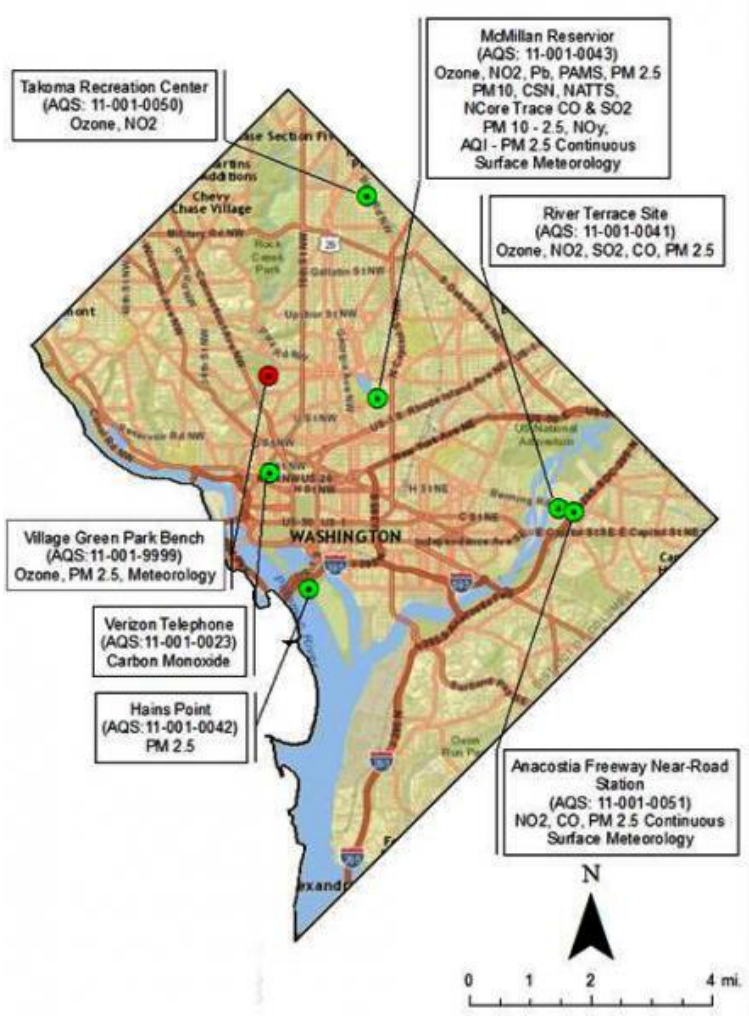
FRESH AIR DC

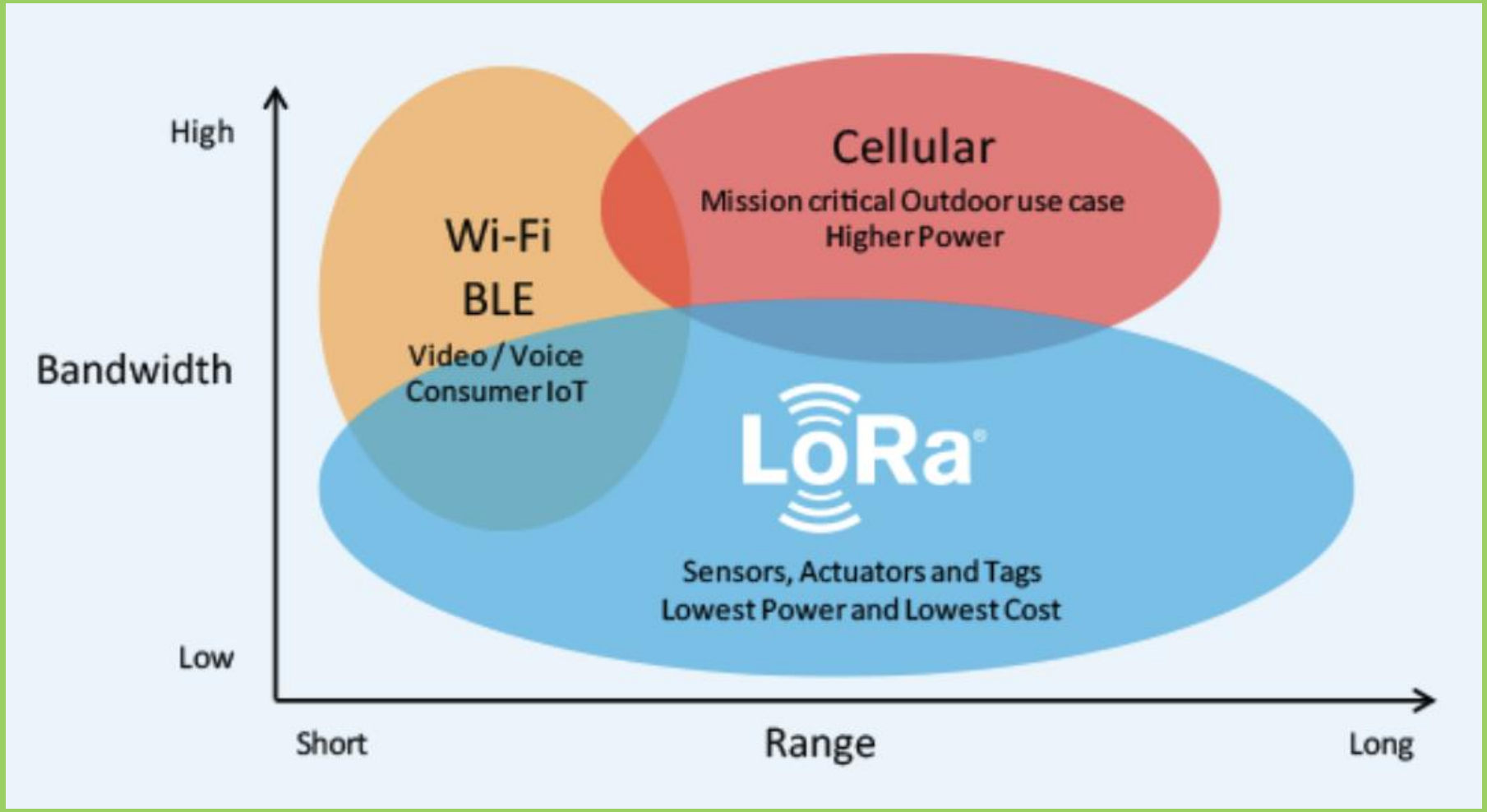
Fall 2019

What is Fresh Air DC?

A **student-run** and **community focused** research project about air quality.

The project's goal is to create a network of **low-cost air quality monitors** at the **neighborhood level** in Washington DC while engaging local communities and involving them in the research.

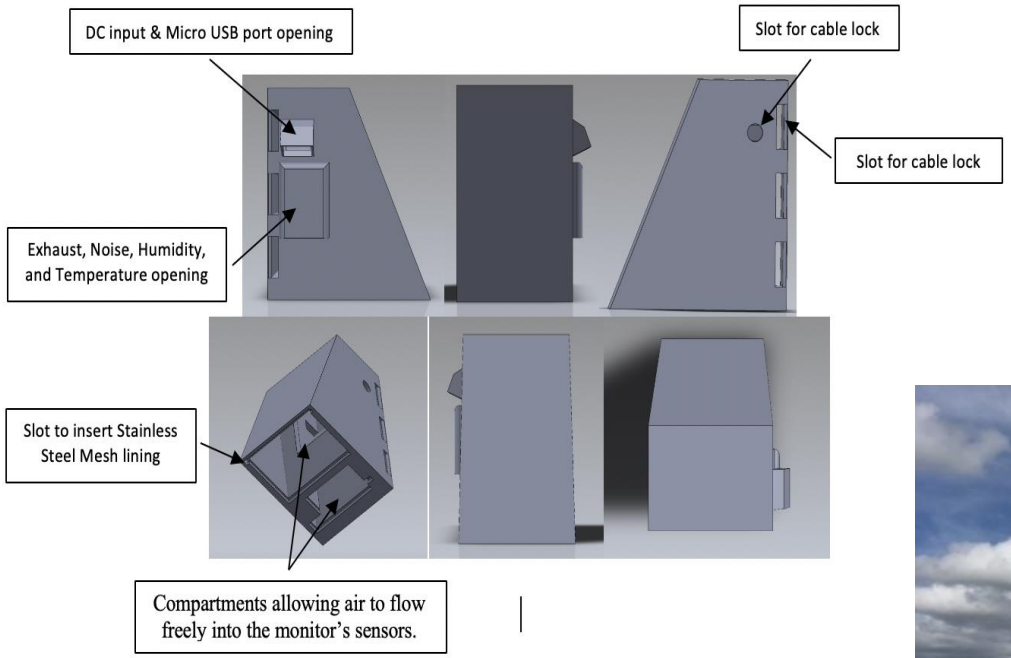

Takoma Recreation Center
(AQS: 11-001-0050)
Ozone, NO2
McMillan Reservior
(AQS: 11-001-0043)
Ozone, NO2, Pb, PAMS, PM 2.5
PM10, CSN, NATTS,
NCore Trace CO & SO2
PM 10 - 2.5, NOy,
AQI - PM 2.5 Continuous
Surface Meteorology
River Terrace Site
(AQS: 11-001-0041)
Ozone, NO2, SO2, CO, PM 2.5
Village Green Park Bench
(AQS:11-001-9999)
Ozone, PM 2.5, Meteorology
Verizon Telephone
(AQS:11-001-0023)
Carbon Monoxide
Hains Point
(AQS:11-001-0042)
PM 2.5
Anacostia Freeway Near-Road
Station
(AQS: 11-001-0051)
NO2, CO, PM 2.5 Continuous
Surface Meteorology
WASHINGTON
N
0
1
2
4 mi.


High
Bandwidth
Low
Short
Range
Long
Cellular
Mission critical Outdoor use case
Higher Power
Wi-Fi
BLE
Video / Voice
Consumer IoT
LoRa
Sensors, Actuators and Tags
Lowest Power and Lowest Cost

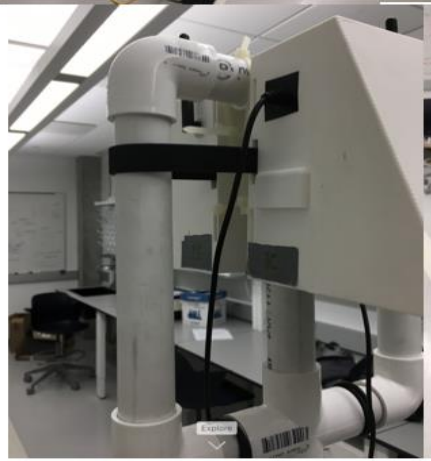
Monitor Testing & Evaluation Progress

- Designed & Printed Cases for the Monitors
- Created a Mounting System for the monitors
- Successfully range tested around campus
- Installed a Gateway and Monitor at the residence of a member of the LeDroit Park Community
- Co-Located five uRAD Air Quality Monitors at the Department of Energy and Environment's River Terrace Location
- Collected data from five uRAD monitors co-located at the River Terrace Site from April 29th – Today

Cases

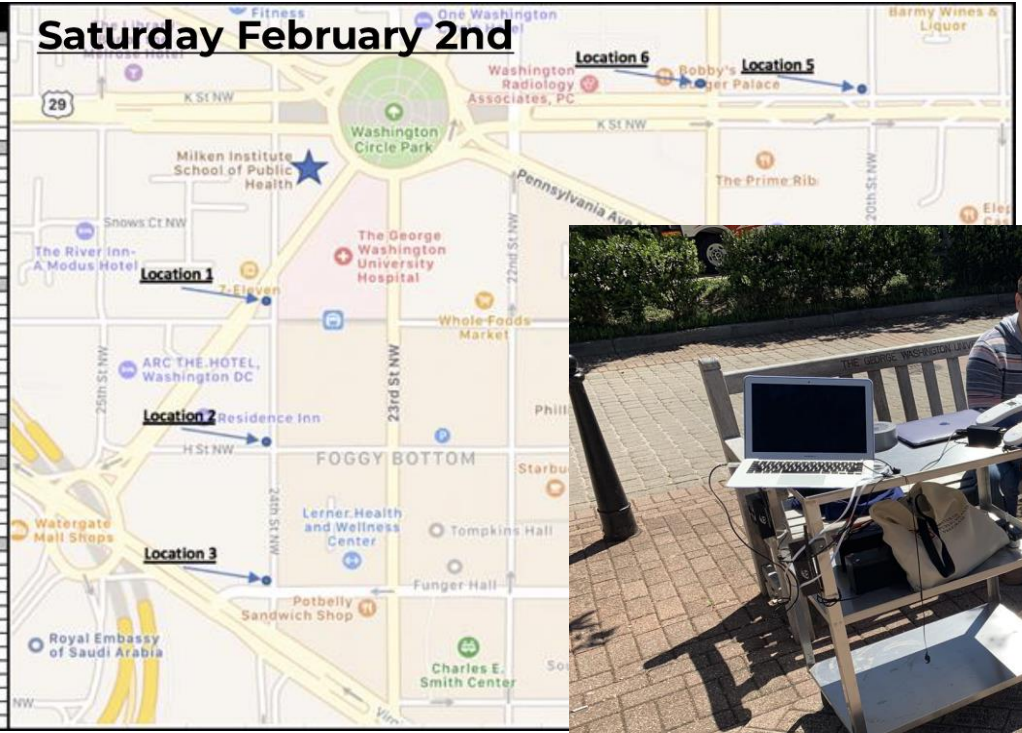

DC input & Micro USB port opening
Slot for cable lock
Slot for cable lock
Exhaust, Noise, Humidity, and Temperature opening
Slot to insert Stainless Steel Mesh lining
Compartments allowing air to flow freely into the monitor's sensors.

Mounting System

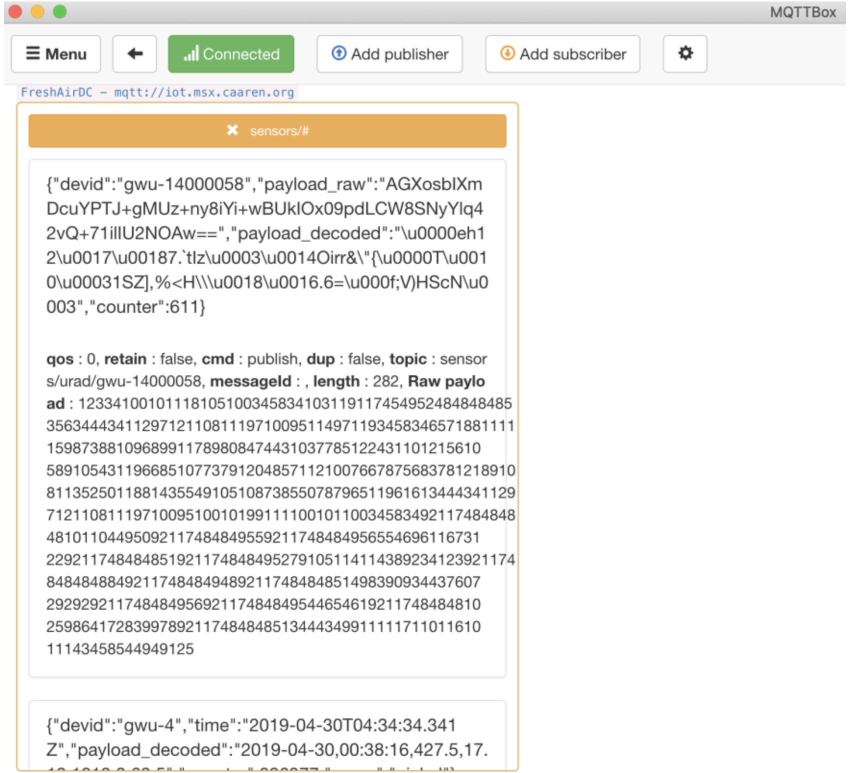


Range Testing

Monitor Range Test Log (February 2nd, 2019)	
Location 1 (Intersection of 24th and Nw Hamphair Ave.)	
12:53PM	Monitors 14000017 & 14000019 were turned on
	Monitor 14000017 sent data
12:57PM	Monitor 14000019 sent data
1:04PM	Monitor 14000019 sent data
1:12PM	Monitor 14000017 sent data
	Monitor 14000019 sent data
1:13PM	Turned monitors off and moved locations
Location 2 (Intersection of 24th and H Street)	
1:17PM	Monitors 14000017 & 14000019 were turned on
	Monitor 14000017 sent data
	Monitor 14000019 sent data
1:19PM	Monitor 14000017 sent data
1:21PM	Monitor 14000017 sent data
1:33PM	Monitor 14000017 sent data
1:35PM	Monitor 14000017 sent data
1:36PM	Monitor 14000017 sent data
1:37PM	Turned monitors off and moved locations
Location 3 (Intersection of 24th and Virginia Avenue)	
1:44PM	Monitors 14000017 & 14000019 were turned on
	Monitor 14000017 sent data
1:48PM	Monitor 14000017 sent data
1:51PM	Monitor 14000017 sent data
1:52PM	Monitor 14000017 sent data
	Monitor 14000019 sent data
1:57PM	Monitor 14000019 sent data
2:01PM	Monitor 14000017 sent data
2:04PM	Turned monitors off and took a break
Location 4 (Intersection of 20th Sreet and Pennsylvania Avenue)	
4:53PM	Monitors 14000017 & 14000019 were turned on
5:13PM	Turned monitors off and moved locations
Location 5 (Intersection of K and 20th Street)	
5:15PM	Monitors 14000017 & 14000019 were turned on
5:16PM	Monitor 14000017 sent data
	Monitor 14000019 sent data
5:17PM	Monitor 14000017 sent data
5:35PM	Turned monitors off and moved locations
Location 6 (Intersection of K and 21st Street)	
5:39PM	Monitors 14000017 & 14000019 were turned on
5:40PM	Monitor 14000019 sent data
5:42PM	Monitor 14000017 sent data
5:43PM	Monitor 14000017 sent data
5:46PM	Monitor 14000017 sent data
	Monitor 14000019 sent data
5:48PM	Monitor 14000017 sent data
5:50PM	Monitor 14000017 sent data
5:52PM	Monitor 14000017 sent data
5:54PM	Lost WIFI connection
5:56PM	Connected to cell phone hot spot and reconnected to MQTT Box
	Monitor 14000017 sent data
5:57PM	Turned monitors off and finished range testing for the day



MQTT Box


MQTTBox
Menu
Connected
Add publisher
Add subscriber
FreshAirDC – mqtt://iot.msx.caaren.org
sensors/#
{"devid":"gwu-14000058","payload_raw":"AGXosblXmDcuYPTJ+gMUz+ny8iYi+wBUklOx09pdLCW8SNyYlq42vQ+71illU2NOAw==","payload_decoded":"\u0000eh12\u0017\u00187.`tlz\u0003\u0014Oirr&\"{\u0000T\u0010\u00031SZ],%<H\\\u0018\u0016.6=\u000f;V)HScN\u0003","counter":611}
qos : 0, retain : false, cmd : publish, dup : false, topic : sensors/urad/gwu-14000058, messageId : , length : 282, Raw payload : 12334100101118105100345834103119117454952484848485356344434112971211081119710095114971193458346571881111159873881096899117898084744310377851224311012156105891054311966851077379120485711210076678756837812189108113525011881435549105108738550787965119616134443411297121108111971009510010199111100101100345834921174848484810110449509211748484955921174848495655469611673122921174848485192117484849527910511411438923412392117484848488492117484849489211748484851498390934437607292929211748484956921174848495446546192117484848102598641728399789211748484851344434991111171101161011143458544949125
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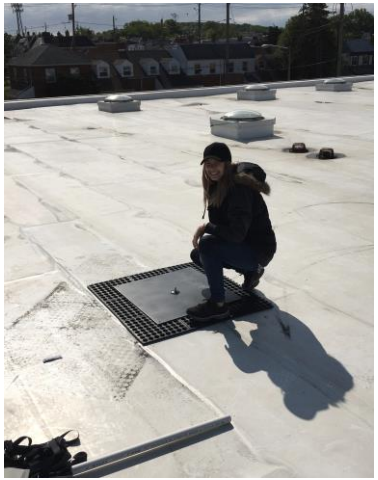
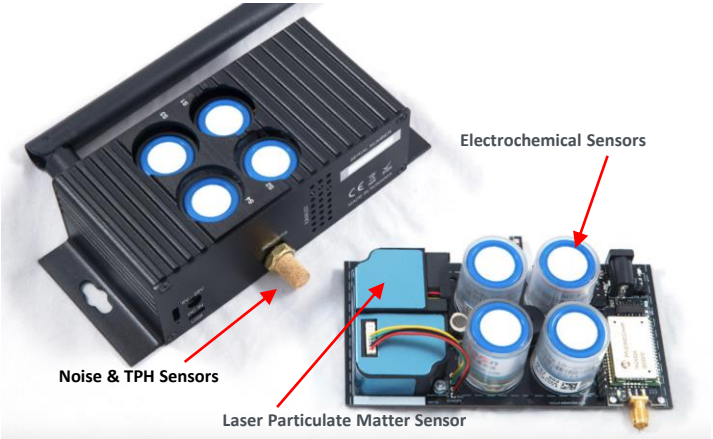
DOEE Co-Location Experiment



uRAD Industrial Monitor



Electrochemical Sensors

-Low power requirements

-Less affected by interfering gasses

-Lower detection limits

Noise & TPH Sensors

-Noise pollution is significant to evaluate, especially in urban environments like DC. This, along with air pollution negatively impacts the quality of life of DC residents.

-Temperature, Pressure & Humidity are important factors when interpreting the data that is received from the sensors

Laser Particulate Matter Sensor

-Wide and dynamic measuring range

-Rapid measuring technique

-Absolute method that's grounded in scientific principles

uRAD Industrial Monitor (Firmware Versions)

- Firmware Version 139
  - 14000018
  - 1400001A
  - 1400001C
- Firmware Version 59
  - 14000058
  - 1400005A
- Firmware Version 60

All uRAD monitors are placed within three meters of the the Department of Energy and Environment (DOEE) equipment and are within one foot of each other to ensure the same air samples are being recorded on all devices.

uRAD Continued

Sensor	Parameter
Bosch BME280	Temperature
	Pressure
	Humidity
Winsen ZH03A	PM1.0
	PM2.5
	PM10
Winsen MP503	VOC
SPU414/MAX4466	Noise level
* Winsen ZE03-O3	Ozone
* Winsen ZE03-CO	Carbon Monoxide
* Winsen ZE03-SO2	Sulphur Dioxide
* Winsen ZE03-NO2	Nitrogen Dioxide

1. uRADMonitor model INDUSTRIAL uses laser scattering sensor to measure Particulate Matter PM1, PM2.5 and PM10 concentrations in air.
2. Four additional electrochemical sensors measure Carbon Monoxide, Sulphur Dioxide, Nitrogen Dioxide and Ozone by default, interchangeable to support additional gases.
3. The Bosch BME280 MEMS sensor reads ambient temperature, pressure and humidity, and a noise sensor measures the noise level.
4. A built in fan assures an active air flow stream across the sensing elements.

Department of Energy and Environment (DOEE)

DOEE Equipment Introduction:

The air quality monitoring equipment at all DOEE monitoring sites (including River Terrace) is FRM/FEM equipment. The EPA designates Federal Reference Methods (FRM) and Federal Equivalent Methods (FEMs); these methods for measuring ambient concentrations of specified air pollutants have been designated as “reference methods" or "equivalent methods" in accordance with Title 40, Part 53 of the Code of Federal Regulations (40 CFR Part 53). DOEE operates the following:

BAM 1022 **PM2.5** Sampler (Designation Number: EQPM-1013-209)

Thermo 42i NO-**NO2**-NOx Analyzer (Automated Reference Method: RFNA-1289-074)

Thermo 49i **O3** Analyzer (Automated Equivalent Method: EQOA-0880-047)

Teledyne T100U **SO2** Analyzer (Automated Equivalent Method: EQSA-0495-100)

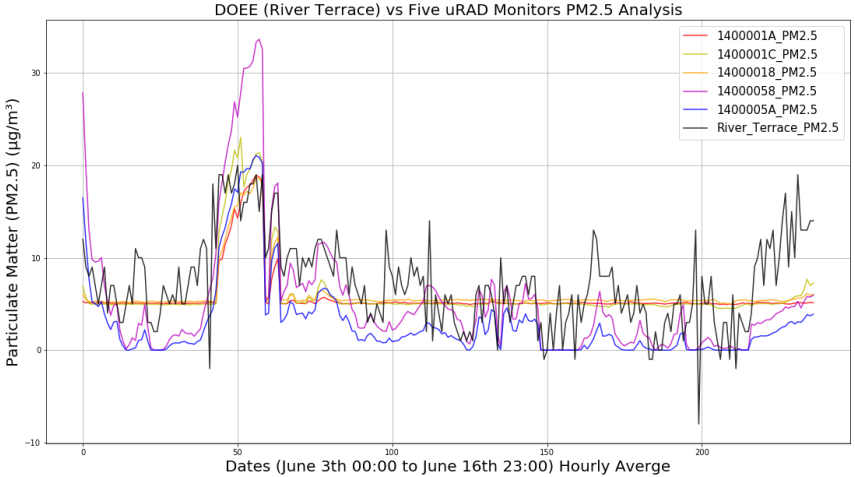
Objectives of Co-location Experiment

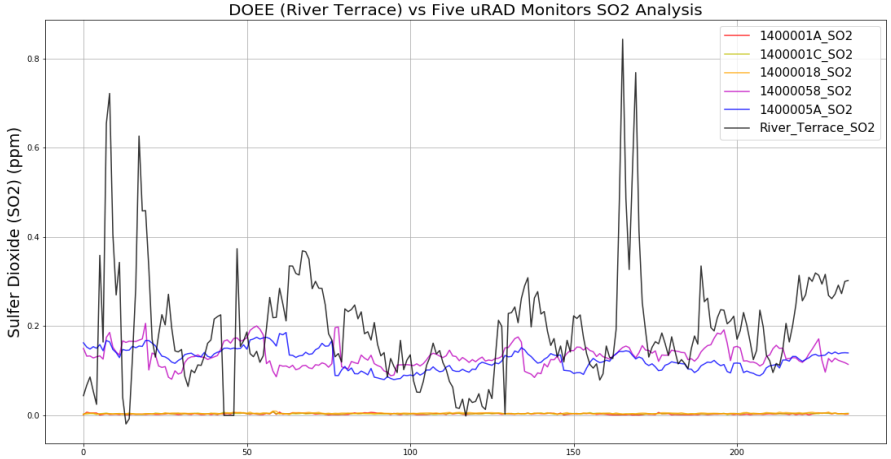
By co-locating the uRAD INDUSTRIAL Monitors alongside Department of Energy and Environment (DOEE) equipment using Federal Reference Methods (FRM) and Federal Equivalent Methods (FEMs), we are looking for a correlation between the two to ensure the uRAD sensors, once deployed into communities throughout the District of Columbia are sending air quality data that aligns with the Environmental Protection Agency's Federal Regulatory Equipment.

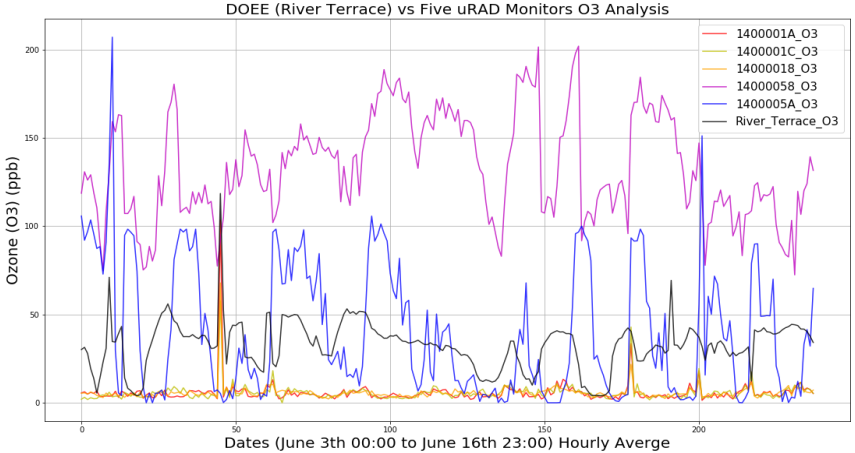
In order to achieve this goal the following data covers the period from 3 June, 2019 – 16 June, 2019.

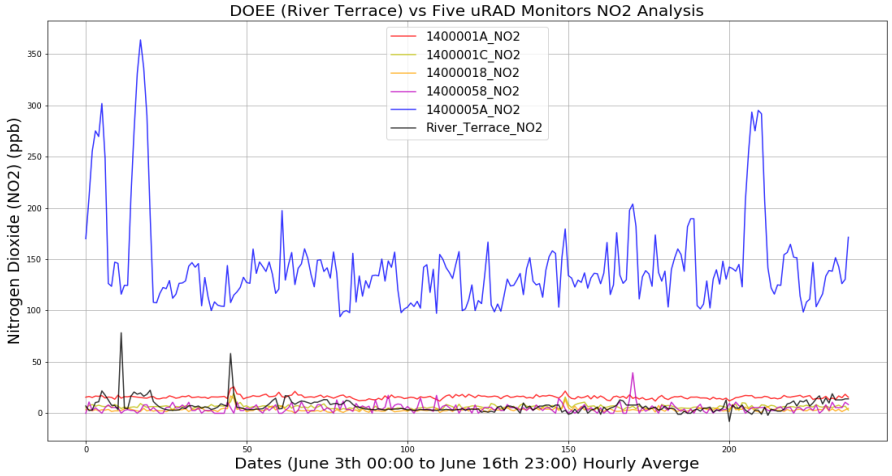
The data collected during this period from the uRAD monitors were compared to the data collected by the DOEE equipment

Time Series Plot







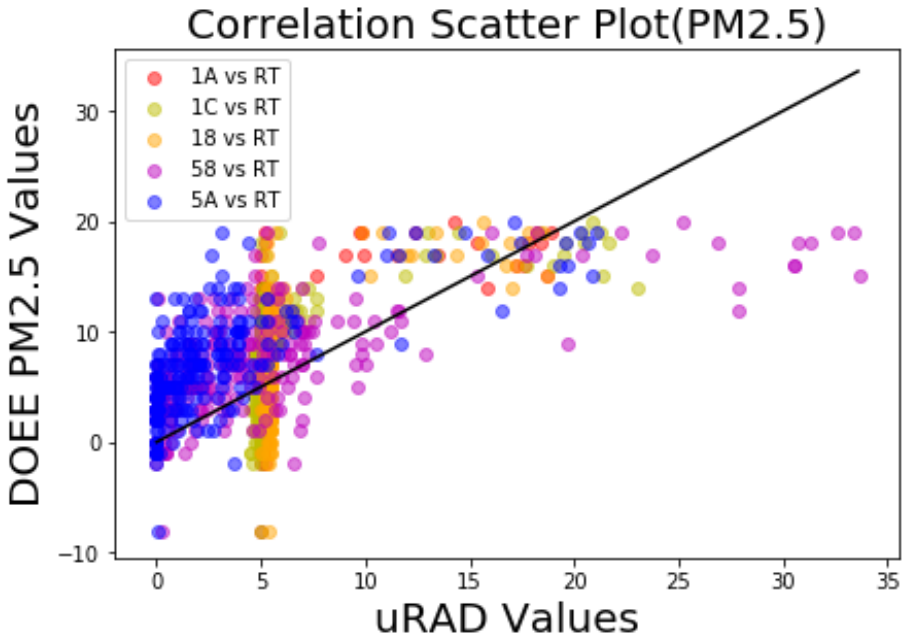


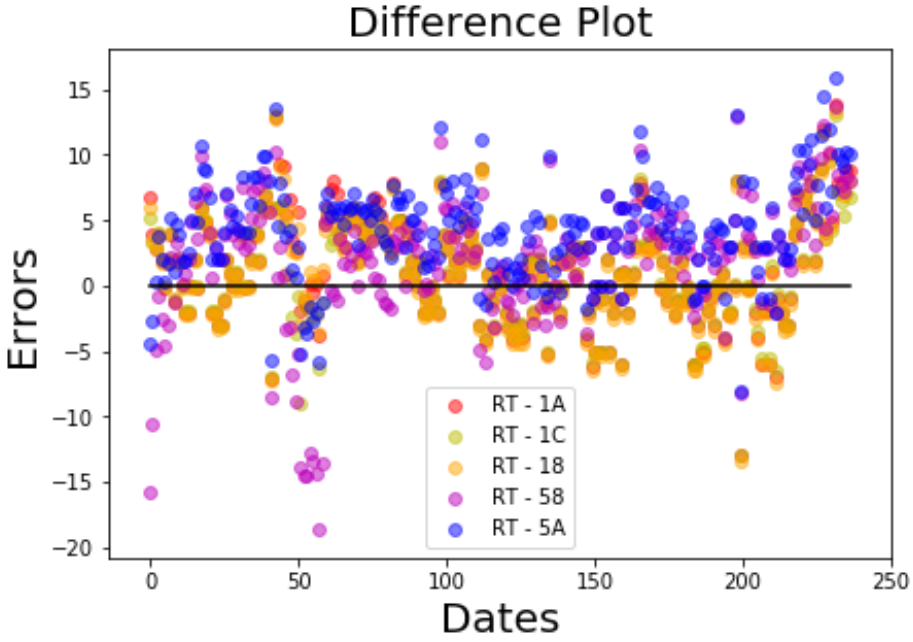
Correlation Table (PM2.5)

Correlation between the Five uRAD Monitors					
	1400001A_PM2.5	**1400001C_PM2.5**	**14000018_PM2.5**	**14000058_PM2.5**	**1400005A_PM2.5**
1400001A_PM2.5	1				
1400001C_PM2.5	0.97	1			
14000018_PM2.5	0.99	0.986	1		
14000058_PM2.5	0.87	0.887	0.882	1	
1400005A_PM2.5	0.889	0.91196	0.9041	0.9949	1

Correlation between the Five uRAD Monitors and DOEE (River_Terrace) Equipment					
	1400001A_PM2.5	**1400001C_PM2.5**	**14000018_PM2.5**	**14000058_PM2.5**	**1400005A_PM2.5**
River_Terrace_PM2.5	0.55	0.61	0.58	0.68	0.68

Correlation Scatter Plot and Difference Plot (PM2.5)





Database

Why is it important that we create our own database?

- Data Security
- Data Backup
- Faster
- No Limitation

Why is it important to learn how to use database ?

Python Tutorials and Project Instructions

link: https://github.com/LihuaPeiNeo/Fresh_Air_DC_neo

Thanks!

ANY QUESTIONS?