

PM_{2.5} Continuous Monitoring

Program Objectives, History, Requirements, and Flexibility

National Ambient Air Monitoring Conference

Atlanta 2014



Program Objectives, History, Requirements, and Flexibility

- ✓ What will we cover?
 - ✓ For topics we won't cover, where can that information be found?
- ✓ Additional Resources on Best Practices for PM_{2.5} Continuous Monitoring
- ✓ Monitoring Objectives
- ✓ Implementation History
- ✓ Regulatory Requirement to Operate PM_{2.5} Continuous Monitors
- ✓ PM_{2.5} Continuous Method Approval Categories
- ✓ Appendix A (QA/QC)
- ✓ When are PM_{2.5} Continuous FEM data used in NAAQS calculations? When are they excluded?
- ✓ Network Design Considerations
- ✓ Probe and Siting Criteria
- ✓ Key Data Reporting Elements
- ✓ PM_{2.5} and the AQI
- ✓ How to handle real-time reporting of the AQI when there are changes in PM_{2.5} concentrations throughout the day?
- ✓ AQS Data Reporting
- ✓ Summary



For topics we won't cover, where can that information be found?

Topic	Where to find?
✓ Hands on training	Ask instrument manufacturers <ul style="list-style-type: none">- Training may already be scheduled- Invite instrument company technical staff to your agency or regional/multi-state workshop
✓ Detailed Method Presentations	Many of these are archived from previous National Monitoring Conferences and are available on the web at: http://www.epa.gov/ttn/amtic/contmont.html (scroll to the bottom of the page)
✓ Detailed information on how EPA developed the Performance criteria for acceptance of Class III PM _{2.5} continuous methods	Available in CASAC files on the web at: http://www.epa.gov/ttn/amtic/casacinf.html#cont Also explained in January 16 th , 2006 Monitoring Proposal and October 17 th , 2006 Monitoring Final Rule on the web at: http://www.epa.gov/ttn/amtic/40cfr53.html



Additional Resources on Best Practices for PM_{2.5} Continuous Monitoring

- Instrument Company Documentation
 - Operation Manuals, Technical Bulletin's, Presentations

- Other Monitoring Agencies; Multi-State and Regional Workshops:
 - Assessments, SOPs, Checklists, additional presentations

- EPA (largely on AMTIC at: <http://www.epa.gov/ttn/amtic/contmont.html>)
 - Guidance Documents, Assessment tools
 - Policy and Data Management, SOPs, CASAC files
 - Monitoring Requirements
 - FEM approvals in 40 CFR Part 53
 - Monitoring requirements in 40 CFR Part 58



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PM 2.5 - Continuous Monitoring

You will need Adobe Acrobat Reader to view the Adobe PDF files on this page. See [EPA's PDF page](#) for more information about getting and using the free Acrobat Reader.

Guidance Documents and Supporting Tools

- [PM2.5 continuous monitor comparability assessment tool](#)
 - [Technical Note - PM2.5 Continuous Monitor Comparability Assessment \(PDF\)](#) (4pp, 150k) - 2/22/12
- [Spreadsheet Template for Candidate FEMs for PM2.5 and PM10-2.5](#)
 - [Spreadsheet without example data \(xls file\)](#) (378k)
 - [Spreadsheet with example data included \(xls file\)](#) (410k)
 - [This spreadsheet can be used for assessing collocated FRM and continuous data at sites with up to 366 data pairs \(XLT file\)](#) (913k)
 - [This spreadsheet can be used for assessing collocated FRM and continuous data at sites with up to 122 data pairs \(XLT file\)](#) (443k)
- [Data Quality Objectives \(DQOs\) for Relating Federal Reference Method \(FRM\) and Continuous PM2.5 Measurements to Report an Air Quality Index \(AQI\), EPA-454/B-02-002, November 2002 \(PDF\)](#) (102pp, 1.9 MB) - 12/19/02
- "Guidance for Using Continuous Monitors in PM2.5 Monitoring Networks," EPA-454/R-98-

Policy and Data Management

- [Instructions and Template for Requesting that data from PM2.5 Continuous FEMs are not compared to the NAAQS \(Microsoft Word\)](#) (17pp, 1.2 MB) - 10/28/2013
 - [Memo \(PDF\)](#) (1pg, 402k)
- [Implementing Continuous PM2.5 Federal Equivalent Methods \(FEMs\) and Approved Regional Methods \(ARMs\) in State or Local Air Monitoring Station \(SLAMS\) Networks \(PDF\)](#) (6pp, 416k) - 7/24/2008
- [Parameter Codes Used to Report PM2.5 Continuous Monitor and Speciation Sampler Data to AQS \(PDF\)](#) (6pp, 29 kb) - 6/2/2006
- [Use of Collocated PM2.5 data and Parameter Occurrence Codes \(POCs\) \(PDF\)](#) (7pp, 27k) - 12/21/1999

Standard Operating Procedures

- [DRAFT SOP for the Met One BAM-1020; Federal Equivalent Method EQPM-0308-170 for PM2.5 \(PDF\)](#) (111p, 1.1 MB) - 8/28/2009
 - [Technical Note - Met One BAM Zero Tests \(PDF\)](#) (3pp, 280k) - 10/05/2012
- [DRAFT SOP for the Thermo Scientific FDMS@ 1405-DF; Federal Equivalent Method EQPM-0609-182 for PM2.5 \(PDF\)](#) (96pp, 1.4 MB) - 9/1/2009
- [DRAFT SOP for the Thermo Scientific 1400a Ambient Particulate Monitor with 8500C FDMS@; Federal Equivalent Method EQPM-0609-181 for PM2.5 \(PDF\)](#) (101pp, 2.5 MB) - 3/1/2011

CASAC

- [CASAC PM2.5 continuous files](#)

Assessments and Verifications

- [Environmental Verification Statements and Reports for Ambient Fine Particulate Monitors](#)

Presentations

- [National Air Quality Conference - Ambient Air Monitoring 2012: Best Practices for Operating PM2.5 Continuous FEMs](#)
- [Continuous PM Presentations from the 2009 National Air Monitoring Conference](#)

- PM 2.5 Navigation**

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➤ EPA AMTIC at:
<http://www.epa.gov/ttn/amtic/contmont.html>

- Guidance Documents & Assessment tools
- Policy and Data Management
- SOPs
- CASAC files
- Assessments/verifications (ETV)
- Presentations



Standard Operating Procedures (SOPs)

- Consensus SOPs are available for three PM_{2.5} continuous FEMs:
 - DRAFT - Met One BAM-1020; Federal Equivalent Method EQPM-0308-170 for PM2.5 (111p) - 8/28/2009
 - DRAFT - Thermo Scientific FDMS® 1405-DF; Federal Equivalent Method EQPM-0609-182 for PM2.5 (96pp) - 9/1/2009
 - DRAFT - Thermo Scientific 1400a Ambient Particulate Monitor with 8500C FDMS®; Federal Equivalent Method EQPM-0609-181 for PM2.5 (101pp) - 3/1/2011
- SOPs were developed with input from monitoring agency stakeholders three years ago.
- Available at:
<http://www.epa.gov/ttn/amtic/contmont.html>

**Standard Operating Procedure for the Continuous
Measurement of Particulate Matter**

Met One BAM-1020 PM_{2.5} Federal Equivalent Method EQPM-0308-170

STI-905505.05-3645-SOP

AUTHOR: _____ Date _____

APPROVED: _____ Date _____

Manager _____ Date _____

Quality Assurance Manager _____ Date _____



Select Previous Conference Sessions on PM_{2.5} Continuous Monitoring - 2006 and 2008 Conferences

Conference	Session	Instruments Covered	Topics Addressed	URL
2006 National Air Monitoring Conference – Las Vegas TN	Air Monitoring Instrumentation – Continuous PM Monitors	<ul style="list-style-type: none"> ➤ TEOM FDMS ➤ Met One BAM 1020 	<ul style="list-style-type: none"> ➤ History, Regs., FEM/ARM performance criteria, Field testing requirements, parameter codes ➤ Setup, Operation, and maintenance 	http://www.epa.gov/ttn/amtic/2006present.html
2008 National Air Quality Conference – Portland OR <i>Note: material in this session was presented by monitoring agency staff</i>	Continuous PM _{2.5} Monitoring Issues	<ul style="list-style-type: none"> ➤ FDMS ➤ Met One BAM 1020 ➤ Nephelometers 	<ul style="list-style-type: none"> ➤ Specific PM_{2.5} continuous methods (tips on configuration, operation, maintenance, calibration and audit, data interpretation) 	http://airnow.gov/index.cfm?action=naq_conf_2008.aq



Select Previous Conference Sessions on PM_{2.5} Continuous Monitoring - 2009 and 2012 Conferences

Conference	Session	Instruments Covered	Topics Addressed	URL
2009 National Ambient Air Monitoring Conference – Nashville TN	Continuous PM Mass Instrument Training Session	Thermo: <ul style="list-style-type: none"> ➤ TEOM 1405-DF, ➤ TEOM 1400ab with 8500C, ➤ SHARP (5030), ➤ FH62C14-DHS Beta Monitor Met One: <ul style="list-style-type: none"> ➤ BAM 1020 Grimm: <ul style="list-style-type: none"> ➤ Model 180 	<ul style="list-style-type: none"> ➤ Method Descriptions ➤ FEM Field Testing ➤ Development Status ➤ Tips for operation and maintenance ➤ Operational Key Points 	http://www.epa.gov/ttn/amtic/2009present.html
National Air Quality Conference – Monitoring 2012 – Denver CO	Best Practices for Operating PM _{2.5} Continuous FEMs - Training Session	GRIMM: <ul style="list-style-type: none"> ➤ EDM 180 Met One: <ul style="list-style-type: none"> ➤ BAM 1020 Thermo: <ul style="list-style-type: none"> ➤ FDMS-TEOM 1405 F ➤ FDMS-TEOM 1405 DF ➤ FDMS-TEOM 1400/8500C FDMS <ul style="list-style-type: none"> ➤ 5014i Beta Monitor ➤ 5030 SHARP Monitor 	This session focused on the most important operational practices necessary to provide data of optimum quality.	http://www.epa.gov/ttn/amtic/2012present.html



What do we say about PM_{2.5} Continuous Monitors in our Monitoring Strategy?

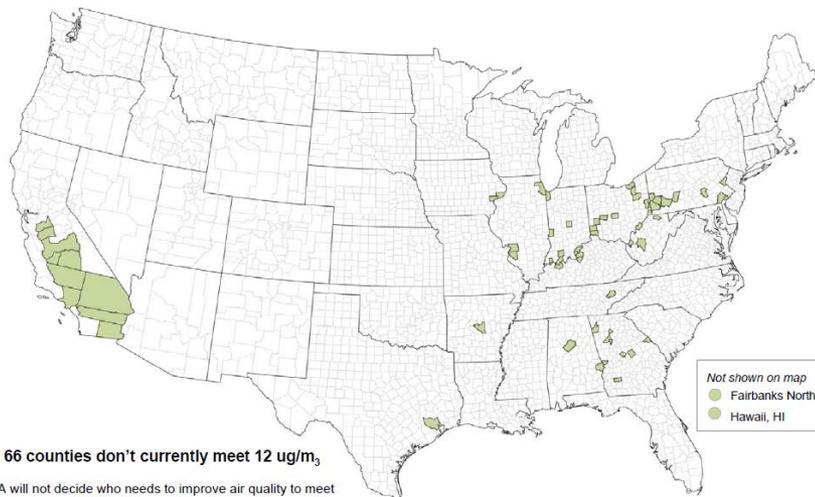
- In the U.S., we have an Ambient Air Monitoring Strategy for State, Local, and Tribal Air Agencies. One of the primary objectives of that strategy is to:
“Encourage the use of continuous ...methods...to provide easy access to timely, high-quality, high-resolution air quality data.”
- Strategy is intended to help facilitate a more balanced approach to filter-based and well performing continuous methods



Major Monitoring Objectives for PM_{2.5} Continuous Monitors

Comparison to NAAQS

Most of the U.S. Already Meets the Annual Fine Particle Health Standard of 12 $\mu\text{g}/\text{m}^3$



66 counties don't currently meet 12 $\mu\text{g}/\text{m}^3$
EPA will not decide who needs to improve air quality to meet the standard until 2014 at the earliest. States will have until 2020-2025 to meet the standard.

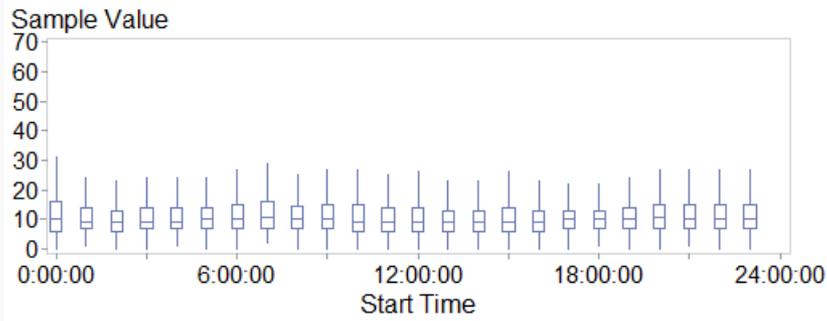
Source: 2009-2011 air quality data as of July 15, 2012
For more information: www.epa.gov/pm



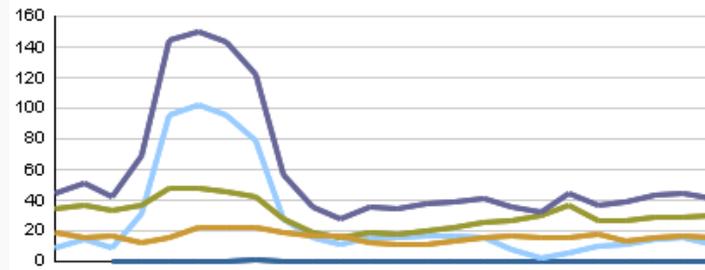


Other Monitoring Objectives

Diurnal Characterization of PM_{2.5}



Comparison with other pollutant data

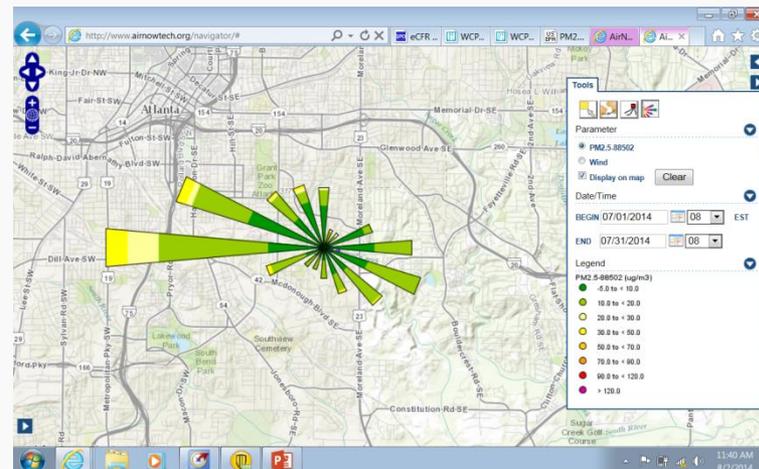


Use in atmospheric and health studies



Daily Data	
Sample Frequency	Samples per year
Daily	365
1:3	122
1:6	61

Pollution Roses



Available now on AIRNowTech



PM_{2.5} Continuous Monitoring Implementation History

PM_{2.5} NAAQS

1997 - PM_{2.5} NAAQS established;
- PM_{2.5} continuous monitors included in network design requirements

- Requirements for approval of PM_{2.5} continuous FEMs not included in this rule

2006 – 24-hour PM_{2.5} NAAQS strengthened to 35 µg/m³

2012 – Annual PM_{2.5} NAAQS strengthened to 12.0 µg/m³

Air Quality Index (AQI)

1999 - AQI Final Rule with PM_{2.5} (previously PSI)

2004 – AQI goes year round on AIRNow with PM_{2.5}

2012 – Corresponding changes to AQI to conform with PM_{2.5} NAAQS changes

PM_{2.5} Continuous FEMs

2006 – Criteria for approval of Class III continuous PM_{2.5} monitors available for the first time

2008 – First PM_{2.5} Continuous FEM approved

2012 - Flexibility added to allow exclusion of certain PM_{2.5} continuous data from NAAQS



Regulatory Requirement to Operate PM_{2.5} Continuous Monitors?

- **Appendix D to 40 CFR Part 58. Section 4.7.2:**

“The State, or where appropriate, local agencies must operate continuous PM_{2.5} analyzers equal to at least one-half (round up) the minimum required sites listed in Table D-5 of this appendix. At least one required continuous analyzer in each MSA must be collocated with one of the required FRM/FEM/ARM monitors, unless at least one of the continuous FEM or ARM monitor is itself a continuous FEM or ARM, in which no collocation requirement applies. State and local air monitoring agencies must use methodologies and quality assurance/quality control (QA/QC) procedures approved by the EPA Regional Administrator for these required continuous analyzers”.

Key points:

1. There is a requirement to have PM_{2.5} continuous monitors
2. There must be some collocation with FRMs
3. Methods and QA/QC are to be approved by the Regional Office



PM_{2.5} Continuous Method Approval Categories

Pre-FEM PM_{2.5} = Methods not approved as FEM or ARM, but can be used to meet PM_{2.5} monitoring requirements

FEM = Federal Equivalent Method

ARM = Approved Regional Method

Element	Pre-FEM PM _{2.5}	FEM	ARM ⁽¹⁾
Approved by EPA-ORD	No	Yes	Yes
Data corrections allowed (user initiated)	Yes	No	<i>If incorporated into testing used to approve method</i>
Can be used to meet PM _{2.5} continuous monitoring requirement	Yes	Yes	Yes
Appendix A requirements apply	No	Yes	Yes
Regional Office Approvals:			
- Annual Monitoring Plan ²	Yes	Yes	Yes
- SOP	Yes	Yes	Yes

- ARM PM_{2.5} Continuous Monitors (None exist!)
 - EPA Office of Research and Development formally approves; can be used in the networks where it was tested and met performance criteria
 - Other agencies may request use through testing and approval from their Regional Office.
- Annual monitoring plans should clearly state when PM_{2.5} continuous are not intended for comparison to the NAAQS



Appendix A and PM_{2.5} Continuous Monitors

(Note: some of these requirements are identified in Appendix C or D)

Requirement	Pre-FEM PM _{2.5}	Primary FEM	ARM
Monthly Flow Verifications	Not required, but a good idea	Yes	Yes
Semi-Annual Flow Audits	Not required, but a good idea	Yes	Yes
Performance Evaluation Audits	Not required, but data often available	Yes	Yes
Collocation with FRM	Yes (from App. D)	Yes – At least 1 site When network has x continuous FEM monitors of same make and model. X = 1-16; 1 required X = 17 – 29; 2 required	At least 1 and 30% of required SLAMS
Required collocation with same make and model of continuous method	Not required	When network has x continuous FEM monitors of same make and model. X = 1-9; 0 required X = 10 – 23; 1 required X = 24 – 36; 2 required	At least 1
Include in Technical System Audits (TSA's)	Yes	Yes	Yes



When are PM_{2.5} Continuous FEM data used in NAAQS calculations? When are they excluded?

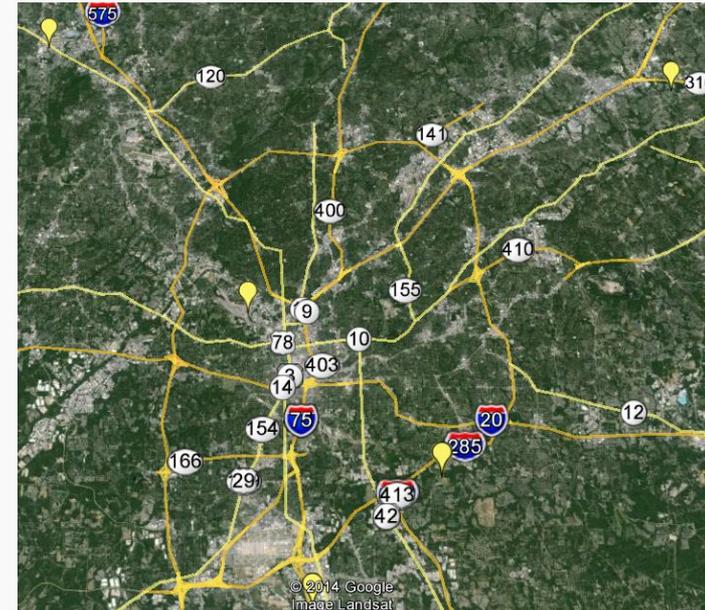
- PM_{2.5} Continuous FEM data are used in NAAQS calculations when:
 - Identified as the primary monitor or only monitor reporting at a site
 - The primary monitor does not have valid data available for a given day

- PM_{2.5} Continuous FEM data are not used in NAAQS calculations:
 - When identified as a Special Purpose Monitor (SPM) with a NAAQS exclusion
 - Regional Office must concur on exclusion
 - Policy allows exclusion for up to the first 24 months of operation.
 - On days when another method (FRM or other FEM) identified as the primary sampler has valid data.
 - e.g., An FRM operating on a 1:1 sample schedule
 - When a data exclusion request has been approved by the Regional office per § 58.11(e)
 - **Note: data meeting performance criteria cannot be excluded.**
 - Data with this exclusion are moved to a different parameter code.



Network Design Considerations

- ✓ Same requirements as all other PM_{2.5} SLAMS
 - Required monitors are to be at “area-wide” locations.
- ✓ Ideally, include a PM_{2.5} continuous monitor at the design value location of a CBSA for use in AQI reporting
- ✓ PM_{2.5} continuous monitors are required at NCore stations
- ✓ PM_{2.5} continuous monitors sited at near road stations are used in AQI reporting
- ✓ Do you have a paired site that can be a “buddy” site?
Note: multiple sites can be grouped as buddy sites





Probe and Siting Criteria

Appendix E to Part 58.

Description	Criteria
Height from ground to Inlet (meters)	2 - 7 (micro and anything at near road) 2 - 15 (everything else)
Horizontal and vertical distance from supporting structures to inlet (meters)	> 2 (all scales, horizontal distance only)
Distance from tree line (meters) ¹	> 10 meters
Distance from roadways to inlet (meters)	<= 50 for near-road
Collocation distance (meters)	<ul style="list-style-type: none">• 1 – 4 (expected)• Up to 10 with Regional approval at neighborhood and larger scales

1. Should be greater than 20 meters from the dripline of tree(s) and must be 10 meters from the dripline when the tree(s) act as an obstruction.

2. Distance from sampler to obstacle such as a building must be at least twice the height the obstacle protrudes above the sampler.



Key Data Reporting Elements For PM_{2.5} Continuous Monitors

Data Reporting Element	Real Time Reporting via AIRNow	AQS Reporting
Required or Voluntary	Voluntary	Required
When to report	As soon as practicable after the end of the hour	Within 90 days of the end of the quarter
Format	AQCSV	AQS RD transaction
Averaging Time	Hourly	
How many minutes constitute a valid hour?	45 <u>or</u> as identified in approved instrument manual	
Time Period examples (EPA uses start hour to represent the hour)	Hour 0 = 00:00 to 00:59 Hour 23 = 23:00 to 23:59	
Time Stamp	Local Standard Time (year round)	



PM and the AQI

- Appendix G to 40 CFR Part 58 – Uniform Air Quality Index and Daily Reporting
- Levels are based on 24 hours

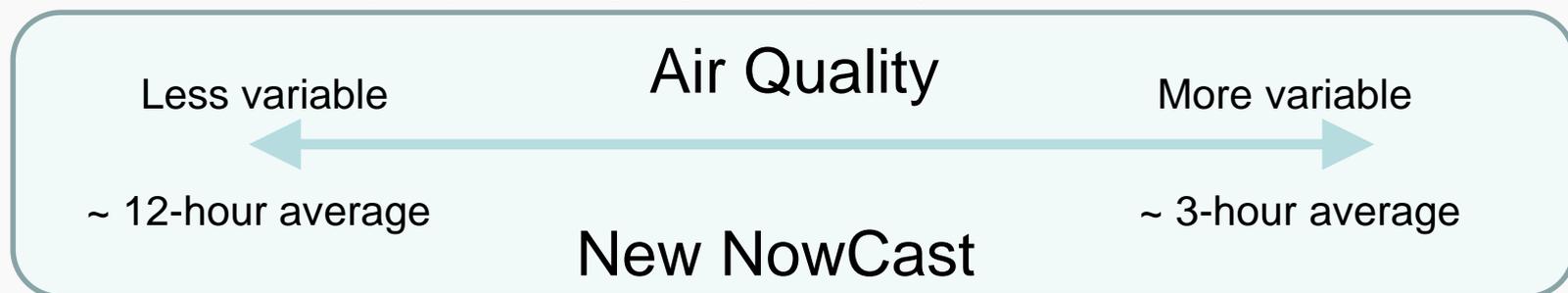
AQI Level	Descriptor	Color	PM _{2.5} Breakpoints (µg/m ³)	PM ₁₀ Breakpoints (µg/m ³)
0 to 50	Good	Green	0.0 – 12.0	0 – 54
51 to 100	Moderate	Yellow	12.1 – 35.4	55 – 154
101 to 150	Unhealthy to sensitive groups	Orange	35.5 – 55.4	155 – 254
151 to 200	Unhealthy	Red	55.5 – 150.4	255 – 354
201 to 300	Very Unhealthy	Purple	150.5 – 250.4	355 – 424
301 and above	Hazardous	Maroon	250.5 – 350.4 350.5 – 500.4	425 – 504 505 - 604



How to handle real-time reporting of the AQI when there are changes in $PM_{2.5}$ concentrations throughout the day?

NowCast:

- AirNow uses a combination of monitor data and air quality projections to show current air quality in the 24-hour AQI form.
- In August 2013, the AirNow program updated the NowCast so it is more responsive to rapidly changing air quality conditions.



- Details are at:
<http://airnow.supportportal.com/link/portal/23002/23002/Article/16118/How-Does-AirNow-Make-the-Current-PM2-5-Air-Quality-Index-AQI-maps>



Computing the NowCast (As used in AIRNow)

1. Compute the concentration range (max-min) over the last 12 hours. This tells us how much the air has changed, but relative to what? We need to scale it.
2. Divide the range by the maximum concentration in the 12-hour period
3. Compute the weight factor by subtracting the scaled rate of change from 1. The weight factor must be between .5 and 1. The minimum limit approximates a 3-hour average. If the weight factor is less than .5 then set it equal to .5.
4. Multiply each hourly concentration by the weight factor raised to the power of how many hours ago the concentration was measured (for the current hour, the factor is raised to the zero power)
5. Compute the NowCast by summing these products and dividing by the sum of the weight factors raised to the power of how many hours ago the concentration was measured.

Example 12-hour period
50 80 75 **90** 82 53 64 74 21 **10** 16 13
Range = 90-10 = 80 ug/m3

Scaled rate of change is 80/90.

Weight factor is $1 - 80/90 = .11 \rightarrow$ less than .5, so use .5

$$13*(.5)^0 + 16*(.5)^1 + 10*(.5)^2 + 21*(.5)^3 + 74*(.5)^4 + \dots$$

$$\frac{13*(.5)^0 + 16*(.5)^1 + 10*(.5)^2 + 21*(.5)^3 + 74*(.5)^4 + \dots}{(.5)^0 + (.5)^1 + (.5)^2 + (.5)^3 + (.5)^4 + \dots}$$

= 17.4 ug/m3



AQS Data Reporting – Parameter Codes

Parameter Name	Parameter Code	Purpose	Used in NAAQS	Used in AQI
PM2.5 Local Conditions	88101	Regulatory Data Reporting for FRMs/FEMs/ARMS	Yes	Yes
PM2.5 Total Atmospheric	88500	Methods measuring PM2.5 aerosols in the atmosphere, including those that can be volatilized from the FRM	No	No
PM2.5 Raw Data	88501	Valid uncorrected data that does not reasonably match the FRM	No	No
Acceptable PM2.5 AQI & Speciation Mass	88502	Valid data that does reasonably match the FRM with or without correction, but not to be used in NAAQS calculations	No	Yes
PM2.5 Volatile Mass	88503	Stores important related data such as the FDMS reference channel	No	No



AQS Data Reporting and Monitor Type

Monitor Type Definition - The monitor's organizational classification.

- **SLAMS** – If a PM_{2.5} continuous monitor is any of the following:
 - Meeting a minimum monitoring requirement
 - Is being used as the NAAQS comparable monitor at a design value site, or
 - Any other required site in the agencies network
 - Is part of the agencies long-term network

- **Special Purpose Monitor (SPM)**
 - Site is a short term study
 - Method evaluation (up to 24 months)

- **Tribal, Industrial, or EPA, non-EPA Federal**



Resource Summary

- EPA:
 - AMTIC Page on PM_{2.5} Continuous Monitoring
<http://www.epa.gov/ttn/amtic/contmont.html>
 - Requirements:
 - FEM Approvals – 40 CFR Part 53
 - Monitoring Requirements – 40 CFR Part 58

- Multi-State Organization Web Sites

- Instrument Manufacturer Web Sites

- AIRNowTech - www.airnowtech.org