Air Sensors International Conference
May 2022

Dan Johnson, Oregon DEQ
September 2020 Wildfires in Oregon

**SensOR Team**
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Lance Hochmuth
Aaron Fellows
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Marissa Meyer
We built a sampler

SensOR™

Cellular Modem

Heated Aluminum Inlet

DC Power Supply

Sample Chamber w/ 2 Plantower PMS5003ST Sensors

Raspberry Pi

Zero Air Pump

Zero Air Relay

Fan (Flow ~2 LPM)

AC Power Input

Sample Chamber w/ 2 Plantower PMS5003ST Sensors
Monitoring Cost and Accuracy

Highly Accurate & Expensive  

Federal Equivalent Method
- MetOne BAM 1022
- Radiance Nephelometer

Lower Accuracy & Cheaper
- Oregon DEQ SensOR
- Purpleair
- Plantower

Sensor evaluation by South Coast AQMD at http://www.aqmd.gov/aq-spec
Near real time information for public health guidance (Nowcast AQI)

https://oraqi.deq.state.or.us/home/map and OregonAir mobile apps
Why build a low-cost PM sensor package at DEQ?

• Received funding in 2017 to add 30 new sites
  • Completed Spring 2022

• Expand PM-2.5 monitoring using an approach that is consistent with existing methods in Oregon
  • Measurement & QA/QC approach
  • Use existing IT and AQM network infrastructure

• Provide publicly-owned near real-time data
  • Shared through AirNow Tech

• Provide data of known quality (e.g., traceable)

• Data should meet DEQ data quality objectives
Oregon DEQ data quality objectives

• Data completeness >= 75%

https://www.oregon.gov/deq/FilterDocs/aqmtargets.pdf

• Air Quality Index data should be within +/- 20%

FRM Data

State of Oregon Department of Environmental Quality
Air Quality Monitoring Performance Targets

<table>
<thead>
<tr>
<th>Application</th>
<th>Pollutants</th>
<th>Precision &amp; Accuracy</th>
<th>Examples</th>
<th>Supporting Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory or compliance monitoring, Air toxics monitoring</td>
<td>Ozone, PM2.5, CO, NO2, SO2, Lead, VOCs, HAPs</td>
<td>+/- 10%</td>
<td>Filter-based FRM&lt;sup&gt;1&lt;/sup&gt; sampler, Continuous FEM&lt;sup&gt;1&lt;/sup&gt; PM monitor, FEM ozone analyzer, EPA laboratory protocols</td>
<td>40 CFR parts 50, 53, and 58, National Air Toxics Trend Station Technical Assistance document</td>
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<td>Supplemental monitoring, Special studies, Real-time Air Quality Index</td>
<td>Ozone, PM2.5, H2S, VOCs, Meteorology</td>
<td>+/- 20%</td>
<td>Nephelometer, E-BAM, H2S monitor for odors, Calibrated met station, Sensor-based with quality control and validation</td>
<td>Organization’s approved quality assurance plan or sampling analysis plan</td>
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<td>Area and source surveys, Screening; Fenceline monitoring, Personal exposure</td>
<td>Ozone, PM2.5, NO2, VOCs, Meteorology</td>
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<td>Calibrated sensors, Home met station</td>
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<td>Information, Education, Community monitoring</td>
<td>Ozone, PM2.5, NO2, CO, VOCs and others</td>
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<td>Low-cost sensors, Personal monitors</td>
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1 This document is for informational use only. DEQ makes no claim, warranty or guarantee of instrument performance when operated by users for their specific applications.
2 These guidelines are likely to evolve as technology and science advance.
3 Hazardous air pollutants or air toxics
4 Federal Reference Method
5 Federal Equivalent Method
Association of Public Health Labs / EPA

Approach

• Treat SensOR™ similar to the nephelometer
• Inline sensors run at multiple sites for at least 30 days
• Correct Plantower output to nephelometer back scatter (BScat)
  • Range of corrections is +/- 20%
• Use nephelometer to Federal Reference Method (FRM) correlations specific to each site as implemented over many years in OR
  • Range of correlations is +/- 15%
  • Wildfire correlation is different from winter time correlations
• Quarterly maintenance checks
  • Sensors don’t respond to calibration gas
• Verify with collocated sites and performance audits
  • 10% of samplers collocated
  • ARP Grant funding for three BAM 1022s to verify and improve SensOR PM2.5 estimates
Use Nephelometer as a ‘transfer standard’ to correlate PM 2.5 estimates

Inline comparison with Radiance M903 Nephelometer

SensOR uses site correlations to FRM
Comparison of inline sensor to Nephelometer Bscat
AQI categories aren’t created equally

USG is the most difficult target...

35 µg/m³  45  55

USG

+/− 25%

...and the most important
Central Oregon Air Quality Network

Designed their sensor in partnership with OSU Cascades.

(aqi.espacelabs.us)
Oregon DEQ data quality objectives

• Data completeness >= 75%
  https://www.oregon.gov/deq/FilterDocs/aqmtargets.pdf

• Air Quality Index data should be within +/- 20%
  FRM Data

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How do I make my data count?

• Define the monitoring objective
  • What data quality is needed?
• Develop a monitoring plan and a QA plan
  • Describe the process in detail
  • Ask questions to support and defend the data
  • How can you verify the data quality objectives are met?
• Validate the data
  • Are the monitoring objectives achieved?
  • Refine and improve the process as needed

Quality Assurance Handbook and Guidance Documents for Citizen Science Projects