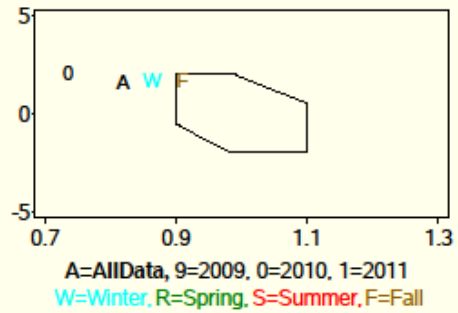
Cont. (y) vs. FRM (x) $PM_{2.5}$ ($\mu g/m^3$)



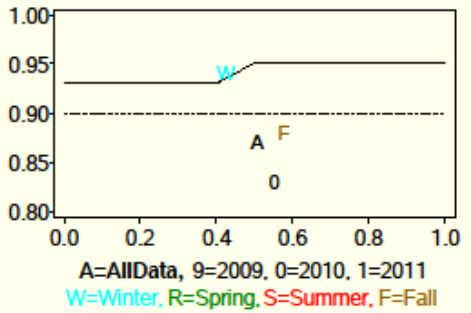
Cont. minus FRM $PM_{2.5}$ ($\mu g/m^3$)



Additive (y) vs. Multiplicate (x) Bias



R (y) vs. FRM CCV (x)



Mean $PM_{2.5}$ ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	73	11.6	11.3	0.97
Winter	23	14.3	14.2	0.99
Spring	3	13.9	15.0	1.07
Summer	22	10.7	8.5	0.79
Fall	25	9.8	10.7	1.09
2009	0	.	.	.
2010	51	10.7	10.1	0.94
2011	22	13.9	14.1	1.02

Appendix A Statistics

Dataset	N (all observations)	Bias	N (only >= 3 ug/m^3)	Bias
AllData	73	1.1	70	2.4
Winter	23	1.6	23	1.6
Spring	3	12.2	3	12.2
Summer	22	-18	20	-16
Fall	25	15.8	24	17.2
2009	0	.	.	.
2010	51	-0.3	48	1.4
2011	22	4.4	22	4.4

Data Source: EPA AQS Data Mart

Generated on: October 18, 2011

Summary

- Successful use of $PM_{2.5}$ continuous monitors is desired
- Several method options to choose from…
  - Advantages and disadvantages to each option
- Success of operating any method is dependent on a number of factors
  - e.g., siting, instrument set-up, HVAC control of shelter, maintenance, validation of data
- Although automated, $PM_{2.5}$ continuous FEM methods still require operators and data analysts to pay attention to the details
- Examples of success exist, but cases with poor data comparability do as well
- More information sharing on best practices is needed
- Automated assessments will help