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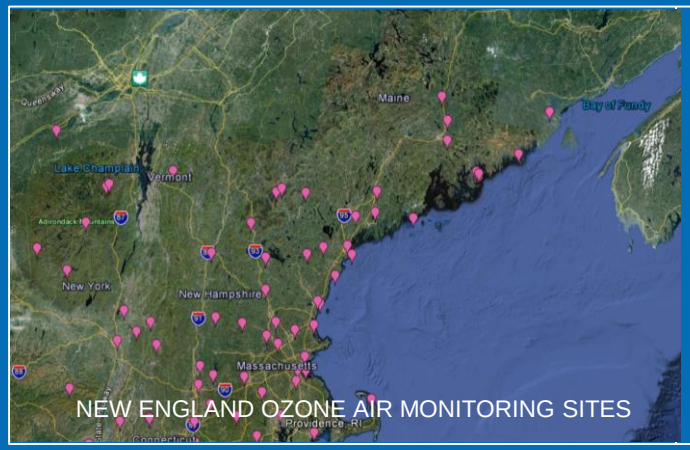
Community Air Monitoring Workshop

Data Quality Considerations Related to Lower Cost Advanced Monitors from an EPA Regional Office Perspective

Bob Judge, EPA – Region 1



NEW ENGLAND OZONE AIR MONITORING SITES

"Mention of trade names or commercial products does not constitute endorsement recommendation for use"

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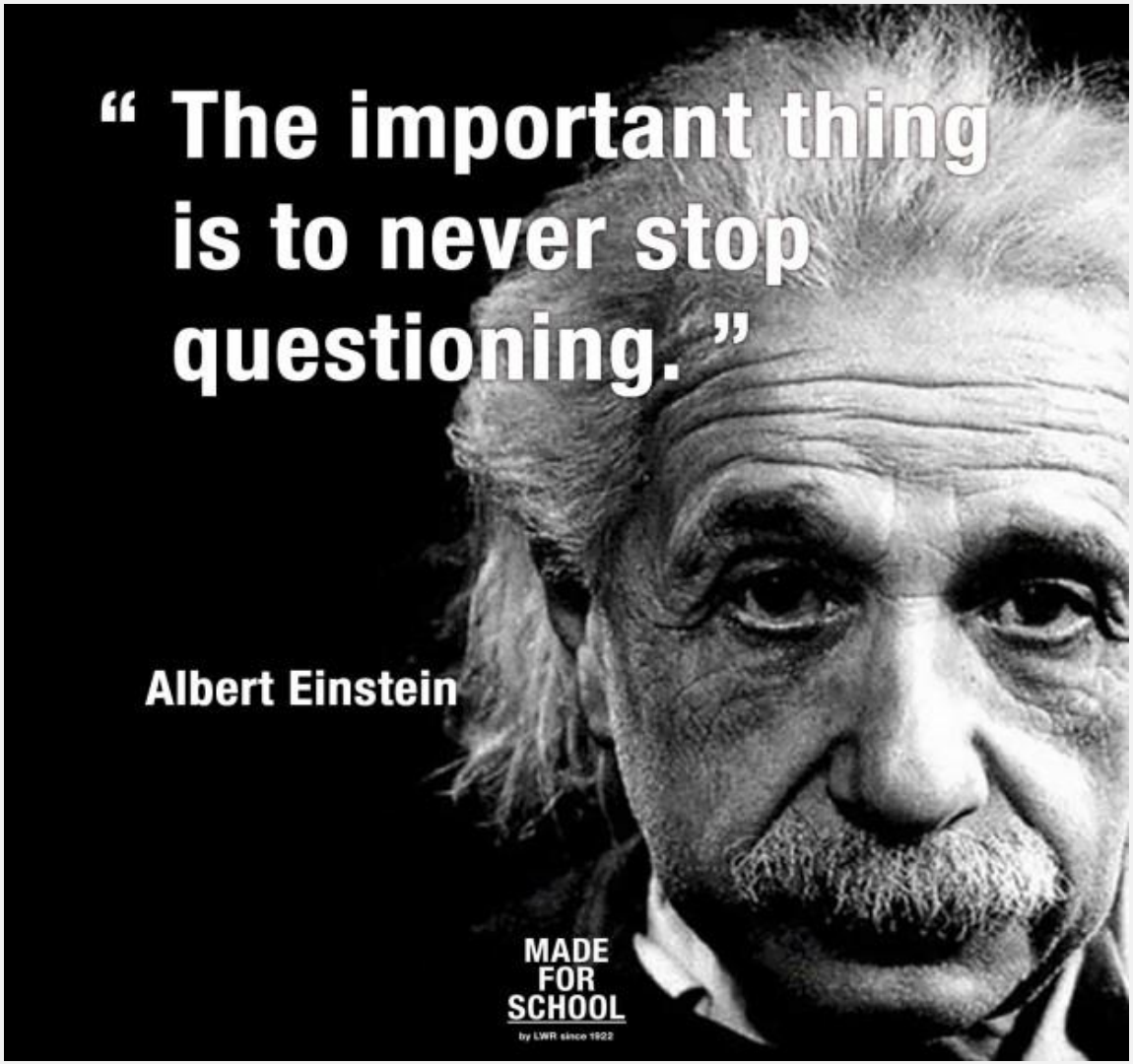
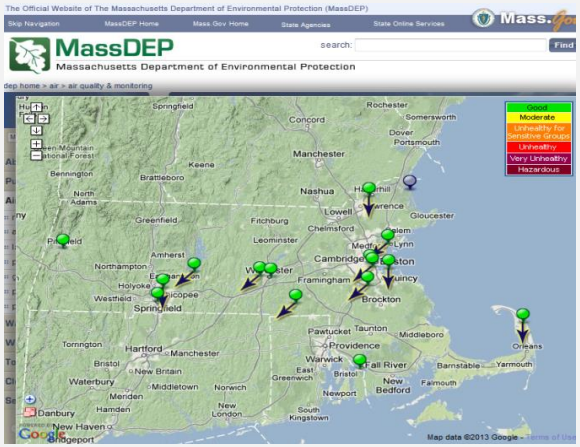
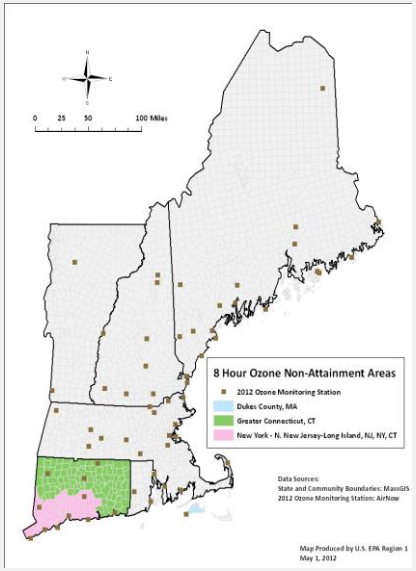


EPA Use of Air Monitoring Data

- Real time data reporting to AQI/ AIRNow and State web sites.
- Determine areas which meet the health based national air standards (NAAQS).
- For nonattainment areas, State/ locals must develop pollution control strategies to reduce emissions.
- Support health studies…





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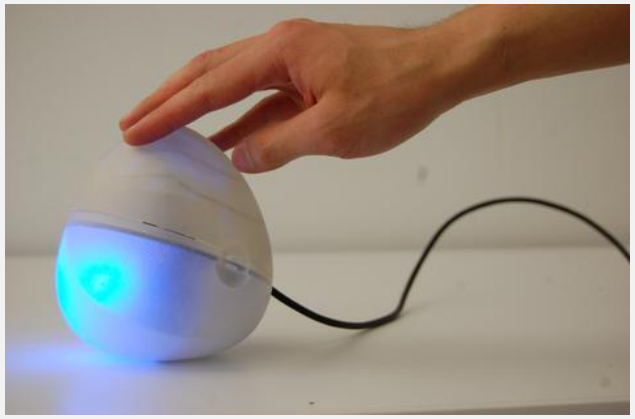
So why not use “less costly” measurement devices?

- Could we use a simpler, less expensive device than we currently use to measure pollutants to make decisions?

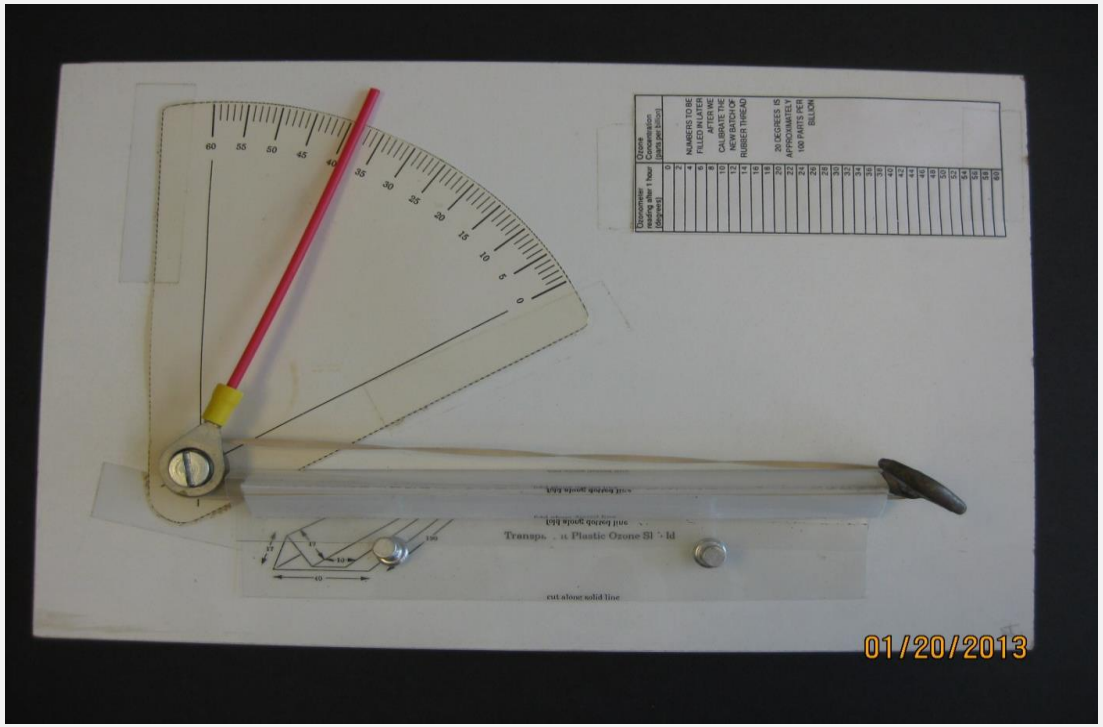


“The Air Quality Egg is a sensor system designed to allow anyone to collect very high resolution readings of NO2 and CO concentrations outside of their home. These two gases are the most indicative elements related to urban air pollution that are sense-able by inexpensive, DIY sensors”– Air Quality Egg Website

“The CairClip (USB version) was initially developed for the real-time measurement of pollutants and survey the effect on people suffering from respiratory conditions. CairClip is presently available for the measurement of O_3/NO_2, H_2S and sulphur compounds, and NH_3.”
– Cairpol Website

The concept of cheaper, simplified air quality measurements is not “new”

- Depicted is a 1940’s vintage ozone monitor- with its “detector” - a rubber band…



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Now, less expensive air measurement devices are widely available….

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But how should I use them..?
What do I want to do with the information I collect..?

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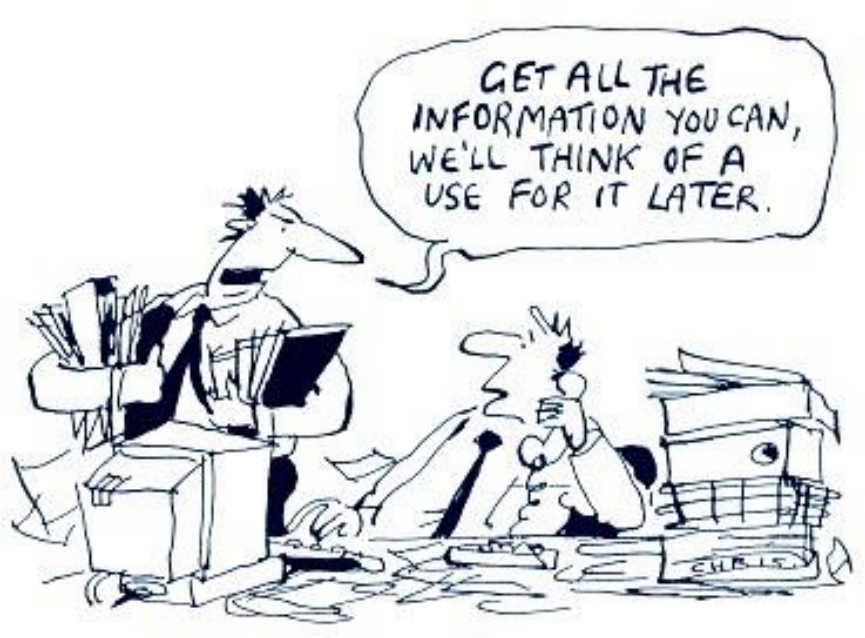
Collecting data…



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So why did EPA require *more complicated* measurement devices?

- Under the Clean Air Act, EPA has established National Ambient Air Quality Standards (NAAQS).
- These pollutant concentrations should not be exceeded, in order to protect the public health and welfare.
- Air that is dirtier than these standards must be cleaned up.
- This can involve costly regulations or control strategies.

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So why did EPA require *more complicated* measurement devices?

In order to ensure high quality data….

- Quality Assurance/ Quality Control
- DQOs (data quality objectives)
- Data completeness, precision, bias and overall accuracy

9

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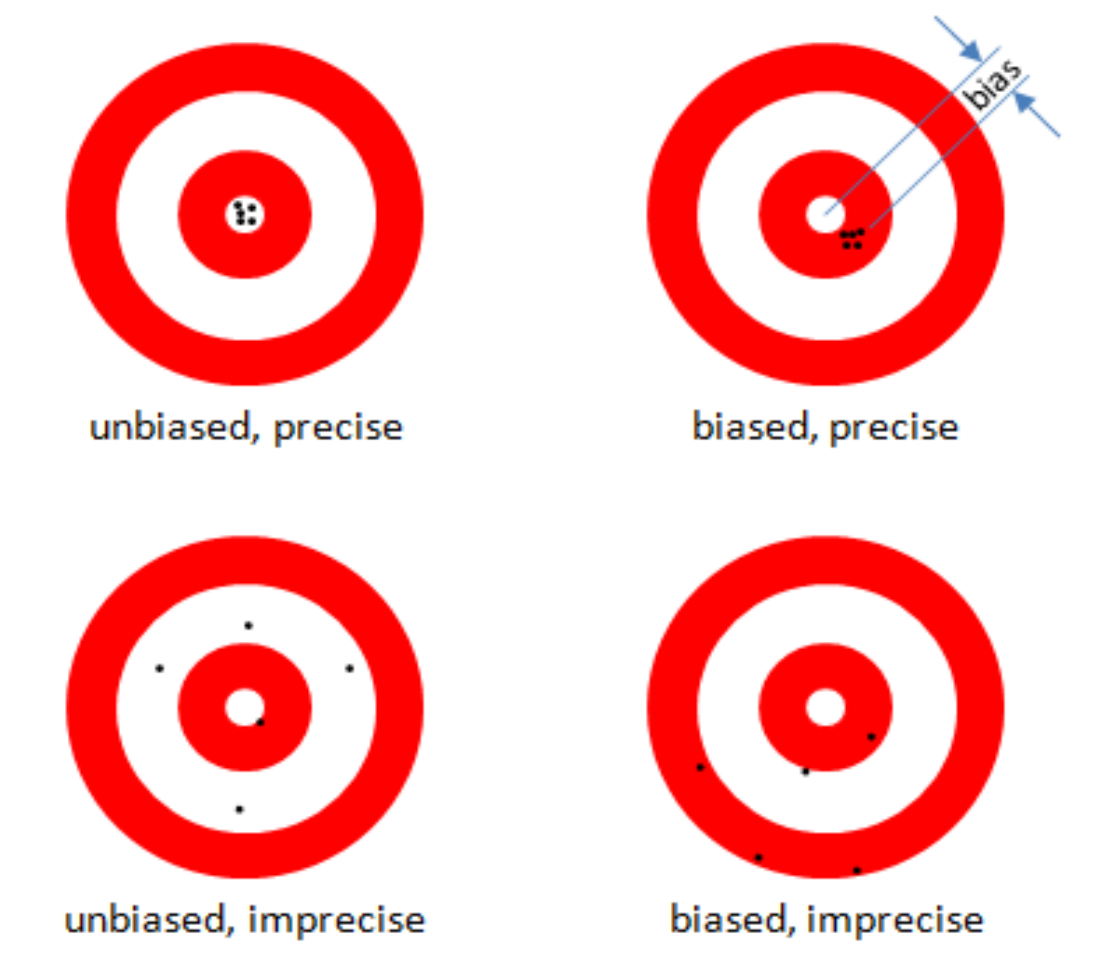
EPA needs unbiased and precise measurements…



This is where we'd like to be…*accurate!*

- EPA established regulatory monitor designations (FRMs and FEMs) to ensure consistency…

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
HUMAN EXPOSURE & ATMOSPHERIC SCIENCES DIVISION (MD-D205-03)
Research Triangle Park, NC 27711

Office of
Research and Development

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

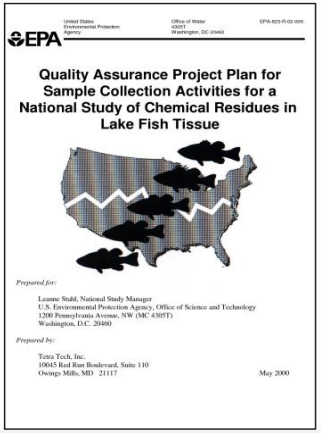
***Issue Date*: December 17, 2012**
(www.epa.gov/ttn/amtic/criteria.html)

These methods for measuring ambient concentrations of specified air pollutants have been designated as "reference methods" or "equivalent methods" in accordance with Title 40, Part 53 of the Code of Federal Regulations (40 CFR Part 53). Subject to any limitations (e.g., operating range or temperature range) specified in the applicable designation, each method is acceptable for use in state or local air quality surveillance systems under 40 CFR Part 58 unless the applicable designation is subsequently canceled. Automated methods for pollutants other than PM_{10} are acceptable for use only at shelter temperatures between 20°C and 30°C and line voltages between 105 and 125 volts unless wider limits are specified in the method description.

Prospective users of the methods listed should note (1) that each method must be used in strict accordance with its associated operation or instruction manual and with applicable quality assurance procedures, and (2) that modification of a method by its vendor or user may cause the pertinent designation to be inapplicable to the method as modified. (See Section 2.8 of Appendix C, 40 CFR Part 58 for approval of modifications to any of these methods by users.)

EPA requires QAPPs when helping fund data collection activities

- **Quality Assurance Project Plans (QAPPs) contain the instructions by which individual projects are implemented. It documents exactly what needs to be done, how to do it, and when it will be done.**



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EPA developed detailed QA procedures to help ensure high quality is collected, reported and used in EPA and State decision making…

Ozone Validation Template

Requirement	Frequency	Acceptance Criteria	Information /Action
CRITICAL CRITERIA-Ozone			
One Point QC Check Single analyzer	1/ 2 weeks	≤ ±7% (percent difference)	0.01 - 0.10 ppm Relative to routine concentrations 40 CFR Part 58 App A Sec 3.2
Zero/span check	1/ 2 weeks	Zero drift ≤ ± 2% of full scale Span drift ≤ ± 7 %	
OPERATIONAL CRITERIA - Ozone			
Shelter Temperature			
Temperature range	**Daily** (hourly values)	20 to 30° C. (Hourly ave) or per manufacturers specifications if designated to a wider temperature range	Generally the 20-30 ° C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance
Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	
Temperature Device Check	2/year	± 2°C of standard	
Precision(using 1-point QC checks)	Calculated annually and as appropriate for design value estimates	90% CL CV≤ 7%	90% Confidence Limit of coefficient of variation. 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	Calculated annually and as appropriate for design value estimates	95% CL ≤ ± 7%	95% Confidence Limit of absolute bias estimate. 40 CFR Part 58 App A sec 4.1.3
Annual Performance Evaluation			
Single analyzer	Every site 1/year 25 % of sites quarterly	Percent difference of each audit level ≤ 15%	3 consecutive audit concentration not including zero. 40 CFR Part 58 App A sec 3.2.2
Primary QA Organization (PQAO)	annually	95% of audit percent differences fall within the one point QC check 95% probability intervals at PQAO level of aggregation	40 CFR Part 58 App A sec 4.1.4
Federal Audits (NPAP)	1/year at selected sites 20% of sites audited	Mean absolute difference ≤ 10%	40 CFR Part 58 App A sec 2.4
State audits	1/year	State requirements	
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving	All points within ± 2 % of full scale of best-fit straight line	Multi-point calibration (0 and 4 upscale points) 40 CFR Part 50 App D sec 5.2.3

http://www.epa.gov/ttn/amtic/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf

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EPA developed siting criteria to ensure monitors were “representative”…

- 40 CFR Part 58, Appendix E
- Things to consider when taking measurements…
  - What are you trying to measure?
  - Too far, too close?
  - Elevated too high, too low?
  - Interferences (trees, walls, etc.)

NPAP PEP Audits

- To help ensure quality, EPA requires auditing of particulate matter regulatory monitors with independent regulatory monitors.
- State/ locals conduct these through routine co-located sampling.
- EPA conducts these audits at State/ local agency sites, usually under contract.

15

NPAP “Through the probe” (TTP) Audits

- To help ensure quality, EPA requires auditing of gaseous regulatory monitors (FEM/ FRMs) with independent FEM/ FRMs, and/ or certified gases.
- States/ local agencies conduct similar at their own sites.
- EPA conducts these audits at State/ local sites.

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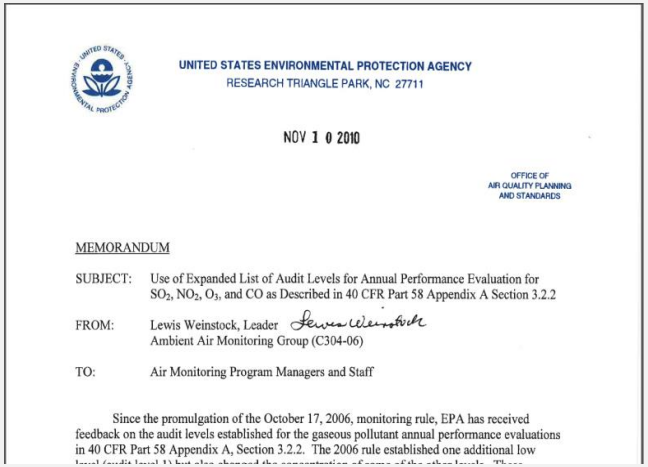
We perform these audits to ensure that the data we collect and report is of high quality and acceptable for its intended use.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

NOV 1 0 2010

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Use of Expanded List of Audit Levels for Annual Performance Evaluation for SO_2, NO_2, O_3, and CO as Described in 40 CFR Part 58 Appendix A Section 3.2.2

FROM: Lewis Weinstock, Leader
Ambient Air Monitoring Group (C304-06)

TO: Air Monitoring Program Managers and Staff

Since the promulgation of the October 17, 2006, monitoring rule, EPA has received feedback on the audit levels established for the gaseous pollutant annual performance evaluations in 40 CFR Part 58 Appendix A, Section 3.2.2. The 2006 rule established one additional low

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What concentrations should the NGAM monitors pursue measuring in ambient air?

- EPA revises these health standards based on studies.
- Note these NAAQS levels are not instantaneous (i.e. averaging times).
- Depending on the monitor's purpose, it ought to pursue accurately measuring at these concentrations, and perhaps much lower since "normal" (routine) concentrations found are often lower.

EPA's National Ambient Air Quality Standards (NAAQS)

Pollutant	Current NAAQS Level	Lower Detectable Limit
Ozone	0.075 ppm (8-hour)	0.010 ppm
CO	9 ppm (8-hour) 35 ppm (1-hour)	0.4 ppm
SO_2	75 ppb (1-hour)	2 ppb
NO_2	53 ppb (annual mean) 100 ppb (1-hour)	10 ppb
$PM_{2.5}$ PM_{10}	12 ug/m^3 (annual average) 35 ug/m^3 (daily) 150 ug/m^3 (daily)	2 ug/m^3
Pb	0.15 ug/m^3 (rolling 3-month average)	

http://www.epa.gov/air/criteria.html

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What concentrations should the NGAM monitors pursue measuring in ambient air?

- "ppm" is parts per million
- "ppb" is part per billion
- "ug/m^3" is micrograms per cubic meter
- Be wary of data reported instantaneously- prone to wide variations and difficult interpretation
- Regulatory monitors typically report minute by minute data. (Even longer for PM)
- Safe (NAAQS) values typically set based on an hour, or longer.
- In some limited cases, such as exposure to CO in confined area, short averaging times might be appropriate.

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http://www.epa.gov/air/criteria.html

So, what's out there?

CO

Features

- Handheld Battery Powered Carbon Monoxide Poison
- Detector - Immediate Accurate Readings, Auto Shut Off
- Simply Click Button, LCD Screen Will Display Levels
- Continuous Alarm Sounds When Reading Is Above 200 PPM
- Measurement Range: 0-1000 PPM;
- Measurement Resolution: 1 PPM; Accuracy: +/- 5%
- Max Hold And Data Hold; Record Mode; Response Time: 1 Sec.;
- Operating Temperature: -32 to 122 deg F; Humidity: 0-99% RH

*Typically, immediate results

amazon.com

Misc. gases

Features

- Detects natural gas, methane, propane, hydrogen and butane gas leaks
- Locates leaks in pipes, valves, fittings and tanks
- Highly sensitive solid state sensor
- Only 6 inches long, fits easily into pocket or tool-belt
- Has both audible and visual alarm indicators

Ozone

Features

- Rugged Handheld Ozone Sensor
- Auto-Ranging for high resolution at low range
- Min, Max and Average readings recorded.
- Portable. Range: 0 - 20 ppm. Display: LCD.
- Outputs: Multiple

PM

Could we standardize appropriate uses and applications?

So what's more important- precision or bias?

- When there are lots of measurement devices, overall bias may be more important.
- Knowledge that "my" individual measurement isn't critical, but when lumped together with 100's/ 1000's of others, the overall results might be reasonable…
- As there are fewer samples, precision (reproducibility) becomes increasingly important as well.

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What has EPA- ORD done to help potential users understand the reliability of these low cost monitors?

- EPA-ORD “evaluation” of reliability of measurement. Is it…
  - Regulatory (FEM/ FRM) monitor quality?
  - Very good, but not FEM?
  - Adequate for “personal exposure” assessment (+/- 30%, or better/ lower)?
  - “Junk”?
- How prone is it to operator error, especially with multiple operators?
- Operation and maintenance (SOPs)
- Instrument calibration needs
- QA/QC issues and questions- what type of quality procedures do you need to have in place?

Air Sensor Measure · Learn · Share — Citizen Science Toolbox — EPA

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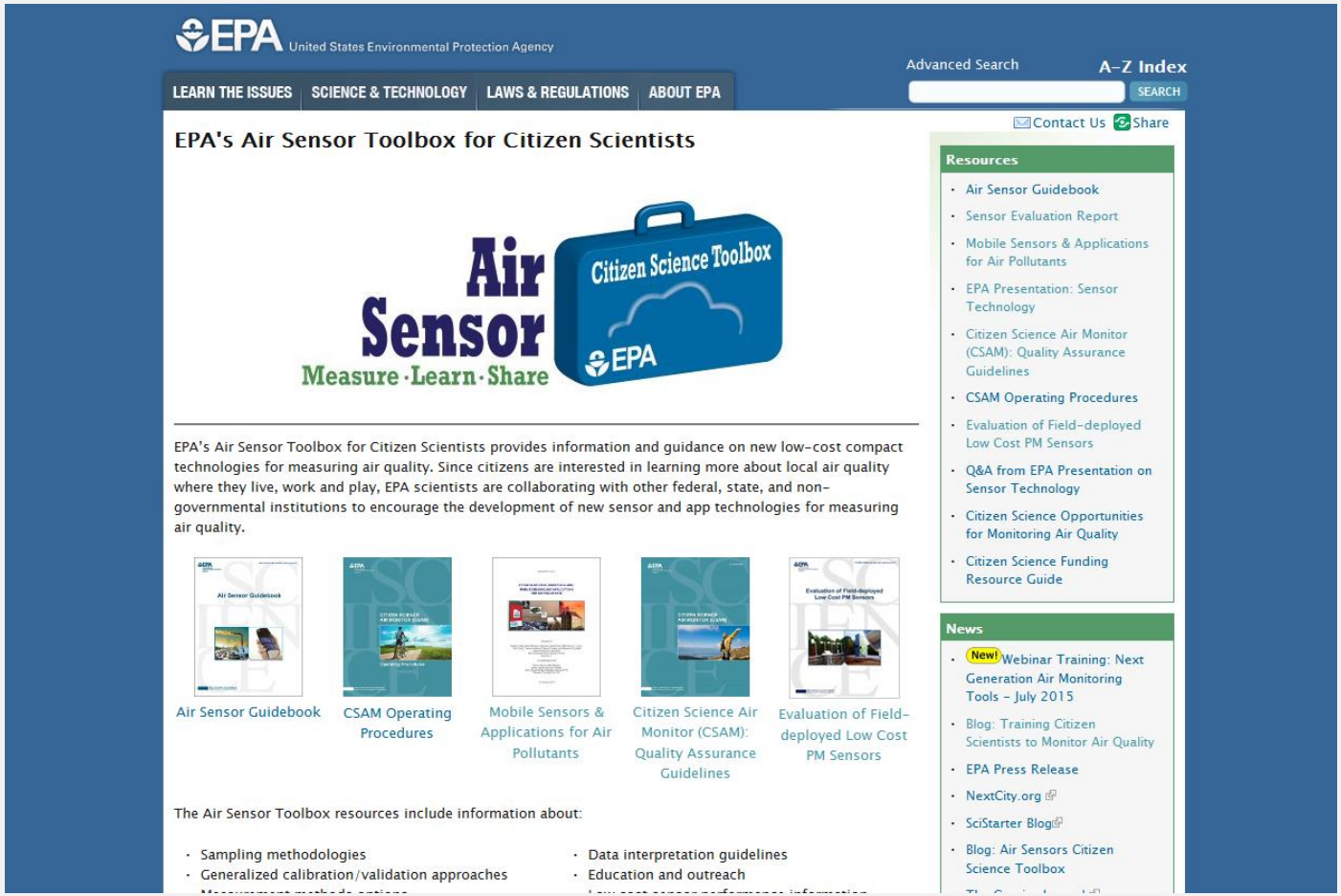
EPA's Air Sensor Website

http://www.epa.gov/heasd/airsensortoolbox/



How can data* from these low cost monitors be useful to EPA?

- A screening tool, to identify a problem area/ “hot spots”
- Personal exposure, health risks
- General environmental awareness
- Emergency planning for air toxics/ superfund
- Helping States/ Local organizations with siting new monitors?

***Monitor must be operated consistent within its limitations, and in accordance with its operating manual.**

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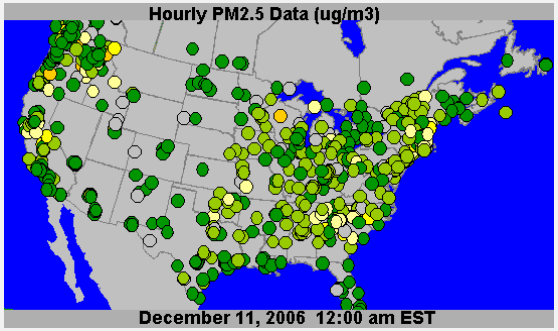
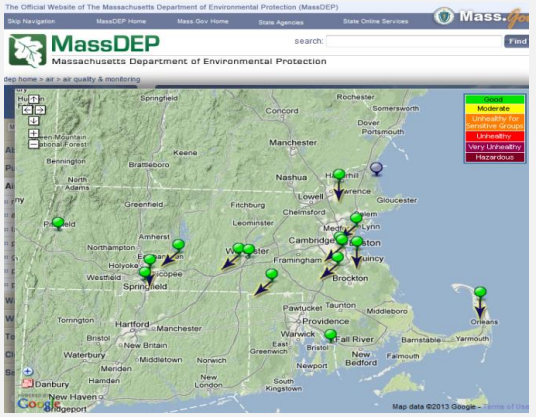
How does your monitor compare to other measurements?

Monitoring in New England

Bridgeport, CT

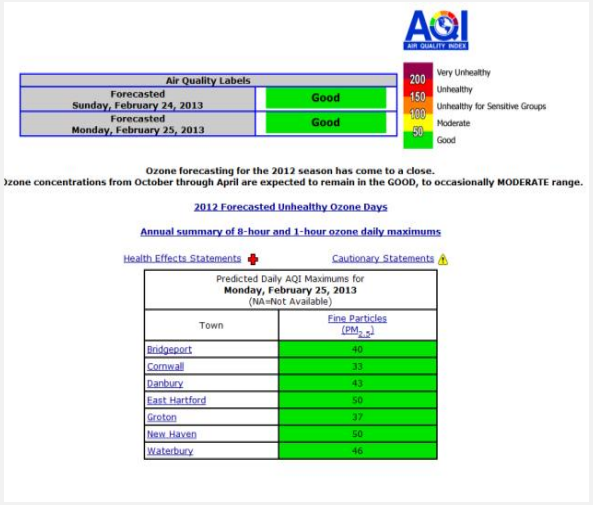
McFarland Hill, Acadia NP Bar Harbor, ME





Narragansett, RI

AirNow EnviroFlash



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So as citizens gathering this data, how do we want to use this information…? (Data quality objectives (DQOs))

- For my own personal use..?
- To inform others?
- To convince a regulatory Agency (State DEP/ EPA) to take an action?

So plan what you want to accomplish…

"If you don't know where you are going, you might end up someplace else." -Yogi Berra

- What are your data quality objectives?
- Consider a plan containing instructions by which your individual project will be implemented.
- Document exactly what needs to be done, how to do it, and when it will be done (QAPP).

Know your monitoring equipment…

- What are its limitations?
- What are the standard operating procedures (SOPs)?
- Know and document maintenance schedules.
- Train your operators and know their limitations.

Consult with your audience/ end users…

- If you want a regulatory Agency to use your data – contact them before you collect data
- Maybe it's already being collected
- They may be able to guide you in monitor selection, training and in planning for data collection
- Help them, help you….

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Now, go forth and collect good data...


EXPERIMENT.
FAIL.
LEARN.
REPEAT.


STAND BACK
I'M GOING TO TRY
SCIENCE

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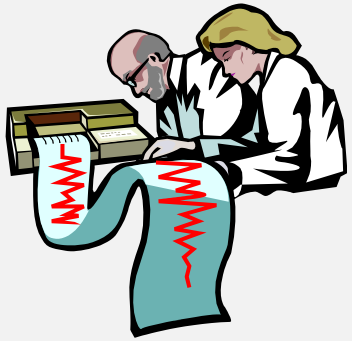
Questions?



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