



Dynamic Evaluation of Meteorological Monitors

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Summary of Presentation

- Dynamic Audits
- EPA's Meteorological Program
- EPA Region 9 Dynamic Audit Test
- Options for EPA to Consider

What are Dynamic Audits?

- Non-dynamic
 - Instrument disassembled and tested
- Dynamic
 - Instrument left in place and collocated
 - 24 hours recommended



EPA's Meteorological Monitoring Program for Ambient Air Networks

- Method Quality Objectives
 - Hypothetically based on the Data Quality needs of the program
 - Some of the MQOs should represent the overall accuracy (precision and bias) of the measurement so that data quality can be evaluated

Other Federal Meteorological Monitoring Standards

- Office of the Federal Coordinator for Meteorological Services and Supporting
- National Oceanic and Atmospheric Administration (NOAA)
 - National Weather Service (NWS)
 - Climate Reference Network (CRN)

EPA and Weather Service Quality Criteria & (Calibration Methods)

	Temperature	Wind Direction	Wind Speed
Photochemical Assessment Monitoring Stations	± 0.5° C (water bath)	± 5 Degrees (various methods)	± 5% (synchronous motor)
National (NCORE)	± 0.5° C (water bath)	± 5 Degrees (various methods)	± 0.25 m/s; 5%; or 2.5 m/s depending on speed (synchronous motor)
National Weather Service	± 0.6° C	± 5 Degrees	± 10%

Limitations of EPA Criteria for Meteorological Audits

- Assuming use of specific monitoring technologies
- Evaluating surrogates – not verifying actual measurements
- Not evaluating response time, siting impacts, and mounting errors

Meteorological Audit Programs in the EPA QA Handbook Volume IV

- Temperature - Water Bath
- Wind Speed and Direction - Removal from tower and a calibration-like check
 - Mentions Collocated Transfer System Method, ASTM Method

Meteorological Audit Programs ASTM D 4430 – 00 (2006)

- General guidance for meteorological instruments
- Monitors being compared are within a cylinder with a 1 meter height and 10 m diameter
- Test considers difference, comparability, precision, standard deviation, skewness, kurtosis, response time, and resolution

Meteorological Audit Programs Dynamic Audits

- Challenges instrument in real time
- Straightforward approach
- Requires more training of auditors
- Requires more complex judgments regarding data quality

Case for Dynamic Audits

- Calibration only adequately answers the question of how equipment operates in an ideal circumstance
- Needed for some types of monitoring equipment
- “Natural exposure cannot be fully simulated.” ASTM D4430

EPA Region 9’s Dynamic Audit Trial

- EPA Region 9 took over the responsibility of auditing the Baja California Monitoring Network’s Meteorological Measurements in 2007
- EPA Region 9 in consultation with OAQPS chose a dynamic model for meteorological audits

The Baja California Network

- Created in 1990's by EPA, the California Air Resources Board (ARB), and the Mexican government
- Operated by the ARB until last year
- Transferred to the State of Baja in April 2007
- Included a commitment by EPA to perform annual audits of meteorological equipment

Baja California Audits

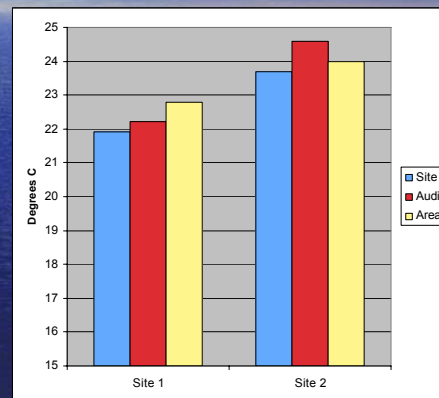
- EPA Region 9 & OAQPS proposed Dynamic Audits
- First Audit October, 2007
- Climatronics AIO Compact Weather Station used for Trail Audits
- Parameters measured:
 - Wind Speed
 - Wind Direction
 - Temperature
 - Barometric Pressure

Limitations of Trial Audits

- Vertical and Horizontal criteria (1 & 10 meters) could not always be achieved
- Not easy to synchronize data systems
- Data not collected at a consistent frequency
- Data system not designed for audits
- Insufficient Quality Control
- Siting issues

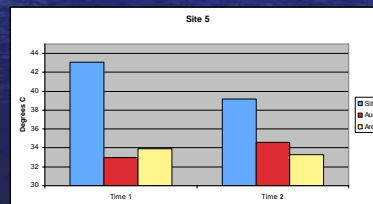
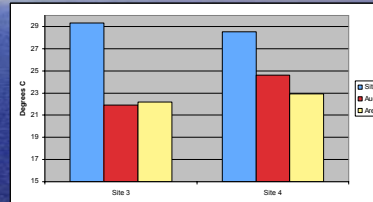
Example of Temperature Data

- All instruments were calibrated using a water bath 1 - 2 weeks prior to the audits by the ARB
- Sites 1 & 2 on roofs with good air movement and white surfaces – data compared well with each other and official weather data



Example of Temperature Data

- Site 3 & 4 trailer mounted – site data consistently higher than audit data
- Site 5 mounted on a tin roof near an HVAC system – site data higher than audit data and variable



Temperature Data Interpretation

- Unlikely the sensors are not operating properly
- Affected by their immediate environment
- NOAA Climate Reference Network (CRN) has 5 site categories for temperature
 - The least accurate is Class 5 with an error of $\geq 5^{\circ}\text{C}$
 - Class 5 includes sensors next to or above heating sources including roof tops, parking lots, or concrete

Typical EPA and CMN Site



Region 9's Path Forward

- Purchase meteorological audit equipment
- Develop audit criteria based on data needs
- Evaluate and recommend changes to instrument siting
- Develop audit procedures

Options for Dynamic Audits

- Continue Status Quo - non-dynamic evaluations
- Develop a program to assess performance of some or all meteorological monitoring that could include:
 - Setting overall DQOs that are realistic
 - Setting MQOs that are applicable to dynamic audits
 - Defining data uses and siting impacts
 - Classifying sites and documented bias