Wood smoke monitoring kits

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Alternate Title

The **PAQM** – **Portable Air Quality Monitoring** Systems for Responding to Highly Localized Pollution Concerns

Overview

- Design and build 8 mobile air quality enclosures
  - Rapid assessment of air quality concerns (specifically **wood smoke** concerns)
  - Flexible and mobile system to address extremely localized events
- Goals
  - Enclosures should be durable, weatherproof
  - Known precision and accuracy (tested and/or known instruments)
  - Affordable

Single wood smoke emission source

Wood smoke haze over a large area in the Adirondacks

Fire earlier this month at Lackawana (near Buffalo, NY).

© Christopher Zak

Measurement Platform

- American Products Enclosure 46"Hx24"Wx18"D – one inch thick foam insulation

Power, Heating, Ventilation

- Power – single 110VAC, 15 or 20 A circuit (24 V and 5 V DC converters inside for sensors)

- Heating – 300 W heater and internal fan

- Ventilation – fan mounted on door

- Control – Omron controller with three goals –
    - Avoid condensation in warm weather
    - Keep inside above 10°C
    - Ventilate the system when T > 30°C

Weather Sensor

- LUFFT WS-500 measures
  - Temperature
  - Relative Humidity
  - Barometric Pressure
 - Wind Speed
  - Wind Direction

Pollutant Measurements

- PM$_{2.5}$ (and other PM fractions) – optical scatter methods - Thermo pDR 1500 and TSI DustTrak DRX

- Black Carbon (Aerosol) – Magee AE33 aethalometer and Brechtel TAP (Tricolor Absorption Photometer)

- Carbon Monoxide (CO) – and potential other gaseous pollutants – Alphasense electrochemical sensors

- VOCs (esp. toxics) – RAE systems ppbRAE 3000

- Whole air samples – canister sampler

- Other user selected options

Rochester, NY Deployments
## March – September 2016
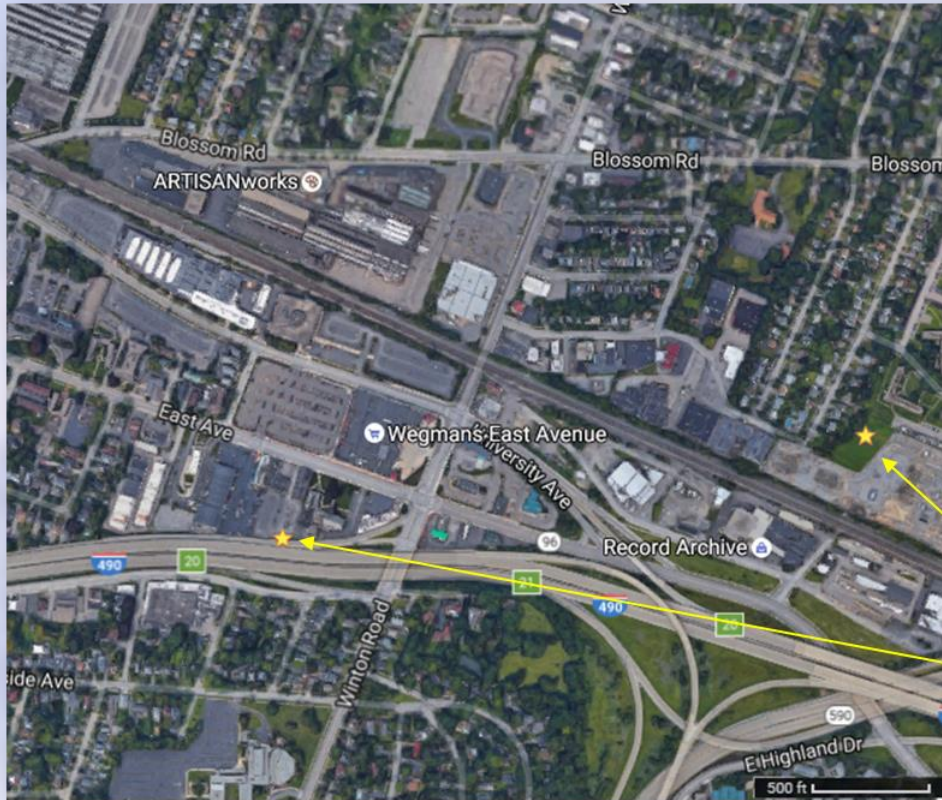
DEC Main Site

DEC Near Road Site

Goals of Deployments

1. Verify system operation

2. Perform measurements and retrieve data for months or longer

3. Test "portable" instruments against established methods at DEC sites

   - DEC Main Site – PAQM contained pDR 1500 and DustTrak DRX for $PM_{2.5}$, and Alphasense CO monitor (DEC site had compliance $PM_{2.5}$ and CO measurements)

   - DEC Near Road Site – PAQM contained pDR 1500 and Magee AE33 and Brechtel TAP for black carbon (DEC site had compliance $PM_{2.5}$ and Magee AE33)

PM$_{2.5}$ TEOM and pDR comparison – near road site
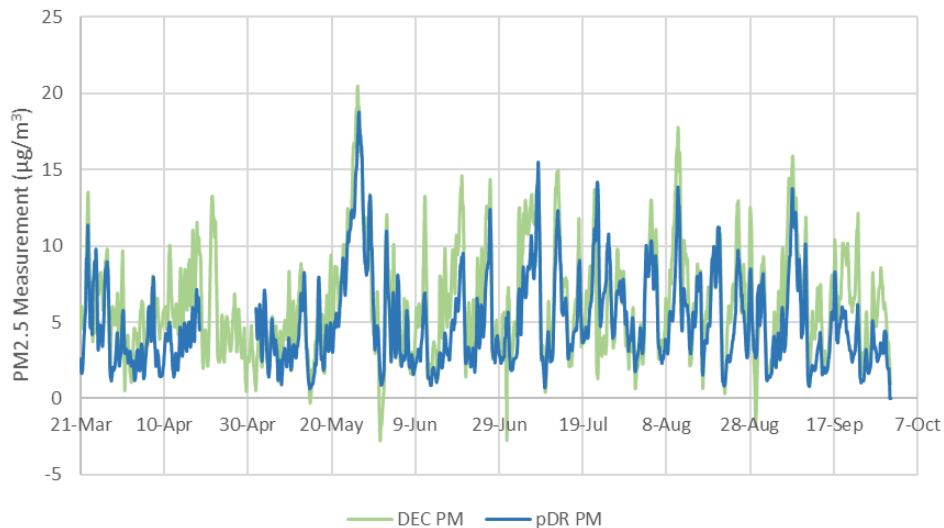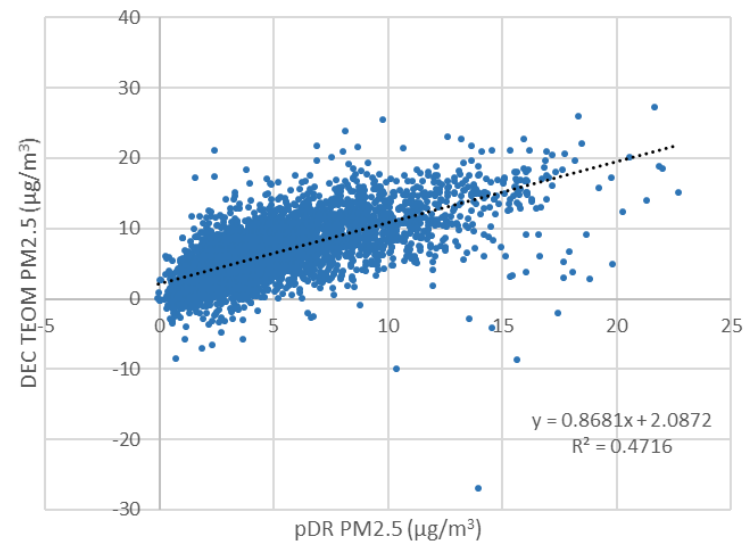
One hour averaged data:
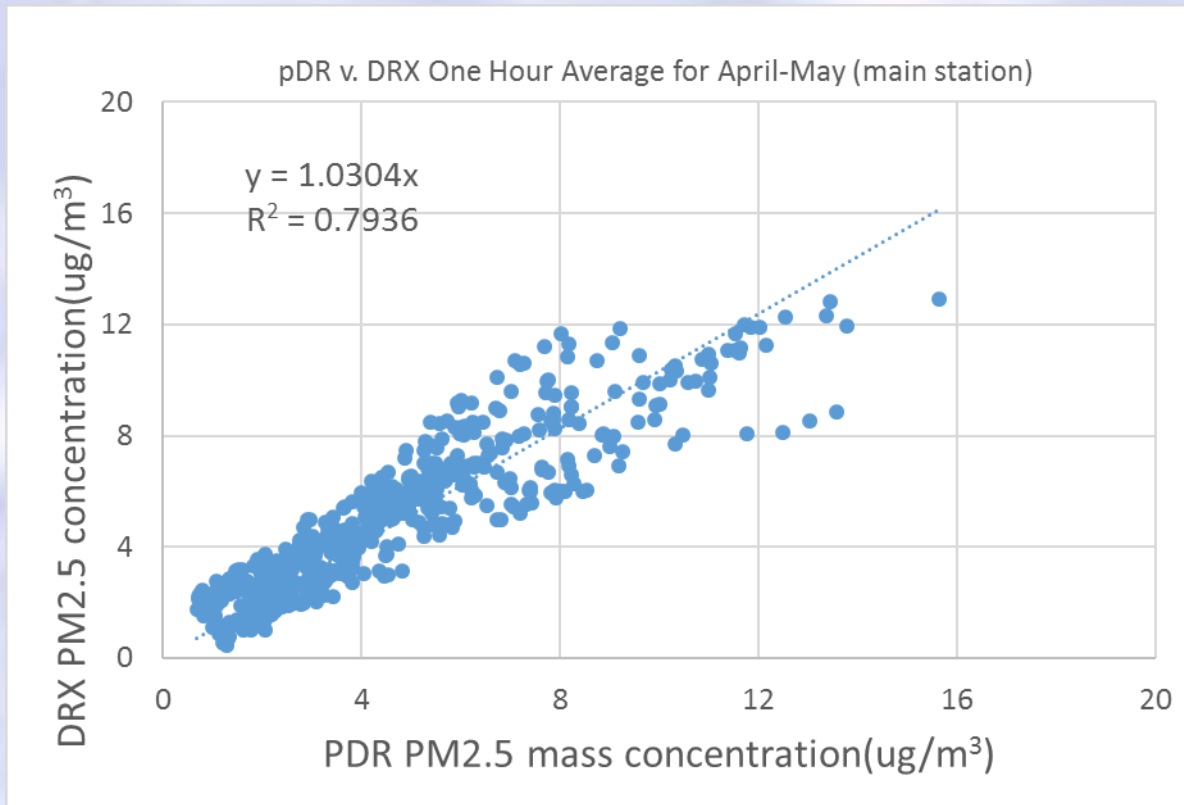Green – TEOM
Blue - pDR

TEOM = 0.87*pDR + 2.1
Small, but noticeable bias – but pretty good overall agreement

PM$_{2.5}$ pDR and DRX comparison - main site

pDR v. DRX One Hour Average for April-May (main station)

$y = 1.0304x$
$R^2 = 0.7936$

DRX PM2.5 concentration(ug/m^3)
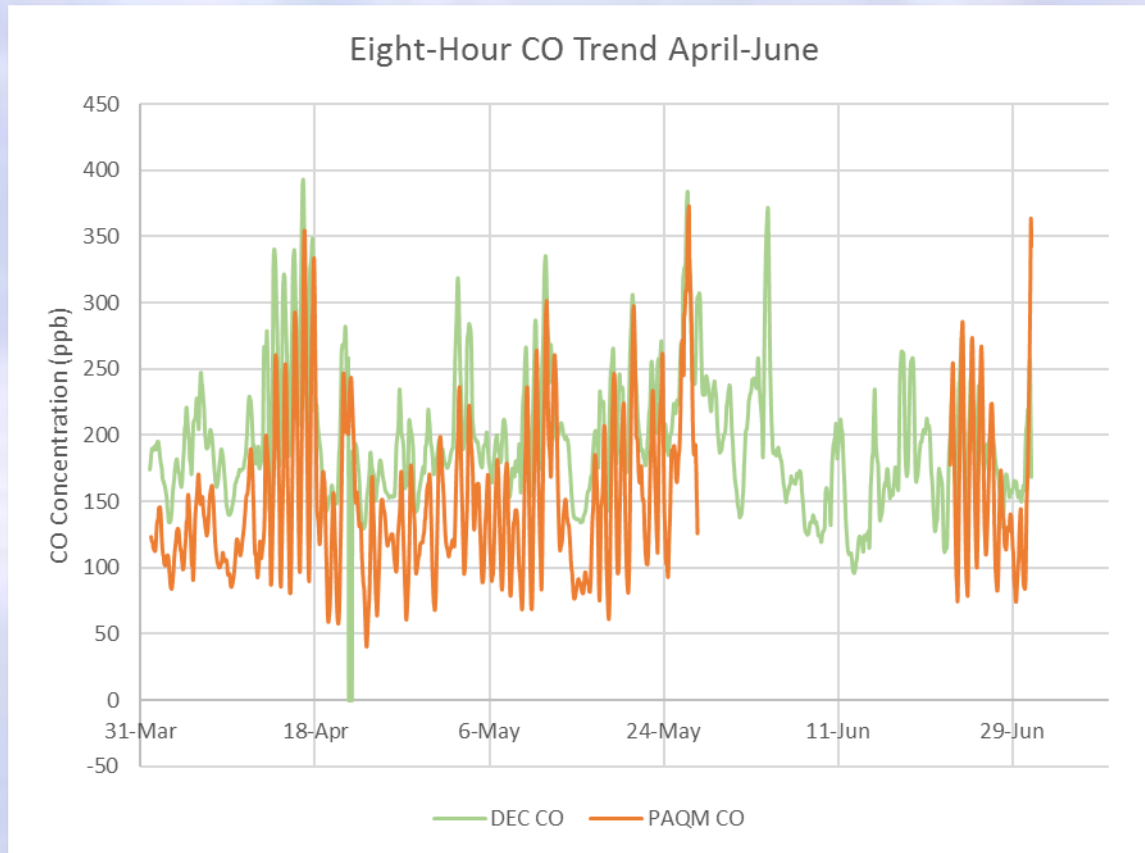
PDR PM2.5 mass concentration(ug/m^3)

DRX data here calculated using a photometric calibration coefficient of 0.38 – which is recommended for ambient measurements

BC Comparisons – near road site
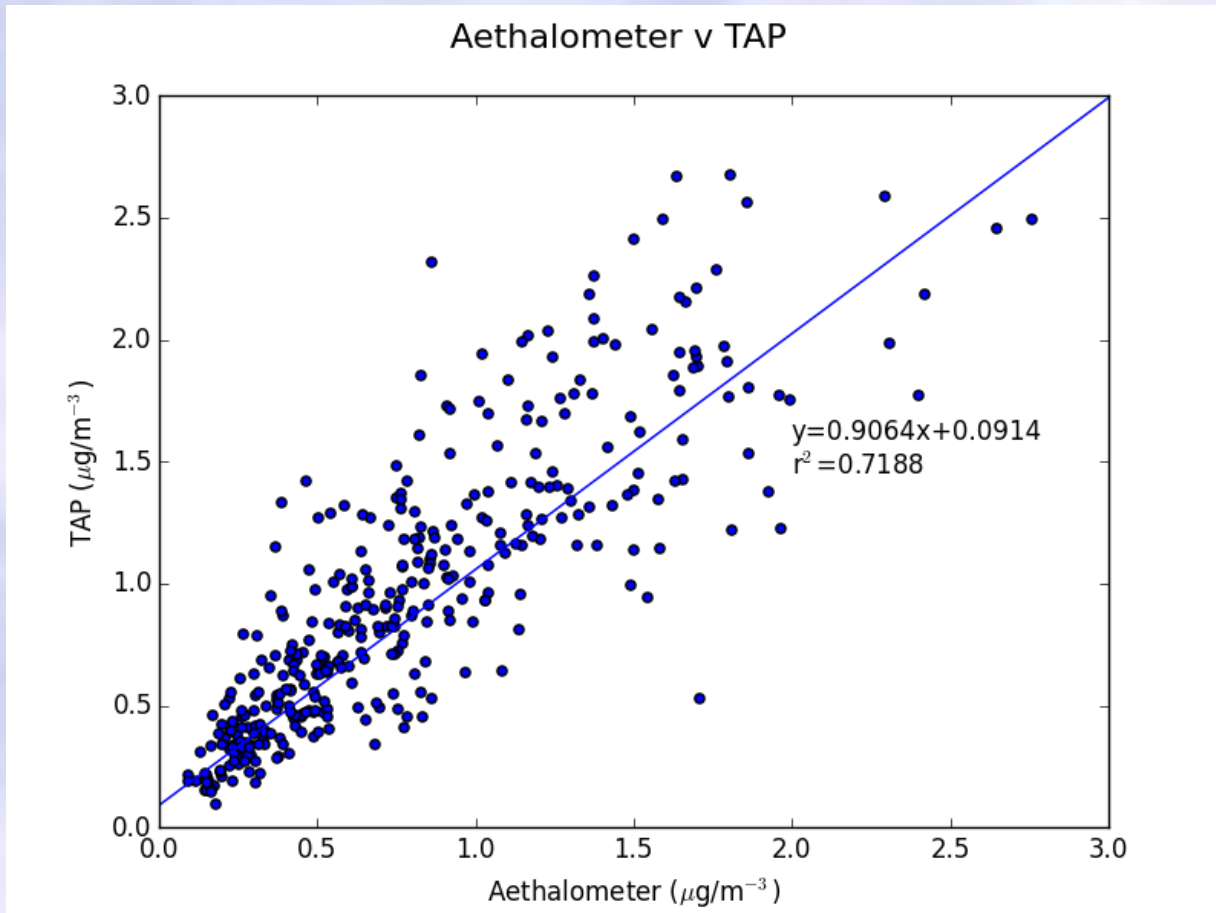
Slope = 0.91
Intercept = 0.09
R^2 = 0.72

CO Comparison – near road site

Eight-Hour CO Trend April-June

Green – DEC CO compliance monitor in shelter

Orange – PAQM Alphasense electrochemical CO sensor

Small electrochemical sensor shows poor agreement – it is worst at low concentrations. Compensation of strong sensor temperature dependence would help quite a bit.

Need for < FRM Monitoring Campaigns

Very often called to address citizen & staff complaints
- Wood smoke: (OWBs, wood stoves)
- Fine dust: (stone crushing operations)
- Odors: composting operations, wood and pellet drying, asphalt production
- Motor vehicle emissions

Need to compare source impacted area to background, not necessarily to a standard or AGC
- Can use met to identify source or deploy in pairs to evaluate air quality at complainant location and at upwind background location every hour for a week/month/season

Generation 1

- NYSERDA and LADCO pooled resources to fund NESCAUM to package the sampling equipment they used in the Adirondack Drainage Model Based Wood Smoke study

- Worked well but only in cold weather

- Aeth, pdr 1500 and met: Design did not support other equipment

Generation 2 & 3 NYSERDA & ASRC

Generation 2:

- Larger box to accommodate other eqpt with adaptive temp control (Fan and Heat)

- Tamper resistant and can be bolted to the ground

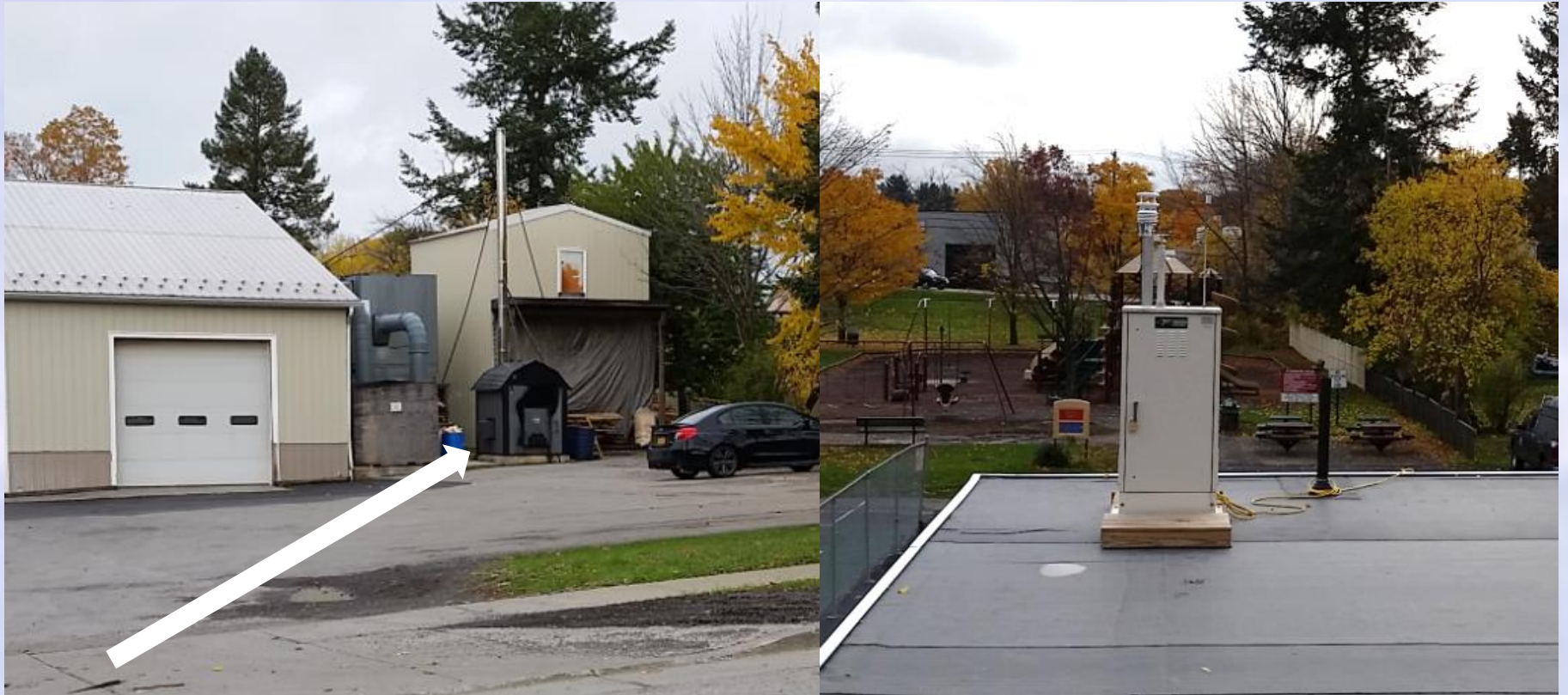Generation 3:

- Added additional insulation (1" foam)

Current PAQM
Deployment
Winter 16-17

OWB next to
school
playground

PAQM
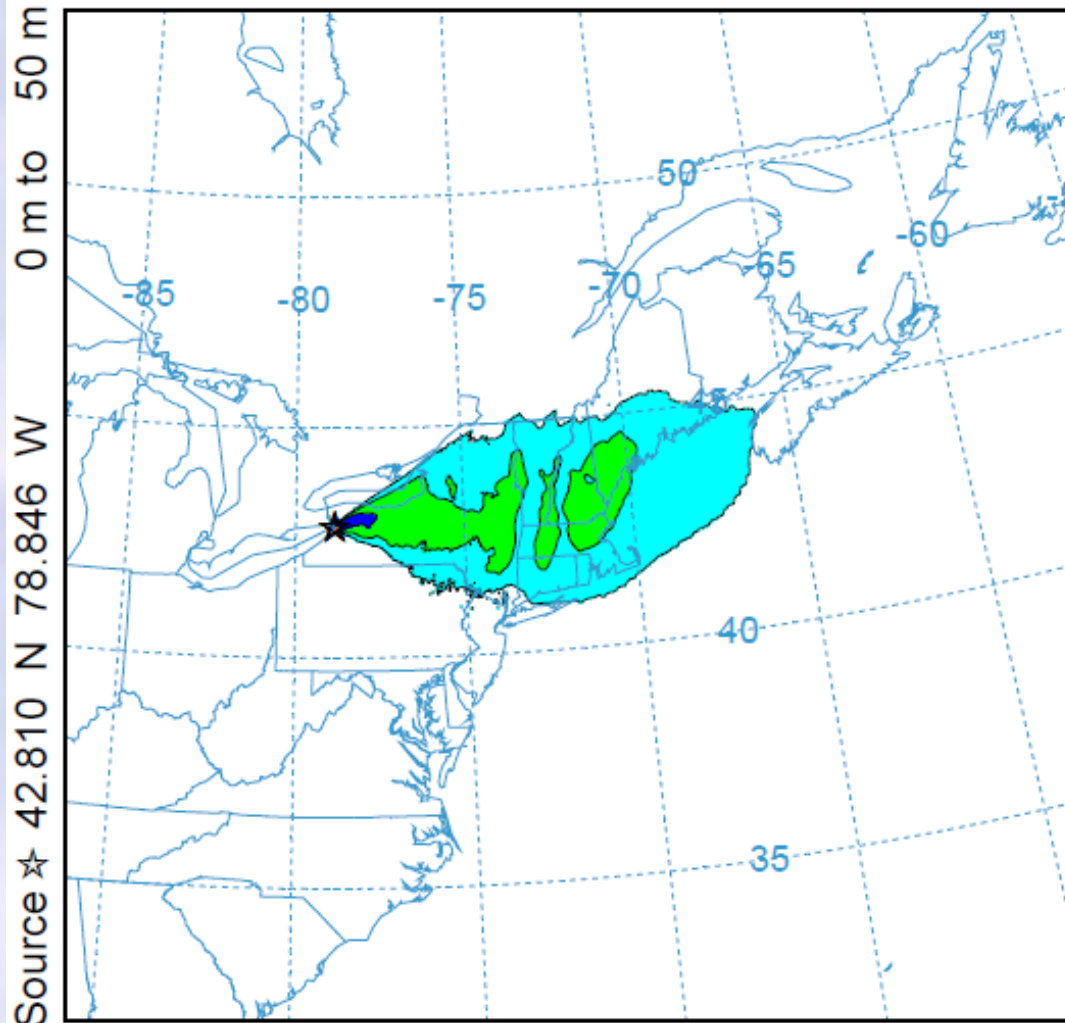installed 90 m
from OWB

PAQM installation and OWB

Central Boiler installed 2006, 123,000 BTU
Fuel: kiln dried cabinet shop wood scraps

Lackawanna Fire: November 9th

NOAA HYSPLIT MODEL
Dilution Factor (1/m3) averaged between   0 m and   100 m
Integrated from 0900 10 Nov to 0900 11 Nov 16 (UTC)
Unit Release started at 0900 10 Nov 16 (UTC)

Meteorologists provided an estimate for plume direction on Thursday

DEC staff used this information to site PM monitors

Deployed NYSDEC PM Samplers
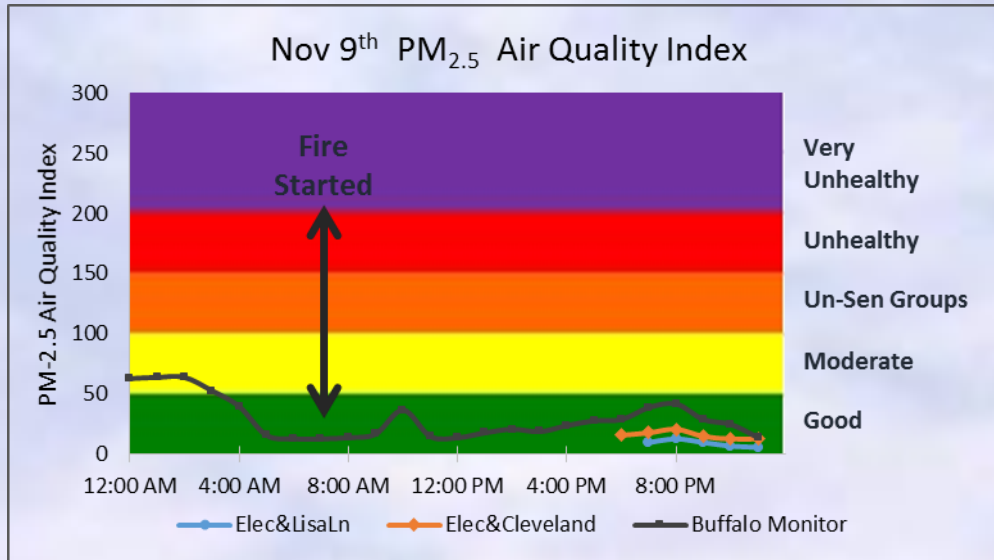
Cleveland Ave and Electric Ave

Lisa Lane and Electric Ave

Samplers can be deployed by one person with a lift gate truck

Lackawanna Fire Results in AQI Scale

Nov 9th PM2.5 Air Quality Index

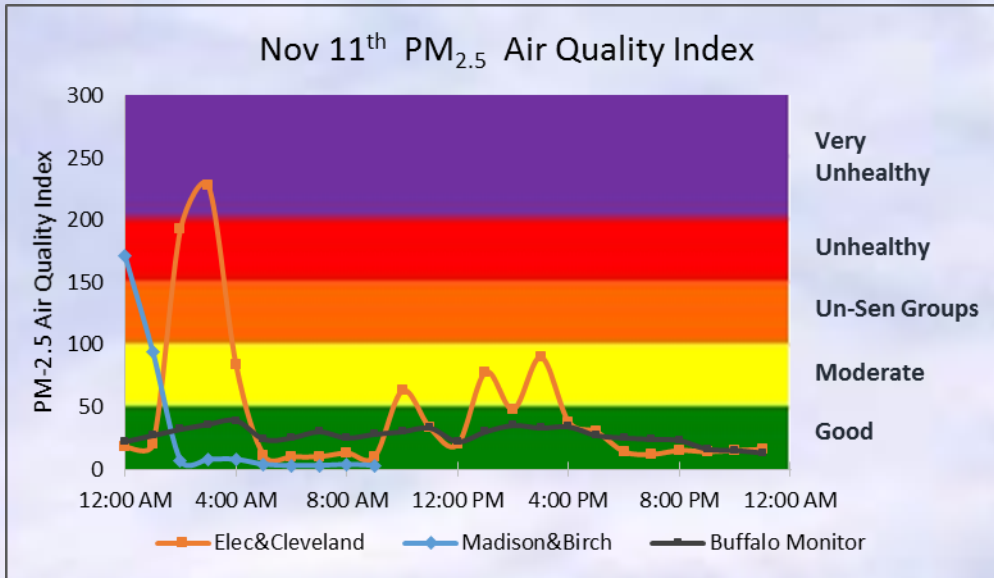Nov 10th PM2.5 Air Quality Index

NYSDEC was able to deploy 2 PAQMs (PM-2.5 and PM-10) by 7:00 pm on the day the fire started

One sampler was moved to the north on the 10th to catch the plume

Readings at that location were in the Hazardous AQI category
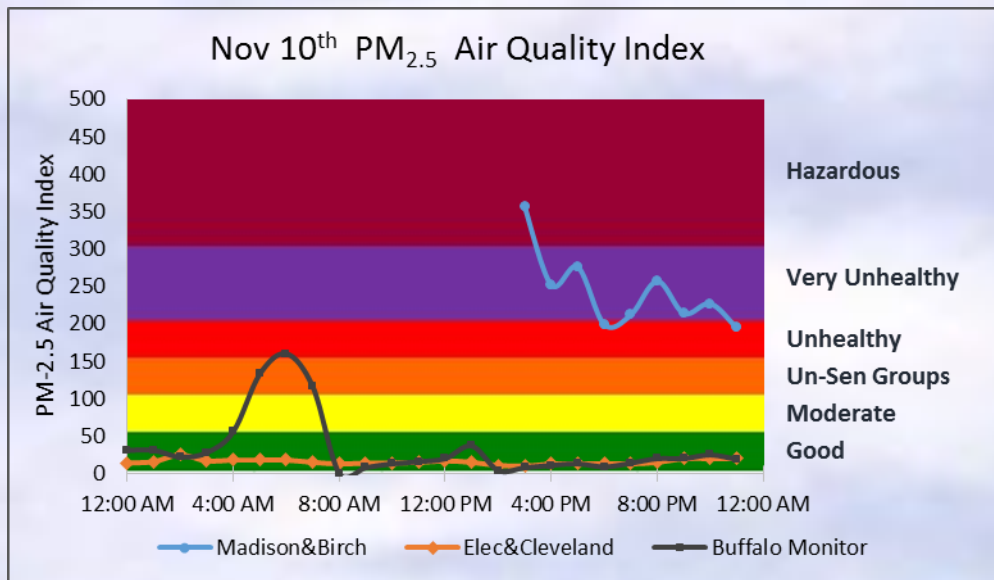
Lackawanna Fire Results in AQI Scale

The fire was extinguished late in the day on the 11th

Conclusions

- The PAQM system is proving to be a flexible and portable platform for localized pollutant measurements.

- Both short term and long term deployments are possible.

- Comparisons with recognized methods indicate reasonable agreement (±25% or better).

- IF DEC responds to more emergency air quality incidents, PAQMs may be further modified with battery and cellular communication options.