"Is it good enough?"

The Role of PM and Ozone Sensor Testing/Certification Programs

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Session 7: Perspectives on Testing/Certification Program Scope and Structure

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"Sensors": a huge range of price and performance

< $10 to > $5,000

Qualitative to Semi-Quantitative to "near-FEM/FRM" data quality

Very different users, different testing / performance needs

Examples of these extremes:

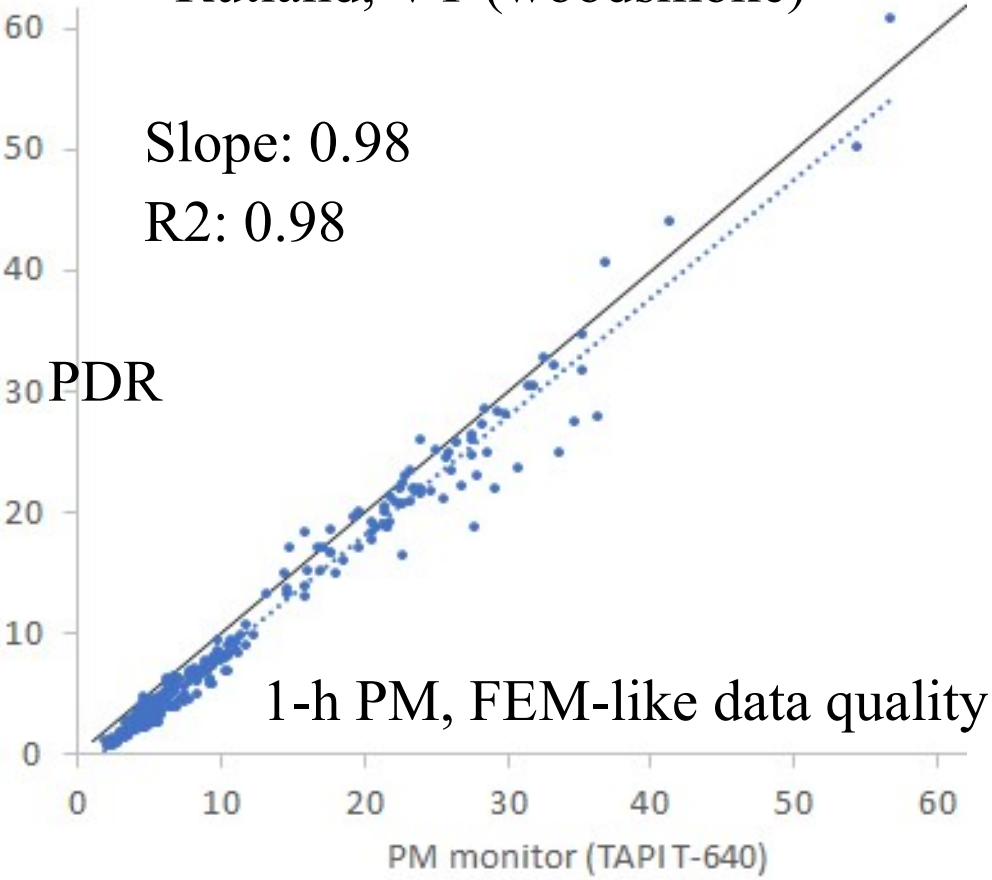
Conscious Clothing: $10 Sharp PM Sensor

Winner of 2013 EPA "My Air, My Health"

Visual indicator of PM

pDR1500 vs. TAPI 640 FEM

Rutland, VT (woodsmoke)



Testing Program Structure and Scope

"Certification" (think EPA regulatory FRM/FEM programs) is difficult
- Expensive for any gov agency to do or sponsor
- Example: EPA Environmental Technology Verification Program (ETV)
  Verified – didn't "certify", vendor funded (!)
- Good longer term goal, meanwhile: test test test

Test programs must communicate a wide range of end-user data quality needs
1. non-technical users: qualitative data
2. everyone else: technical audience, (semi) quantitative data

AQ-Spec: high end model (disclosure: member of AQ-Spec Advisory Board)
- Very expensive project, but very valuable product
- Does not make application recommendations
  – is a testing pgm but not a certification pgm.
  – results are for a technical audience

Sensor Performance Parameters

Accuracy (bias), stability over time, temperature, averaging time

Linearity (including saturation)

R^2 (if appropriate), RMSD, other? – averaging time

Precision (in-motion degradation?), bias corrected precision?

Sensitivity / LOD (as a function of averaging time)

Baseline stability (with time / temperature)
- Important at low end of sensor range
- Can be driver of data quality at ambient concentrations

Interferences Can be data quality driver!

Values for these parameters depend on
- type of sensor, pollutant
- performance tier / DQOs
- averaging time of interest

Interferences!

Example: Electrochemical O3 sensor – NO2 interference

– Can have 1:1 response with NO2

– In urban air, NO2 is higher and O3 is lower (NO scavenging)

– Result: large positive error for O3

Example: PM Sensor – RH interference

– Ambient tests in semi-arid climate (western US) may not reflect performance in humid climate (eastern US)

– Useful to know if a sensor measures and reports RH (and corrects data for it?)

Cloud-based post-processing of data

Could it improve sensor performance?

Integrated with sensor package?

- include as part of data quality evaluation?

Binary (yes/no) vs. Tiered Performance Systems

Binary: One set of performance targets (for all non-regulatory purposes)

Tiered: Different performance targets for different sensor applications
- as defined in Workshop Objectives

Tiered is preferred – "Is it good enough" for my application?
- cost effective (don't pay for what you don't need)
- defines a sensor's suitability for a given use: Qual/(semi)Quantitative

  ... for what I want to find out / how I plan to use the data?
- useful when messaging sensor performance to non-technical end users
- A testing pgm should include results for non-technical users

Possible Tier Descriptors

0. Just don't use it:	R^2 <0.25 ..or..	RMSD > 100%
1. Qualitative:	R^2 0.25 to 0.50,	RMSD < 100%
2. Semi-quantitative:	R^2 0.50 to .75,	RMSD <50%, bias < 50%
3. Reasonably quantitative:	R^2 0.75 to .90,	RMSD <20%, bias <30%
4. Almost regulatory quality:	R^2 >.90,	RMSD <10%, bias < 15%

Example for PM2.5: Thermo pDR1500 (EPA Village Green PM)

Need to specify averaging time.

Summary

- Testing programs must accommodate a wide range of:
  - sensor quality/price
  - end user data quality needs, level of technical knowledge

- "Certification": desirable but will be complicated/difficult...
  Verification?

- Tiered Performance Testing: more relevant to end-user needs
  5 Tiers: "don't use" to "almost regulatory quality"

- Performance Parameters should include:
  - Accuracy, Precision, R^2 and/or RMSD
  - Zero/span stability over time and temperature
  - Interferences
  - Specify averaging time!

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