ARRAY OF THINGS

Initial Co-location Results from SPEC Sensors & KWJ Engineering

Ed Stetter, GM/CFO

efs@spec-sensors.com
(510) 574-8300 x 211
www.spec-sensors.com

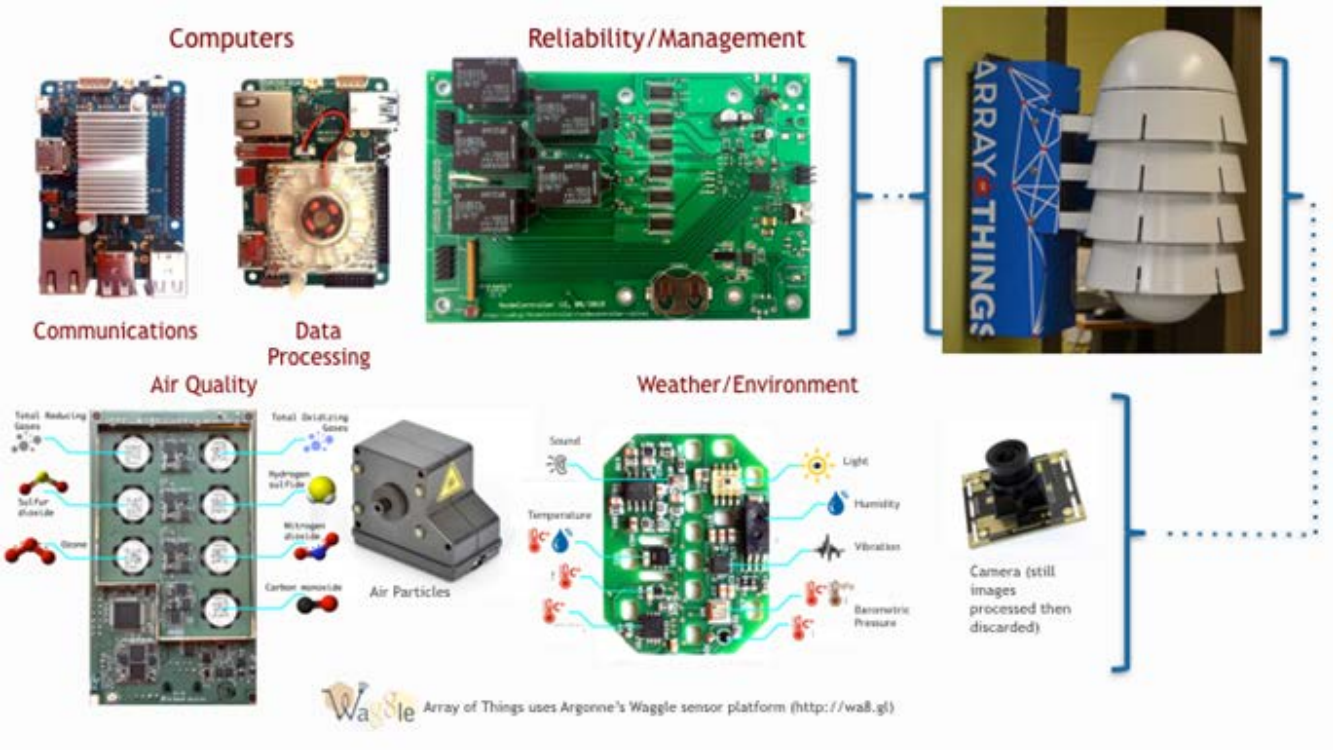
Company History

- Started in 2012 as a partnership between
  - KWJ Engineering, Inc. (USA)
  - Alphasense, Ltd. (UK)
- Purpose
  - To reduce the size and cost of high performance sensors.
  - To expand gas sensing technology into the IoT.
- Low cost, high performance sensors to power the Internet of Things
  - Wireless and wearable – next generation devices

- Expertise:
  - High performance gas sensors and modules
    - Low cost
    - Low power consumption
    - Small size – 5mm – 10 mm.
  - Engineering services
    - Board and system design
    - Calibration
    - Sensor integration
    - Implementation

Array of Things: Fitness Tracker for the City

- University of Chicago, Argonne National Labs, National Science Foundation and Others
  - project to deploy up to 500 sensor nodes in the City of Chicago
  - Whats's Inside?



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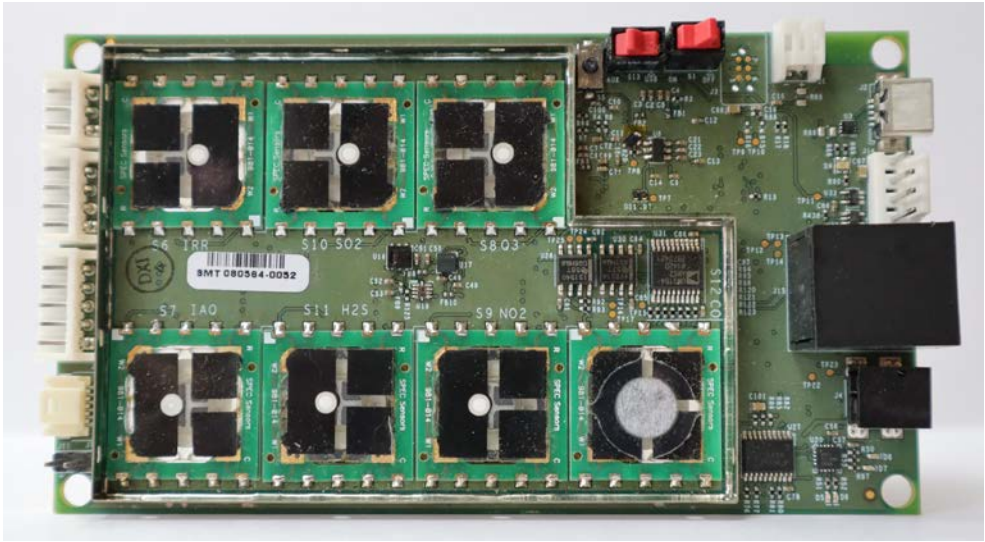
Chemsense Board by KWJ/SPEC

7 sensor air quality boards
Individually zeroed and calibrated in the lab:

- *CO, H_2S, NO_2, SO_2, O_3, Total Oxidizing Gases, Total Reducing Gases*
- *No further Calibration or Zero on Site*



Near 100 devices distributed throughout Chicago

Installed about 15 feet above ground, w/single array. Collocated with NO_2 & O_3 EPA monitor at site in Chicago (Soon with CO monitor)

Raw Data retrieved at 5 second intervals

Raw Data Stored to Cloud

Raw Data corrected for baseline effects of temperature and converted to concentration values in ppm or ppb

Concentrations filtered for cross sensitivity with simple and advanced filter

Signals averaged with 1 hour exp. smoothing, to compare to collocated 1 hour EPA data

NO2 & O3 Measurements March.1st -15th

Hi/Low Temp

-1 to 10 °C

Hi/Low Rh

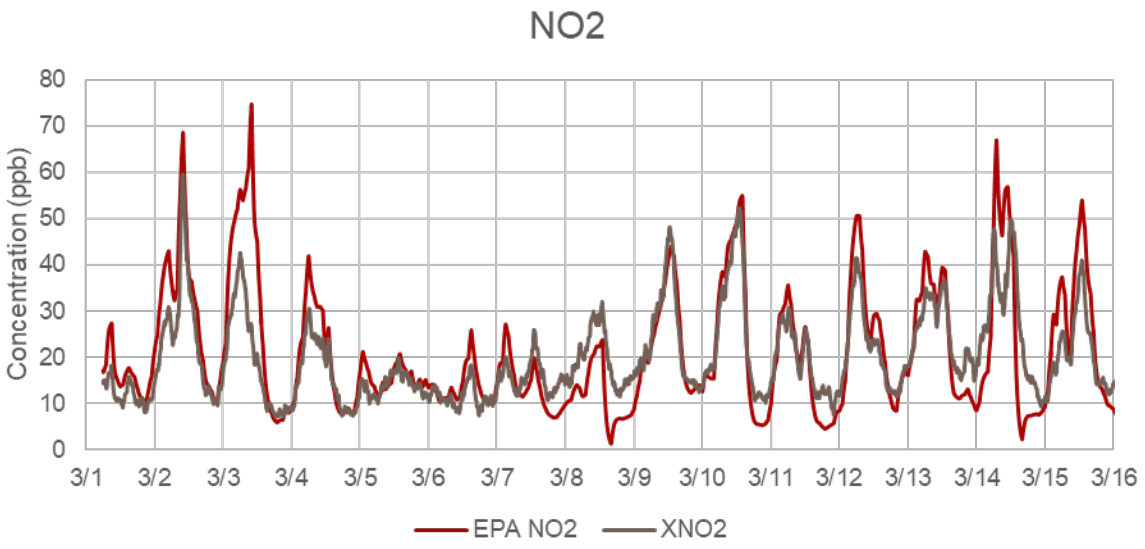
19.5 to 88.8 %

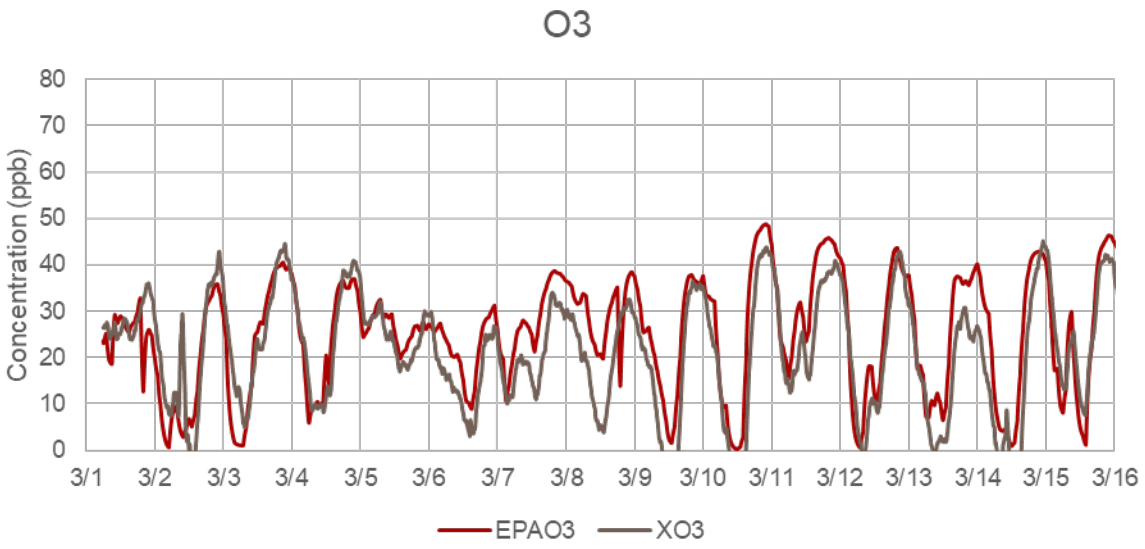
For March 1st to May 10th 2018 the Correlation Values (Excel Corr())

- NO2 0.73
- O3 0.80

Data is 5 minute samples with 1 hour exponential smoothing.

EPA reports at 1 hour intervals.





NO2 & O3 Measurements Apr.20th-May.5th

Hi/Low Temp

4 to 26 °C

Hi/Low Rh

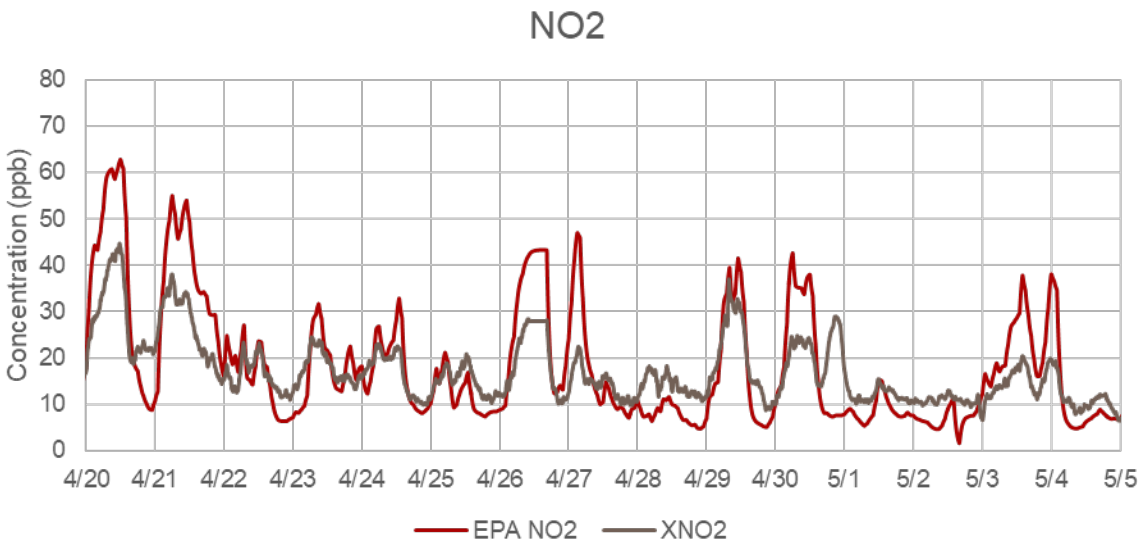
13.2 to 97.6 %

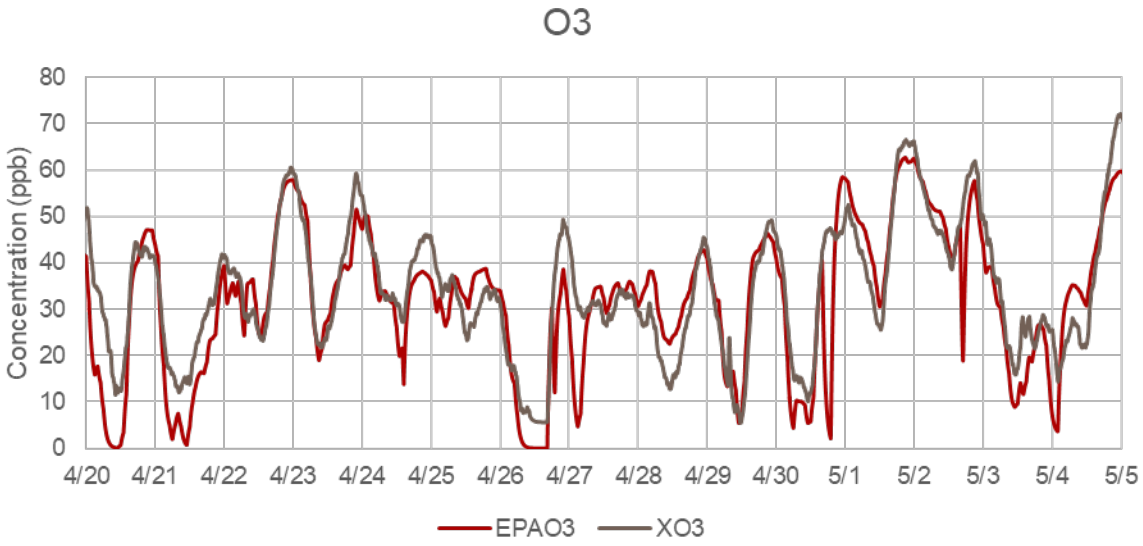
For March 1st to May 10th 2018 the Correlation Values (Excel Corr())

- NO2 0.73
- O3 0.80

Data is 5 minute samples with 1 hour exponential smoothing.

EPA reports at 1 hour intervals.





NO2 Total Correlation

March 1st -May 10th

Hi/Low Temp

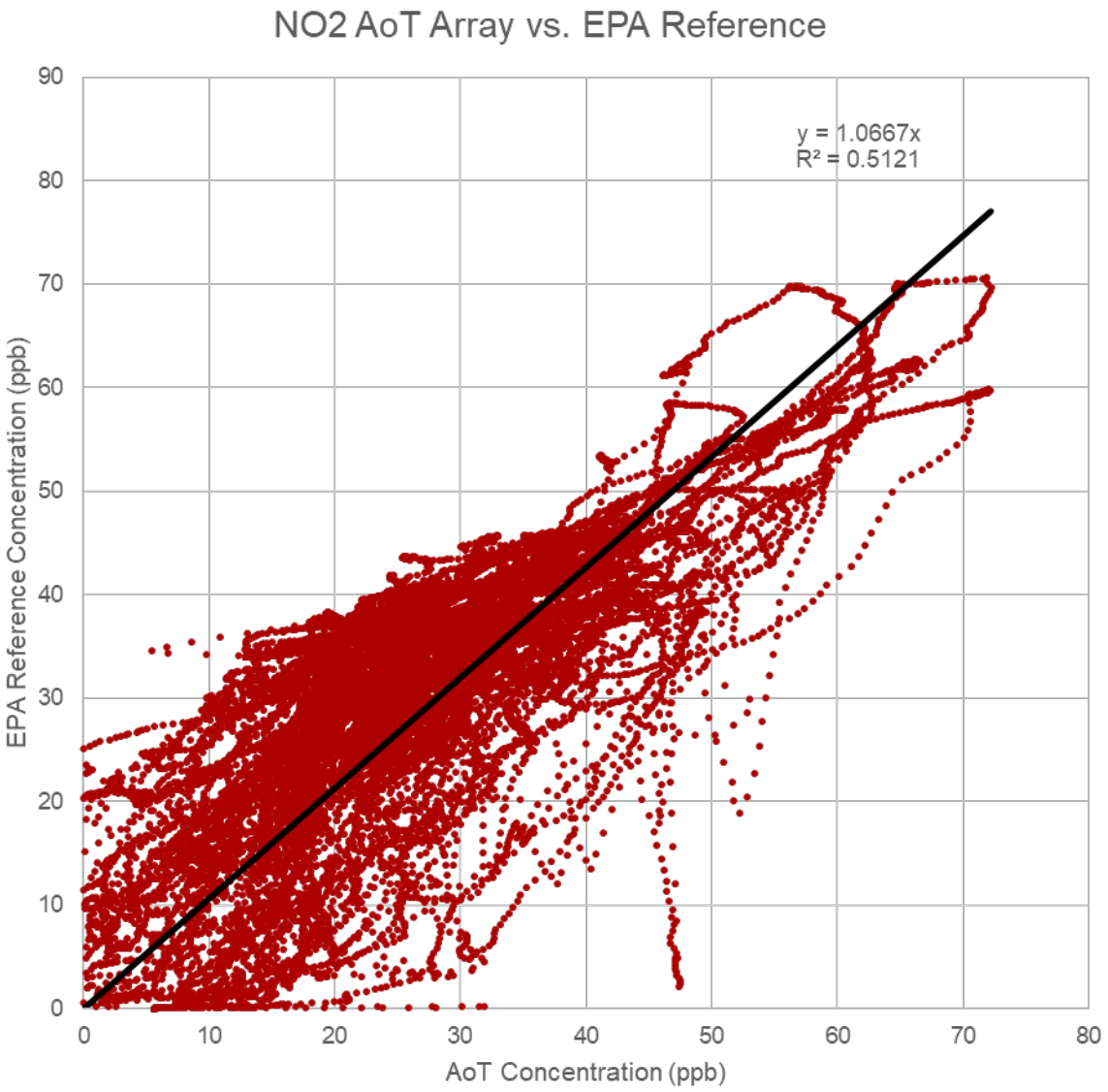
-1.6 to 26.0 °C

Hi/Low Rh

13.2 to 97.6 %

For March 1st to May 10th 2018 the Correlation Values (Excel Corr())

- NO2 0.73



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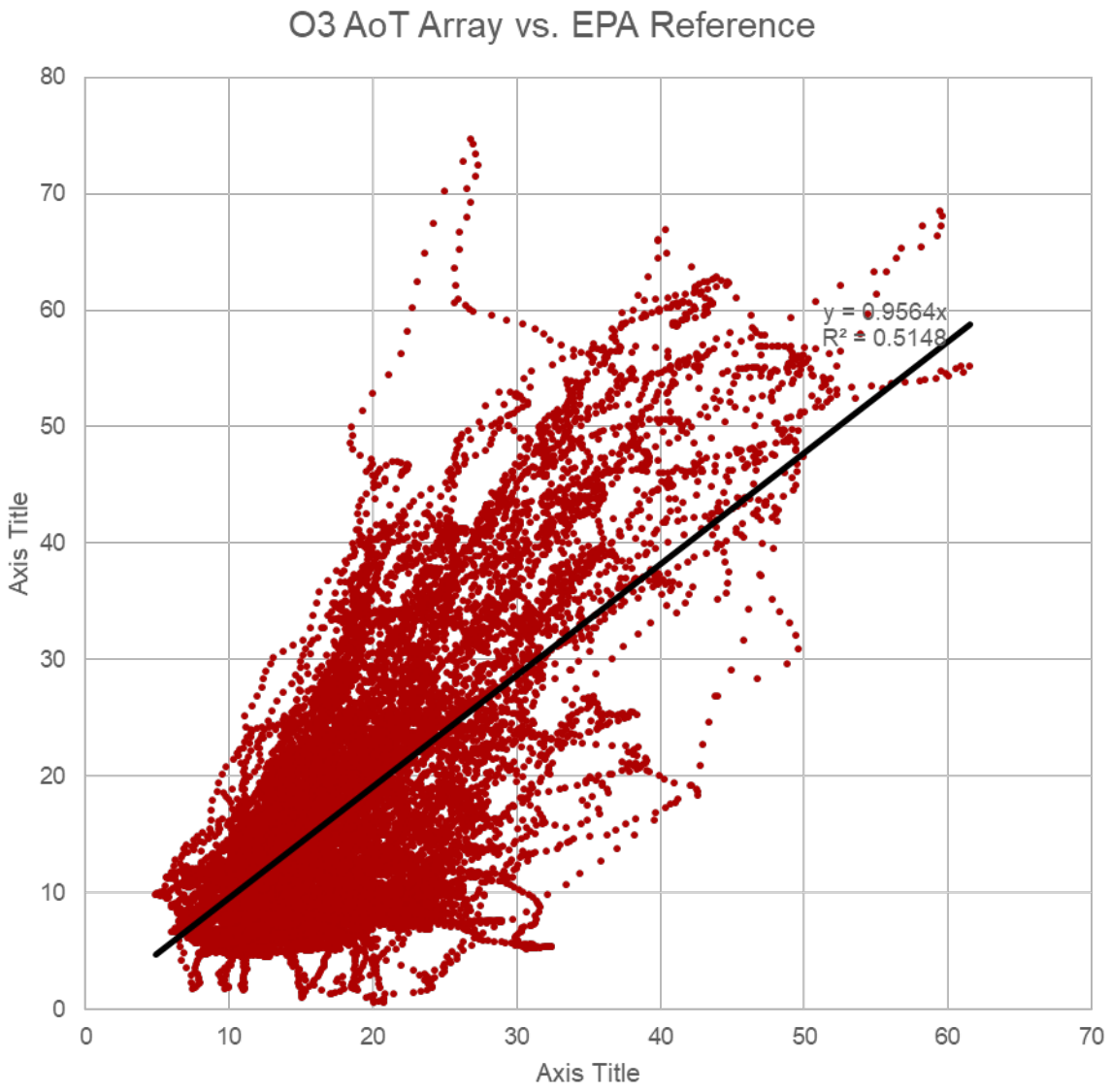


CO and H_2S Measured

March 1st -May 10th

Hi/Low Temp

4 to 26 °C

Hi/Low Rh

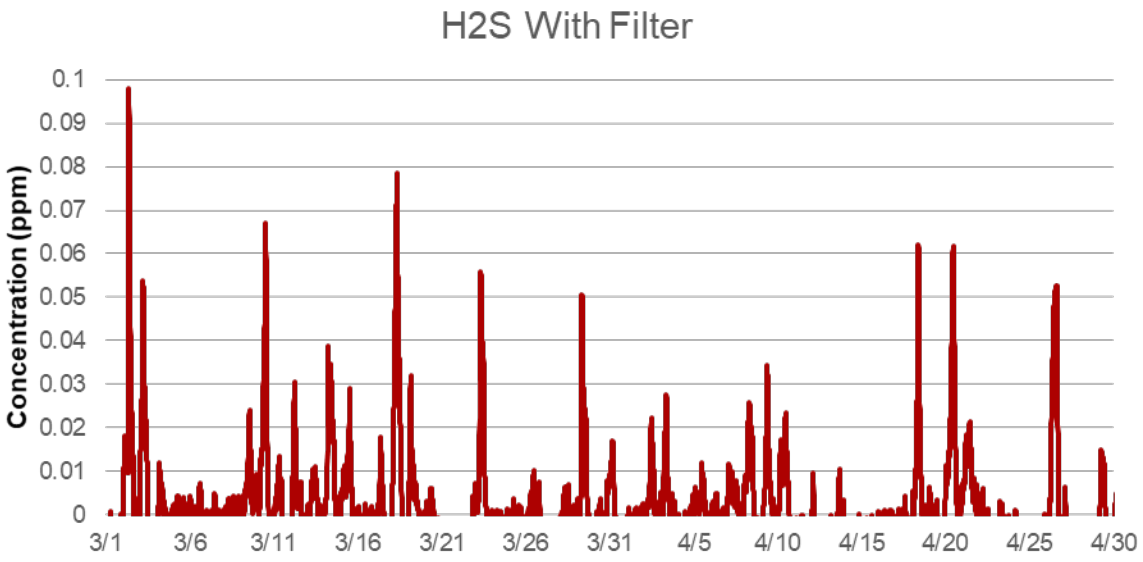
13.2 to 97.6 %

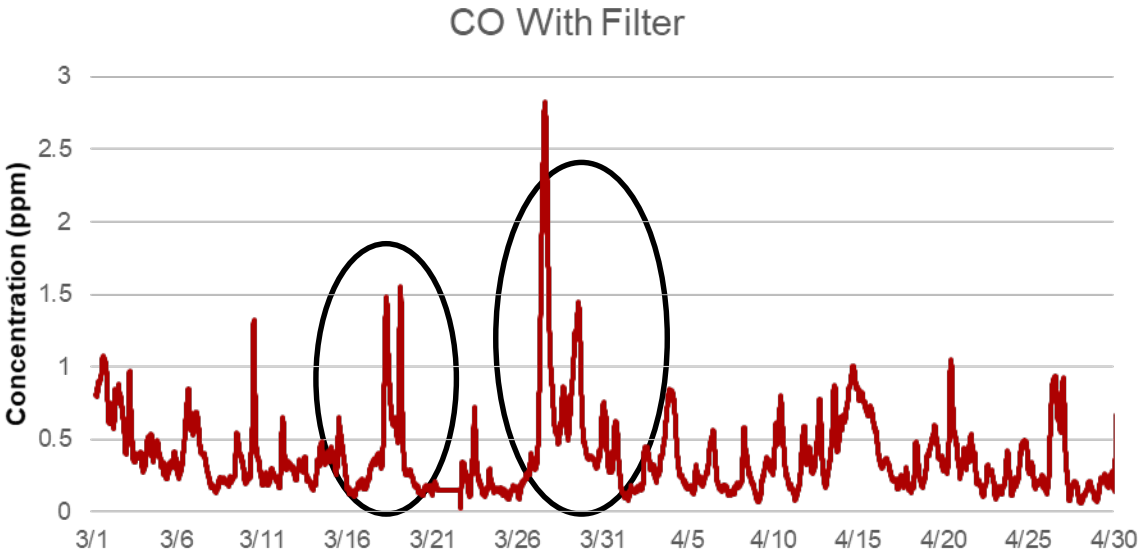
Peaks typically occur over one day.

2 major CO events observed in March.

Data is 5 minute samples with 1 hour exponential smoothing.

EPA reports at 1 hour intervals.





Results

- 6 months of outdoor co-location data for NO2 and O3 at EPA site in Chicago
- 70%-80% correlation to reference for NO2 and O3
  - Resolution/LDL = <10ppb
  - Correlation can be improved with calibration/zero at device level
  - Cross sensitivities impact correlation – Transients
- CO - <100ppb resolution
- H2S – <10ppb resolution
- Data will soon become available to the public for all 100 sites in Chicago

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The Benefits to the City

- Better health and quality of life for residents
  - Immediate and makes the entire city more attractive
- Information and advanced warning
  - Better and more efficient services
    - Early fire and leak detection – fire, police and other services
    - Sanitary & Garbage service
    - Traffic improvement
    - Transportation for people and industry
    - Urban planning
- What can you do with the Data?

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