The Sensor Verification System – a novel way to check the performance of air sensors anywhere

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TD ENVIRONMENTAL SERVICES
Air quality sensing, analytics, and insights

Outline

- Bay Air Center
- Purpose and need
- Solution
- Initial testing
- Example – Brightline Defense
- Other uses
- Contacts

Bay Air Center

BAY AIR CENTER
Working Together for Clean Air

Agency: Bay Area Air Quality Mgmt. District

Bay Air Center

- Provide technical assistance to communities interested in understanding air quality
- Build technical capacity in local organizations
- Provide accessible resources on best practices and methods
- Support Air District initiatives and staff

Team: TD Environmental, Kearns & West, T&B Systems, and InterEthnica,

Services

- ✓ Support community-led monitoring
- ✓ Data & information analysis
- ✓ Capacity building & training
- ✓ Awareness and outreach support
- ✓ Action development
- ✓ Grant support

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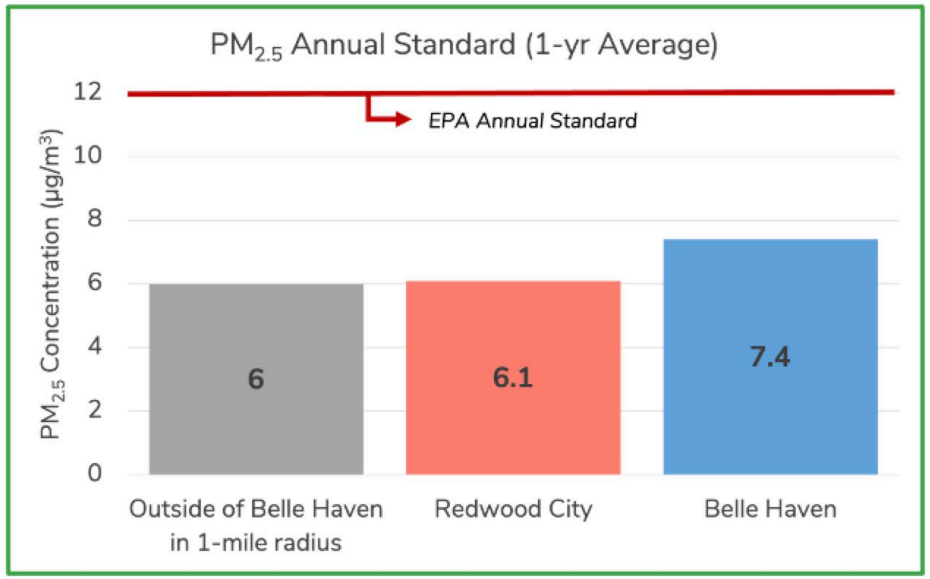
Bay Air Center Projects

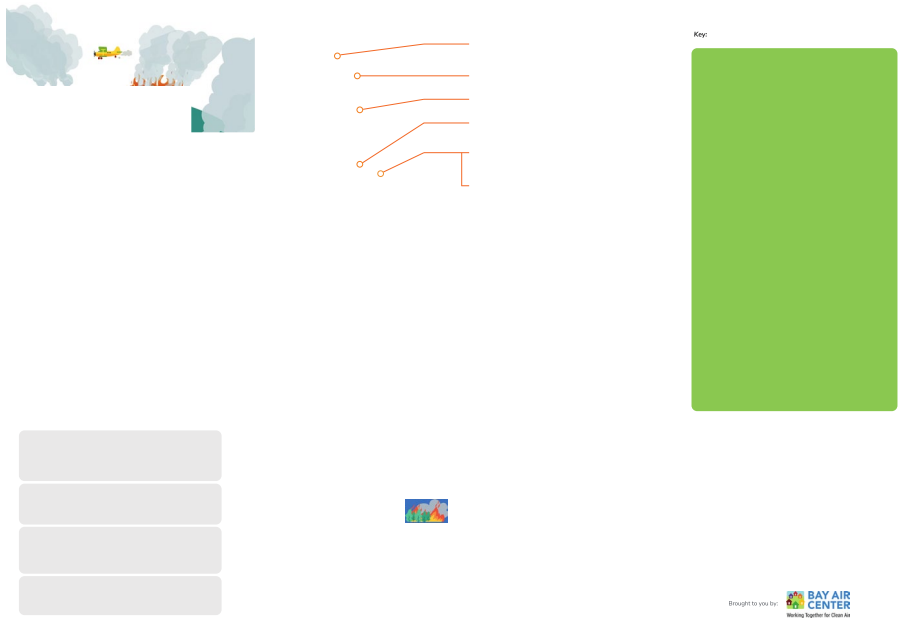
BAY AIR CENTER
Working Together for Clean Air

- **Data Analysis:** Processed 1 year of Purple Air and Clarity data to show that $PM_{2.5}$ was 23% high in the community than immediately outside.



- **Grant support:** Helped community group respond to EPA's recent ARP solicitation

- **Outreach Support:** Created a large tri-fold display board that is accessible to a wide audience & can be moved and used differently counties libraries. It includes a section on air pollution and equity.



Purpose and Need

- Bay Air Center was designed to help community groups in achieving their intended objective(s) of air monitoring.
- Community groups want to “validate” or ”compare” their air sensors to high-quality instruments at sites run by the Bay Area Air Quality Management District.
- Challenges exist with locating at Air District sites:
  - Monitoring site access
  - Staffing requirements
  - Sites not located in environmental justice communities

Solution: Sensor Verification System

- The Sensor Verification System provides:
  - flexible approach to sensor QA/QC
  - better understanding of sensor response as deployed in the field
  - can check all sensors in a network over time
- Design specifications:
  - High-quality instruments
  - A rugged case that fits in a trunk and is watertight
  - Carried and set up by not more than 2 people
  - Quick set up (less than 5 minutes)
  - Powered by wall and battery (up to 24 hours)
  - Automate communications (cellular)
  - Onboard display screen to ensure it’s operating

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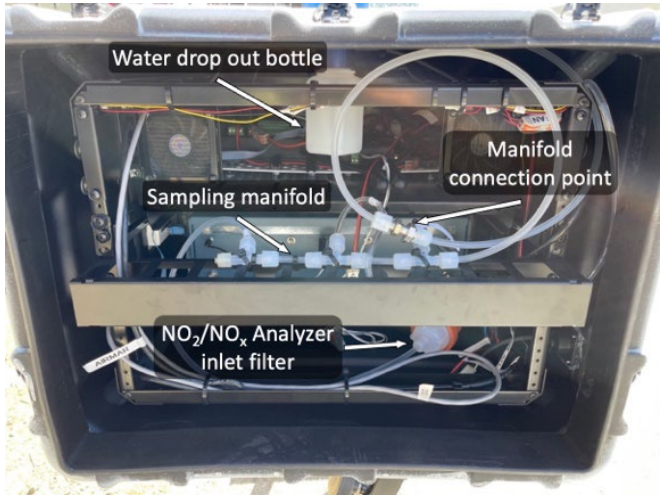
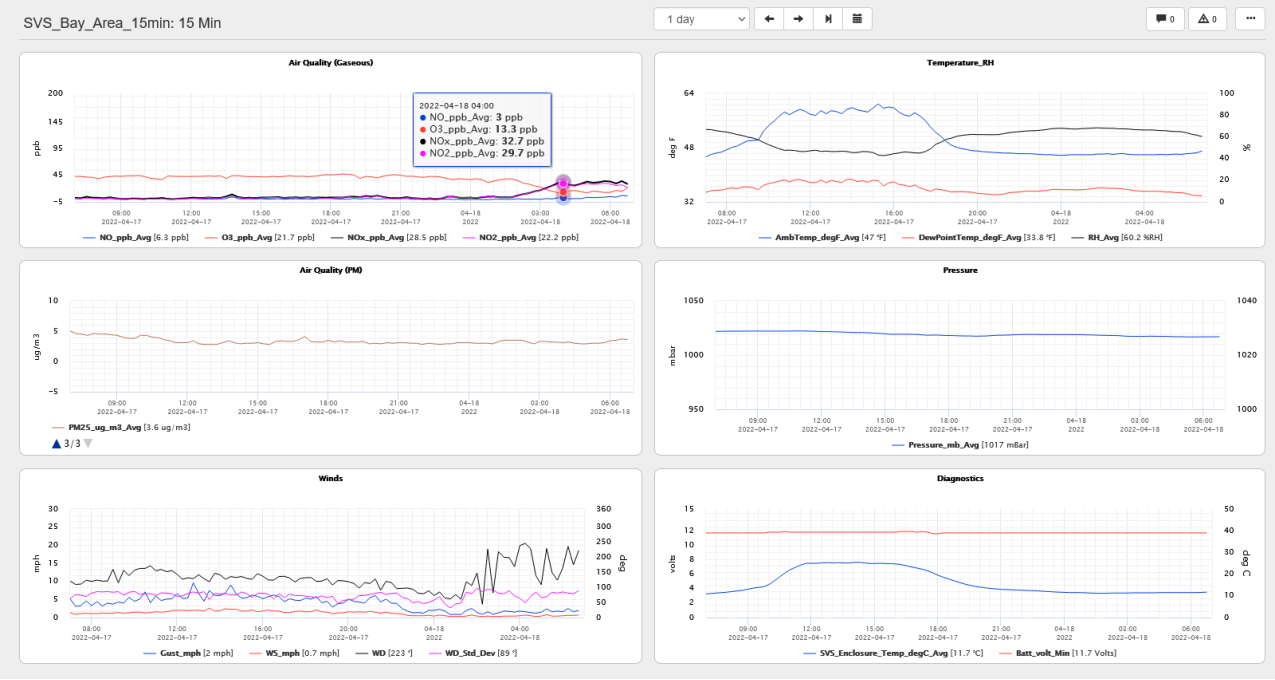
Sensor Verification System



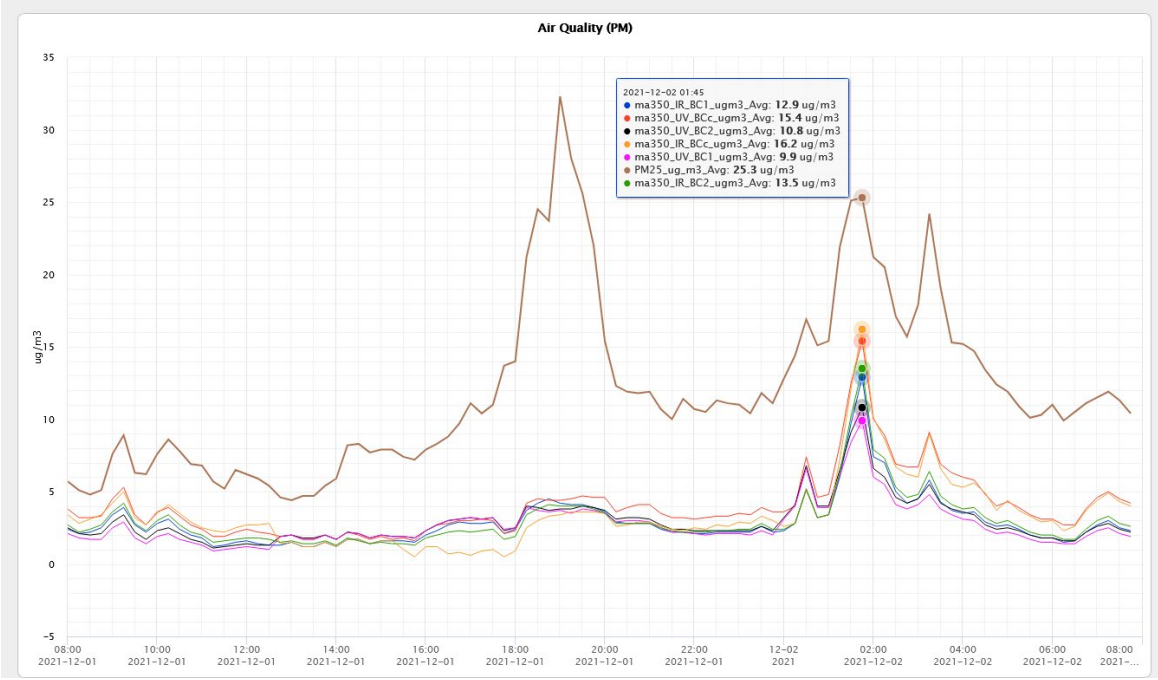
Sensor Verification System

- Include data and related services:
  - QA/QC
    - Data management and review
    - Quality Assurance Project Plan (QAPP)
    - Quick Start Guide
    - Training
    - Calibration and troubleshooting
  - Data management
    - Real-time display of air quality and meteorological data, as well as diagnostic data for samplers
    - Community access (password protected)
    - Online downloading of data
    - Data set generation for community groups
    - Data quality reports for groups who don’t want to do it themselves

Sensor Verification System



Web-based data display / data review



Web-based($PM_{2.5}$ and black carbon channels)

Sensor Verification System

Parameter	Accuracy	Precision	Resolution	Range	Sample Flowrate (lpm)	Scan Rate	Operating Temp
Particulate Matter ($PM_{2.5}$) Met One Model 212 2	+/- 10%			.5-10µm	1.0	1 - 60 seconds	0 - 40 °C
Ozone (O_3) 2B Tech Personal Ozone Monitor	1.5 ppb or 2% of reading	1.5 ppb or 2% of reading	.1 ppb	0 ppb - 10 ppm	0.8	2, 5 seconds	0 - 50 °C
Nitrogen Dioxide (NO_2) 2B Tech Model 405	2 ppb or 2% of reading	<.5 or .5% of reading	.1 ppb	0 ppb - 10 ppm	1.5	5 seconds; 1, 5 min	10 -50 °C
Black Carbon (BC) AethLabs Model 350			0.001 µg BC/m3		0.17	1, 5, 10, 30, 60 seconds	5 - 40 °C
Meteorology AIRMAR 220WX					----	1 second	-25 - 55°C
Wind Speed	5% at 10 m/s at 4 angles		.1 m/s	0 to 40 m/s			
Wind Direction	+/- 3° at 10 m/s		0.1°	0° to 359.9°			
Air Temperature	±1.1°C at 20°C		0.1 °C	-40° to 80°C			
Relative Humidity	±5% RH at 0 to 90% RH at 20°C		0.1% RH	0 to 100% RH			
Barometric Pressure	±0.5 hPa at 25°C		0.1 hPa	300 to 1100 hPa			
Datalogger/Comms							
Campbell Scientific CR6 Datalogger					----	----	-40 - 70°C
Campbell Scientific CELL210 Cellular Modem					----	----	-40 - 80°C
Campbell Scientific Mountable Display w/Keypad					----	----	-40 - 85°C
Rackmount Case/Enclosure							
Pelican Blackbox 7U					----	----	----

Initial Testing

At the BAAQMD Air Monitoring Stations:

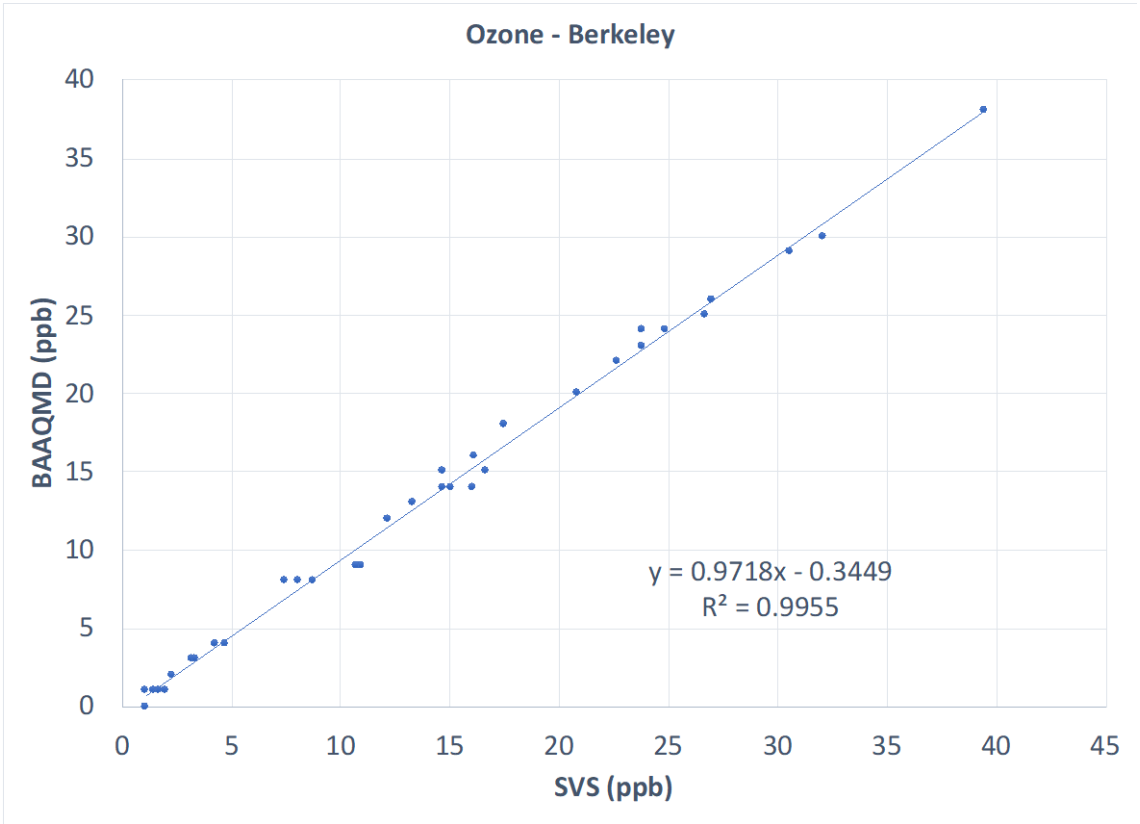
- Evaluate set up and ease of use
- Evaluate against the BAAQMD roadside monitoring locations

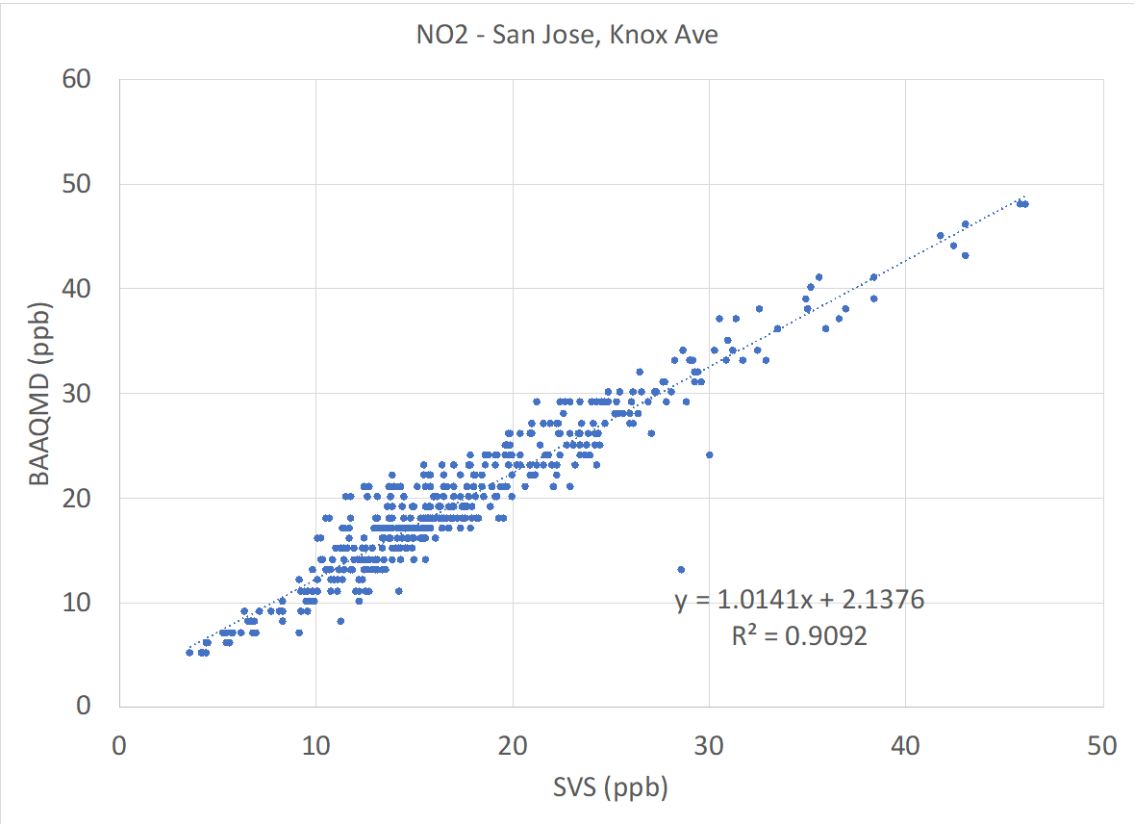
Deployed to:

- Berkeley - Aquatic Park – 2 days
- San Jose Knox Avenue (ozone not measured) – 19 days

Initial Testing

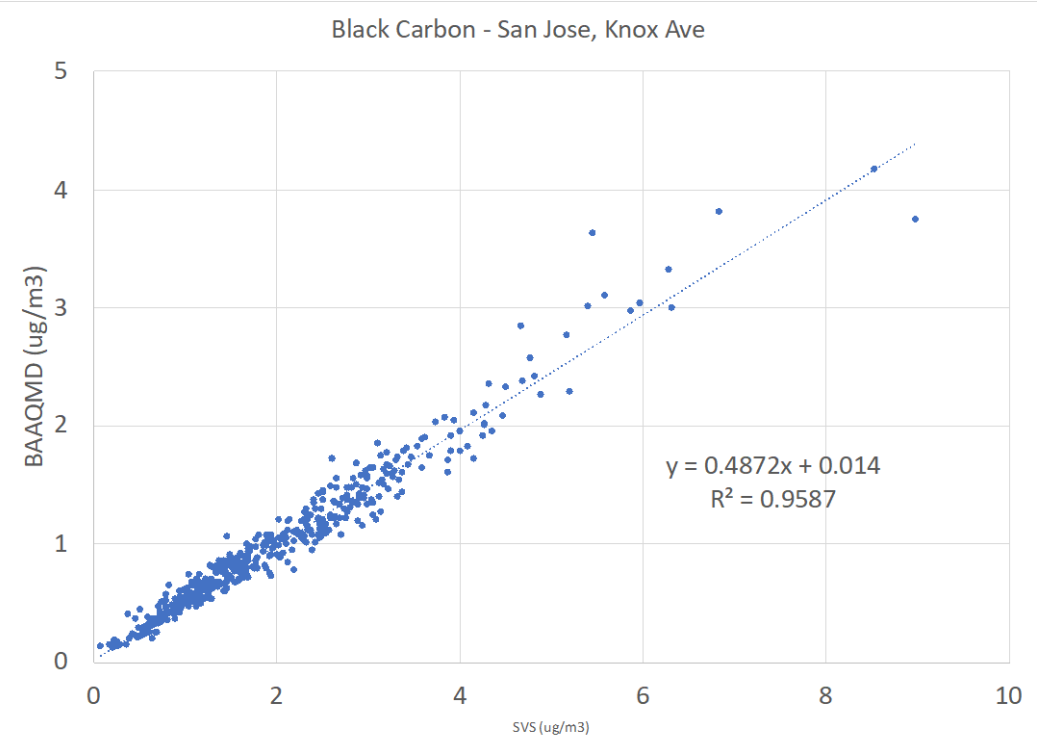
Very good agreement for ozone and NO_2

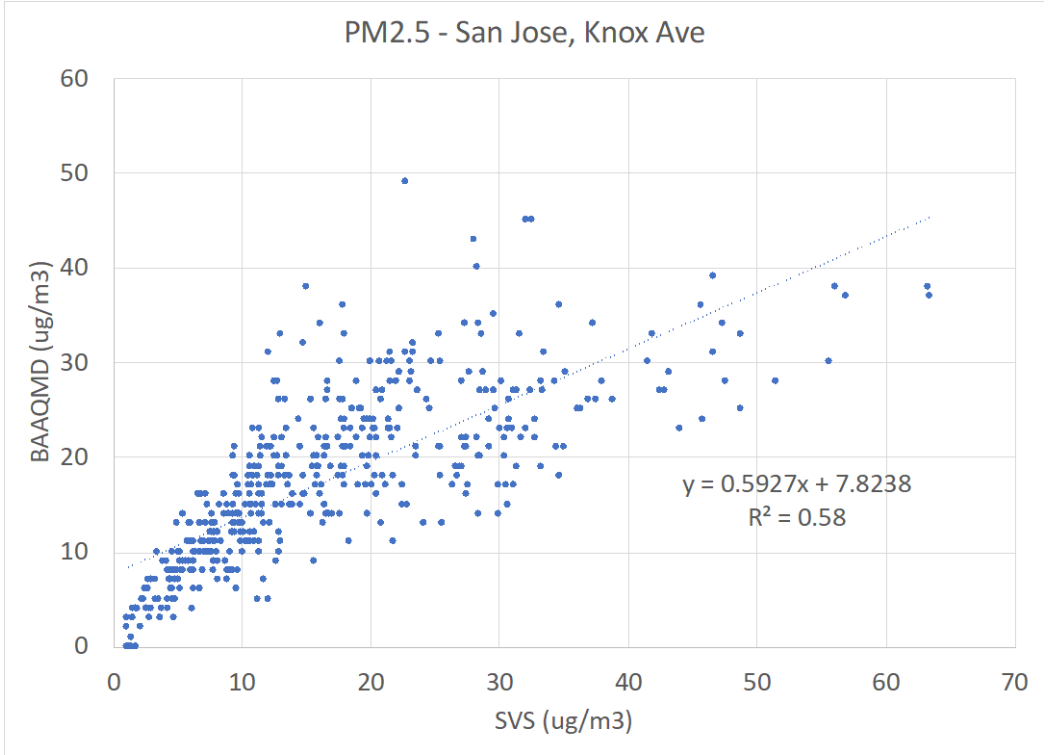




Initial Testing

- Good correlation for black carbon, though adjustment factor needed
- Optical $PM_{2.5}$ measurements potentially impacted by complexity of roadside PM emissions





Example Use

Group: Brightline Defense Project, San Francisco

"The Sensor Verification System has supported the expansion of air quality monitoring capacity for Brightline's community-based network!" - Cecilia Mejia

Need:

- Want to measure NO_2 (BC and $PM_{2.5}$) in San Francisco
- Need to calibrate NO_2 sensors (Clarity) against high-quality data
- NO_2 sensors collecting data for residents in eastern San Francisco for two years

Approach:

- Required collocation of eight (8) sensors; not possible at the Air District site
- Set up SVS in San Francisco
- Installed on an apartment balcony
- Operated for 4 weeks
- Validated data and provided to Brightline Defense and Clarity

Example Use

brightline DEFENSE

SVS collocated with eight Clarity sensors measuring NO_2

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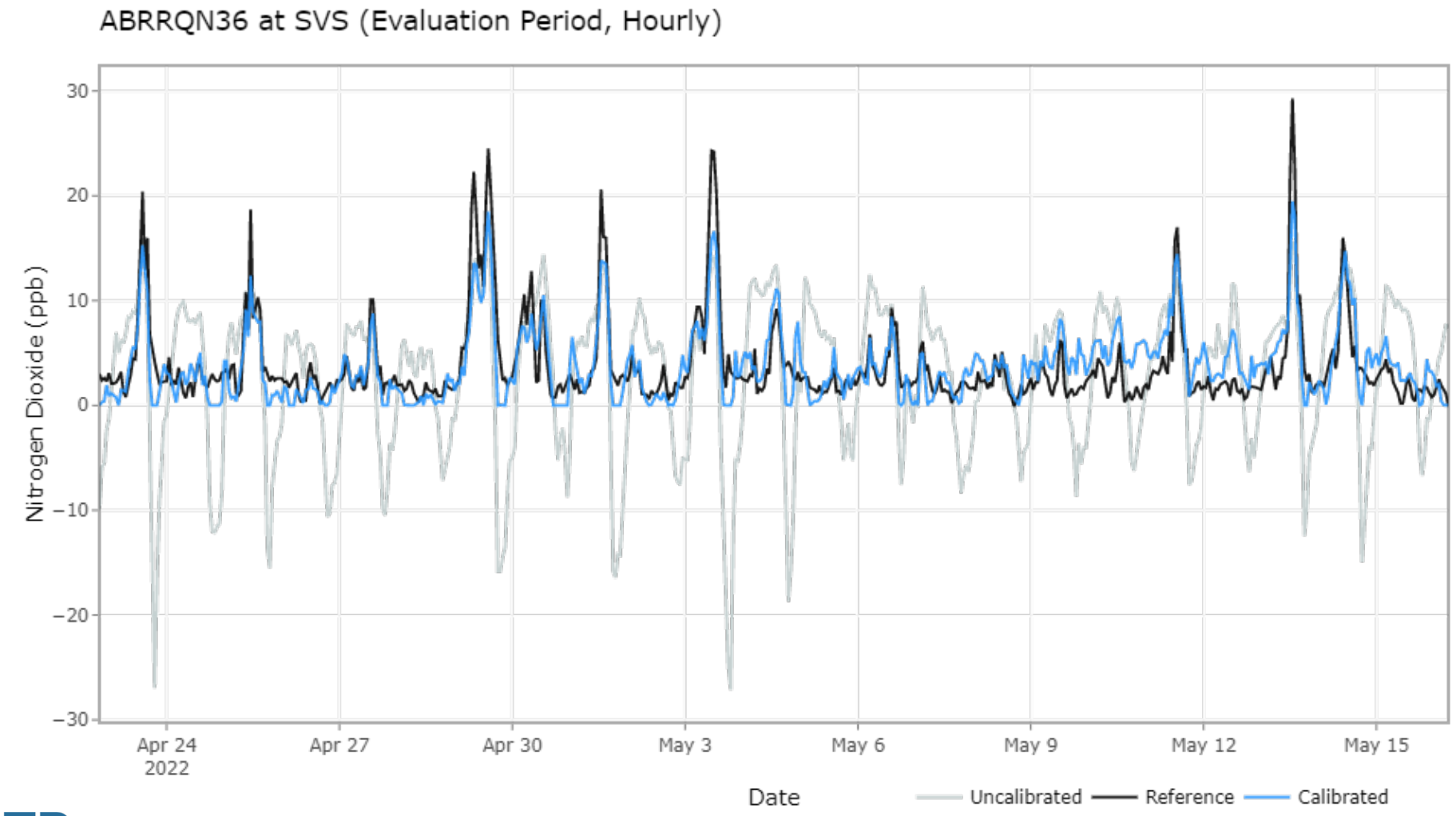
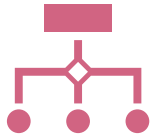
Example Use



Clarity and Brightline used SVS data to calibrate sensor NO_2 data and control for baseline shift in the raw sensor data.

Other uses



Parking Lot Check. Deployment of multiple sensors at the same secure location within or near a specific community operating a sensor network. Secure location required.

Field Check. Deployment lasting less than one day and attended by someone in the field or for longer durations. Deployments to multiple sites in a network over time by moving the SVS.

Demo and Training. Used for several hours at meetings, schools, and training to demonstrate how instruments operate. It could be opened to show the different instruments and equipment.

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