EPA Community Air Toxics Grant:
PAH Measurements Using Passive and Active Techniques

"CALIBRATING CONCERN ABOUT PAHS IN URBAN AIR USING MONITORING AND MODELING"

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Co-Investigators

Minnesota Pollution Control Agency

MINNESOTA MDH DEPARTMENT OF HEALTH

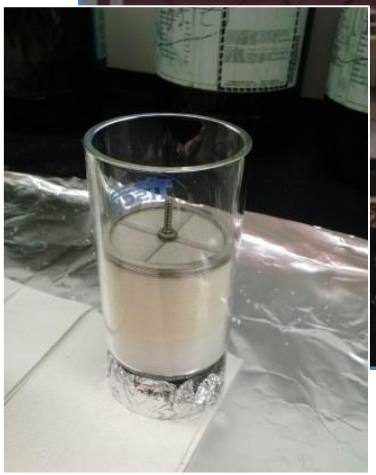
1855 MILLE LACS RESERVATION (10 STAT. 1165)

Sampling Locations

Passive PAH Monitor

Active PAH Monitor

Active and Passive Air Sampling



Sampling Locations

Passive PAH Monitor

Active PAH Monitor

Chemical Analysis

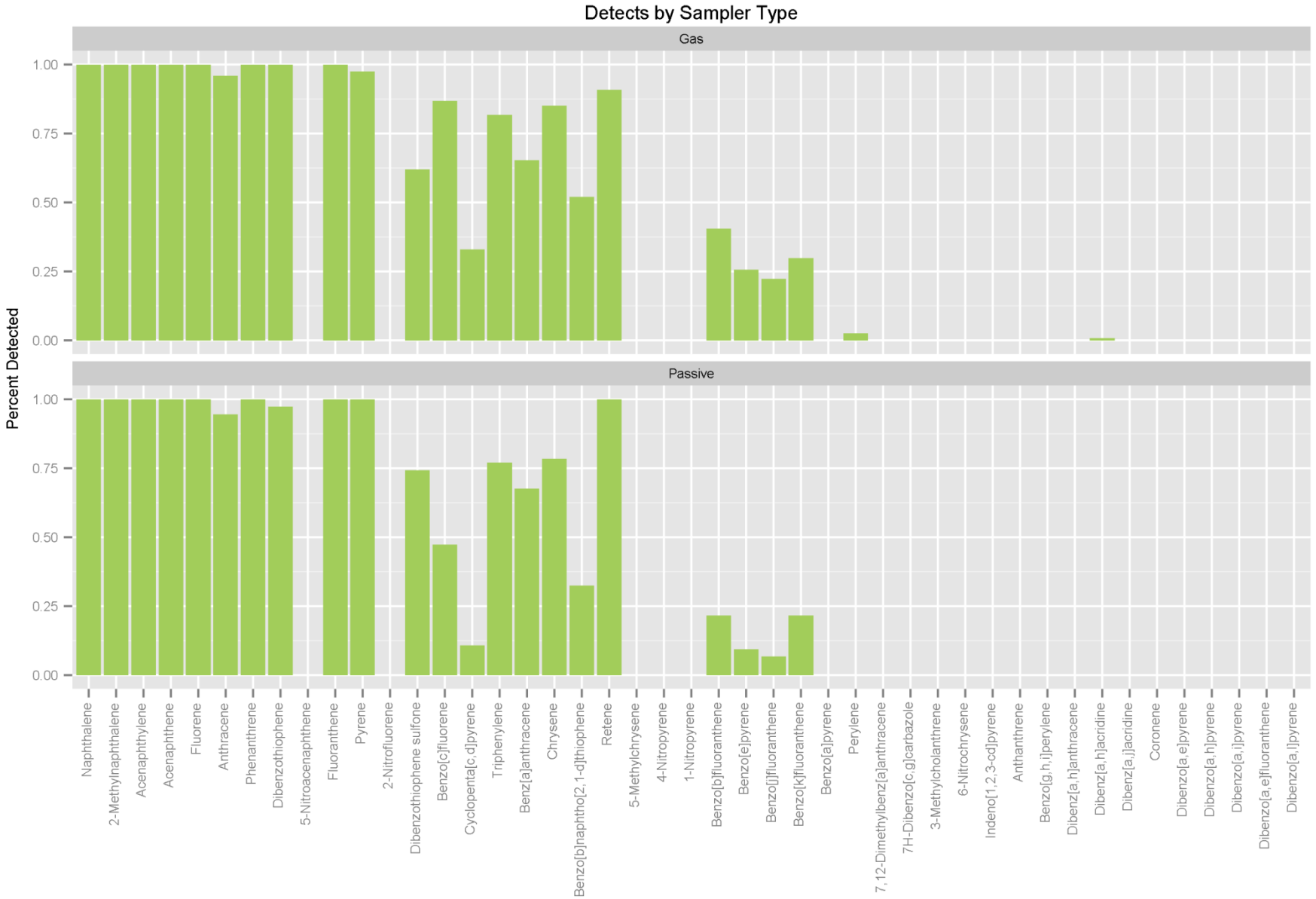
- Extract: XAD-4 and Quartz fiber filters
  - Dionex ASE-350
- Separate: Varian Select PAH column
  - 30m x 0.25mm (0.14µm film thickness)
- Detect: Agilent 5977 GC/MS, SIM (selective ion monitoring)

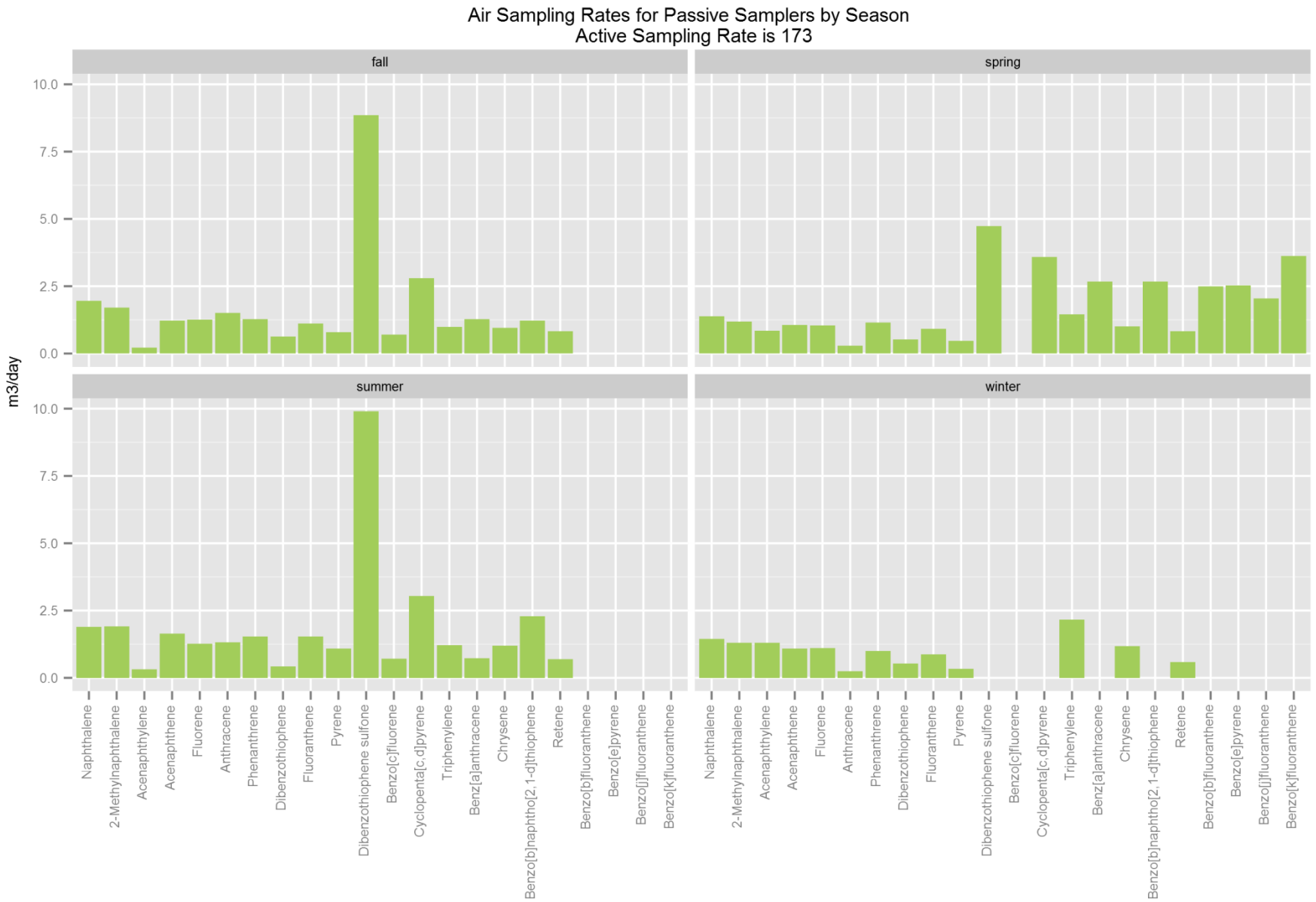
Calibration of Passive Samplers

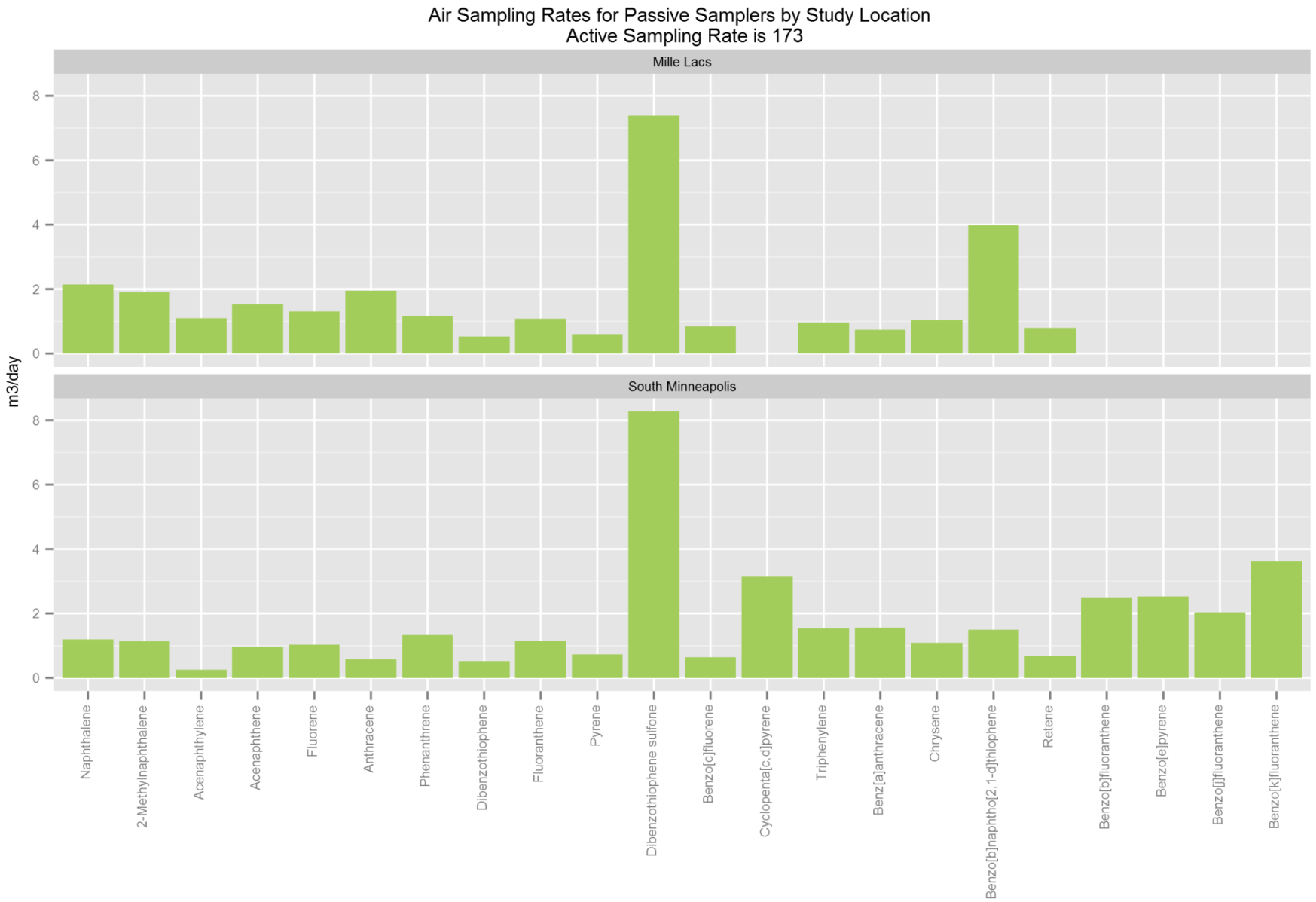
Sampling Rate (m^3 day^{-1}) = $\frac{C_{PAS}}{C_{AIR} * Sampling\ Duration\ (days)}$

C_{PAS} = mass of specific PAH on passive sampler media (ng)

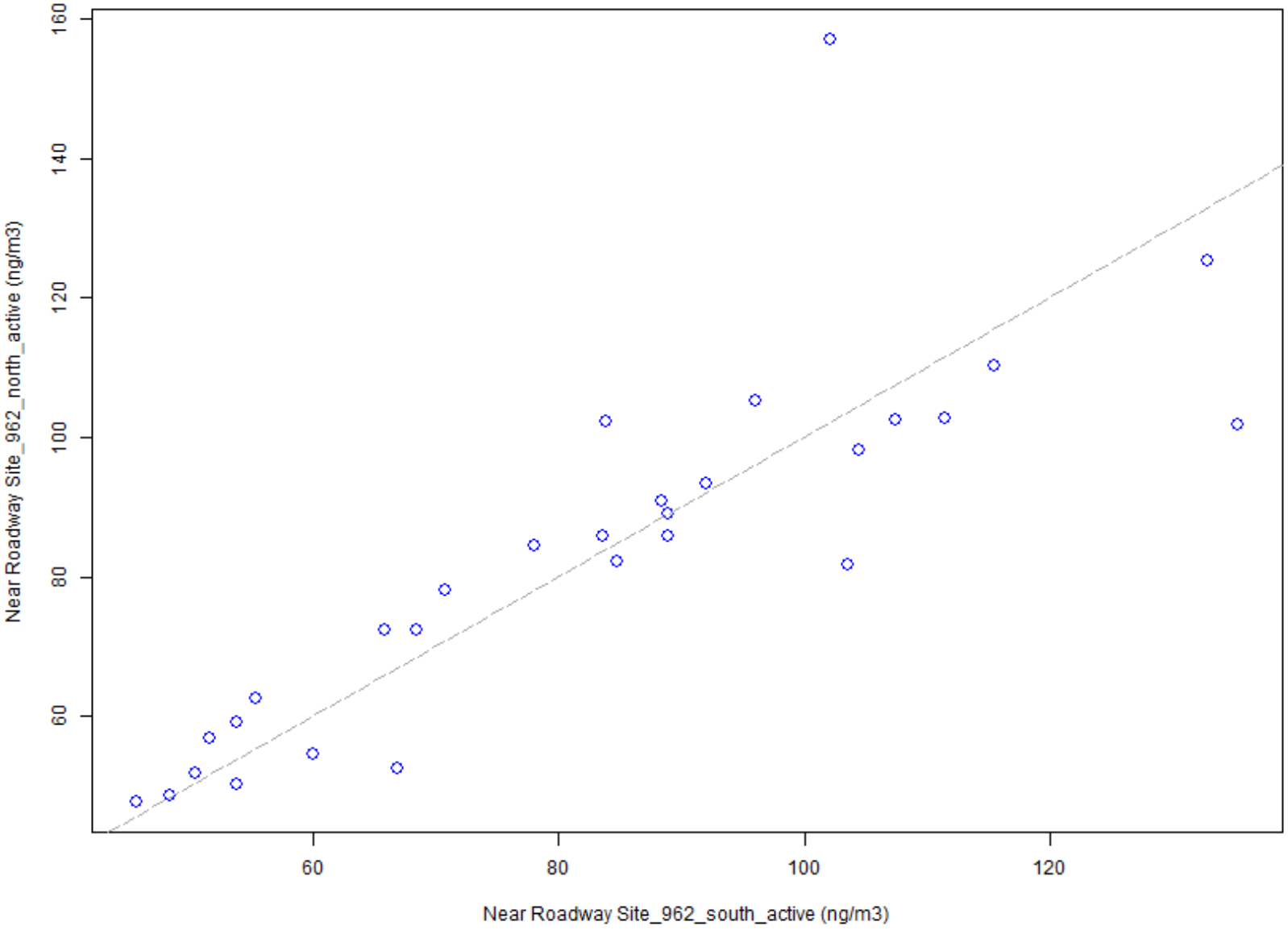
C_{AIR} = concentration of specific PAH in air (ng m^{-3})
by SEASON AND STUDY LOCATION


Detects by Sampler Type
Gas
Passive
Percent Detected
1.00
0.75
0.50
0.25
0.00
Naphthalene
2-Methylnaphthalene
Acenaphthylene
Acenaphthene
Fluorene
Anthracene
Phenanthrene
Dibenzothiophene
5-Nitroacenaphthene
Fluoranthene
Pyrene
2-Nitrofluorene
Dibenzothiophene sulfone
Benzo[c]fluorene
Cyclopenta[c,d]pyrene
Triphenylene
Benz[a]anthracene
Chrysene
Benzo[b]naphtho[2,1-d]thiophene
Retene
5-Methylchrysene
4-Nitropyrene
1-Nitropyrene
Benzo[b]fluoranthene
Benzo[e]pyrene
Benzo[j]fluoranthene
Benzo[k]fluoranthene
Benzo[a]pyrene
Perylene
7,12-Dimethylbenz[a]anthracene
7H-Dibenzo[c,g]carbazole
3-Methylcholanthrene
6-Nitrochrysene
Indeno[1,2,3-cd]pyrene
Anthanthrene
Benzo[g,h,i]perylene
Dibenz[a,h]anthracene
Dibenz[a,h]acridine
Dibenz[a,j]acridine
Coronene
Dibenzo[a,e]pyrene
Dibenzo[a,h]pyrene
Dibenzo[a,i]pyrene
Dibenzo[a,e]fluoranthene
Dibenzo[a,l]pyrene

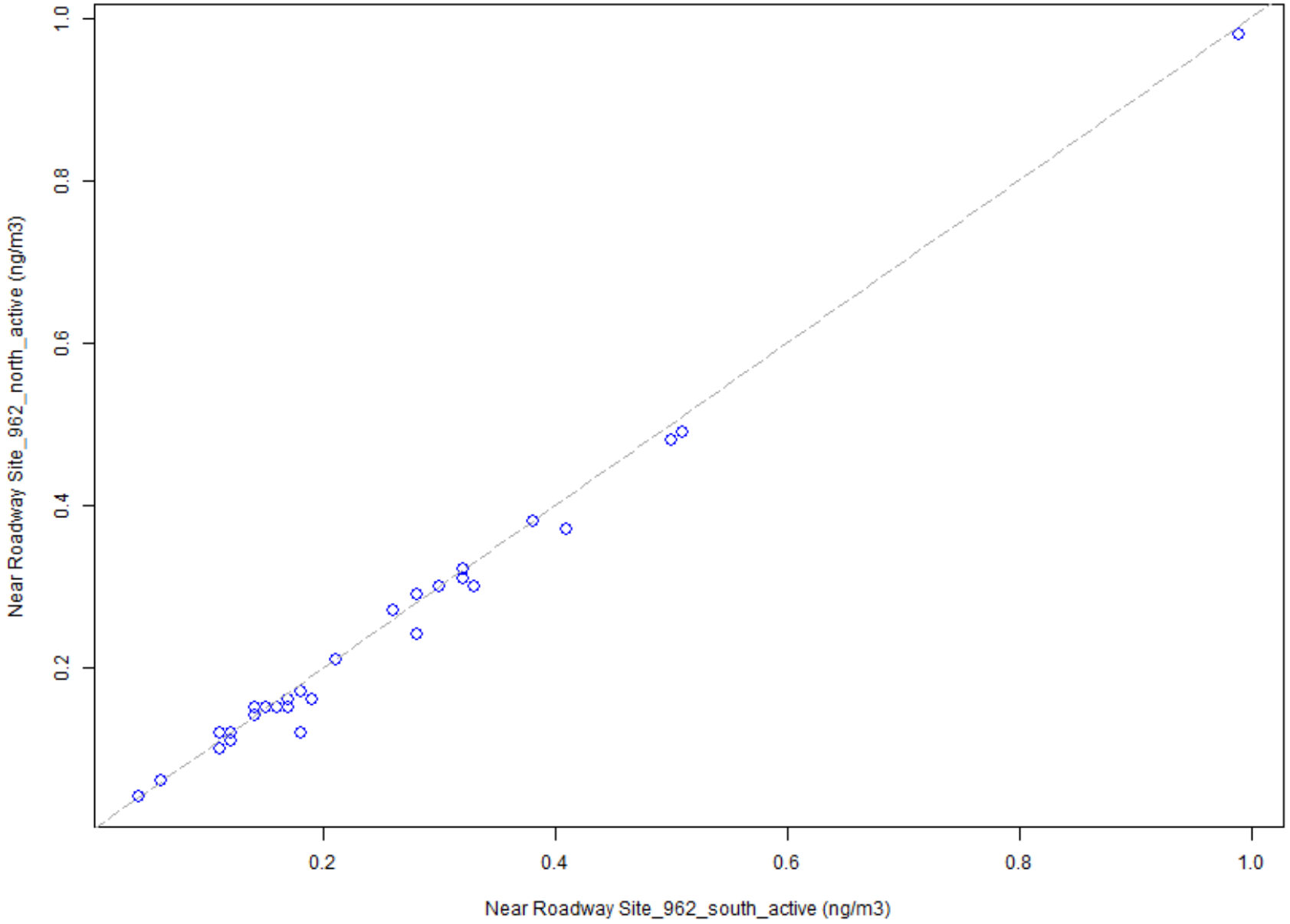

Air Sampling Rates for Passive Samplers by Season
Active Sampling Rate is 173
fall
spring
summer
winter
m3/day
10.0
7.5
5.0
2.5
0.0
Naphthalene
2-Methylnaphthalene
Acenaphthylene
Acenaphthene
Fluorene
Anthracene
Phenanthrene
Dibenzothiophene
Fluoranthene
Pyrene
Dibenzothiophene sulfone
Benzo[c]fluorene
Cyclopenta[c,d]pyrene
Triphenylene
Benz[a]anthracene
Chrysene
Benzo[b]naphtho[2,1-d]thiophene
Retene
Benzo[b]fluoranthene
Benzo[e]pyrene
Benzo[j]fluoranthene
Benzo[k]fluoranthene

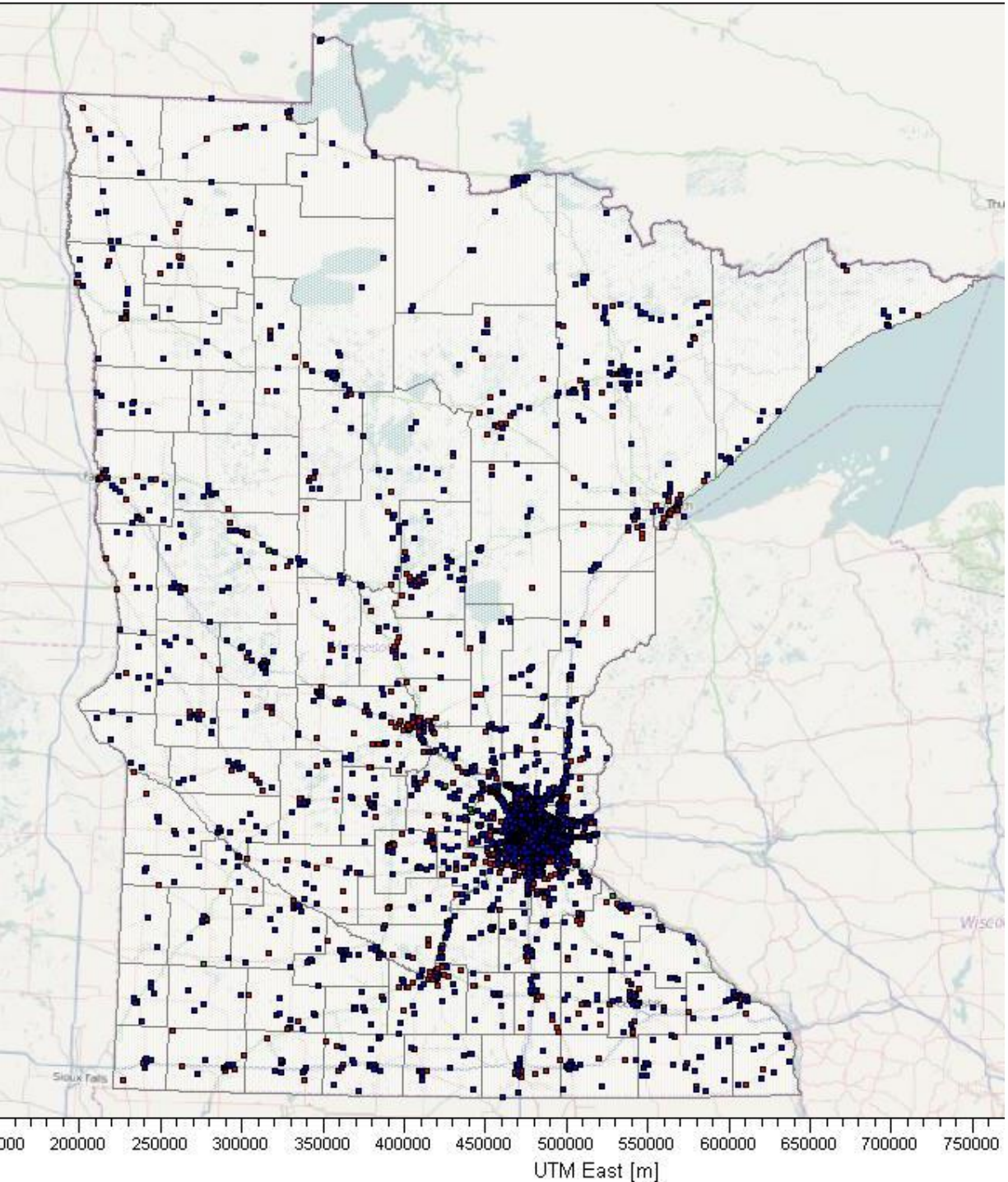

Air Sampling Rates for Passive Samplers by Study Location
Active Sampling Rate is 173
Mille Lacs
South Minneapolis
m3/day
0
2
4
6
8
Naphthalene
2-Methylnaphthalene
Acenaphthylene
Acenaphthene
Fluorene
Anthracene
Phenanthrene
Dibenzothiophene
Fluoranthene
Pyrene
Dibenzothiophene sulfone
Benzo[c]fluorene
Cyclopenta[c,d]pyrene
Triphenylene
Benz[a]anthracene
Chrysene
Benzo[b]naphtho[2,1-d]thiophene
Retene
Benzo[b]fluoranthene
Benzo[e]pyrene
Benzo[j]fluoranthene
Benzo[k]fluoranthene

Collocated Naphthalene Results at Near Roadway



Collocated Benzo(a)pyrene Results at Near Roadway





MNRiskS (Minnesota Risk Screening)

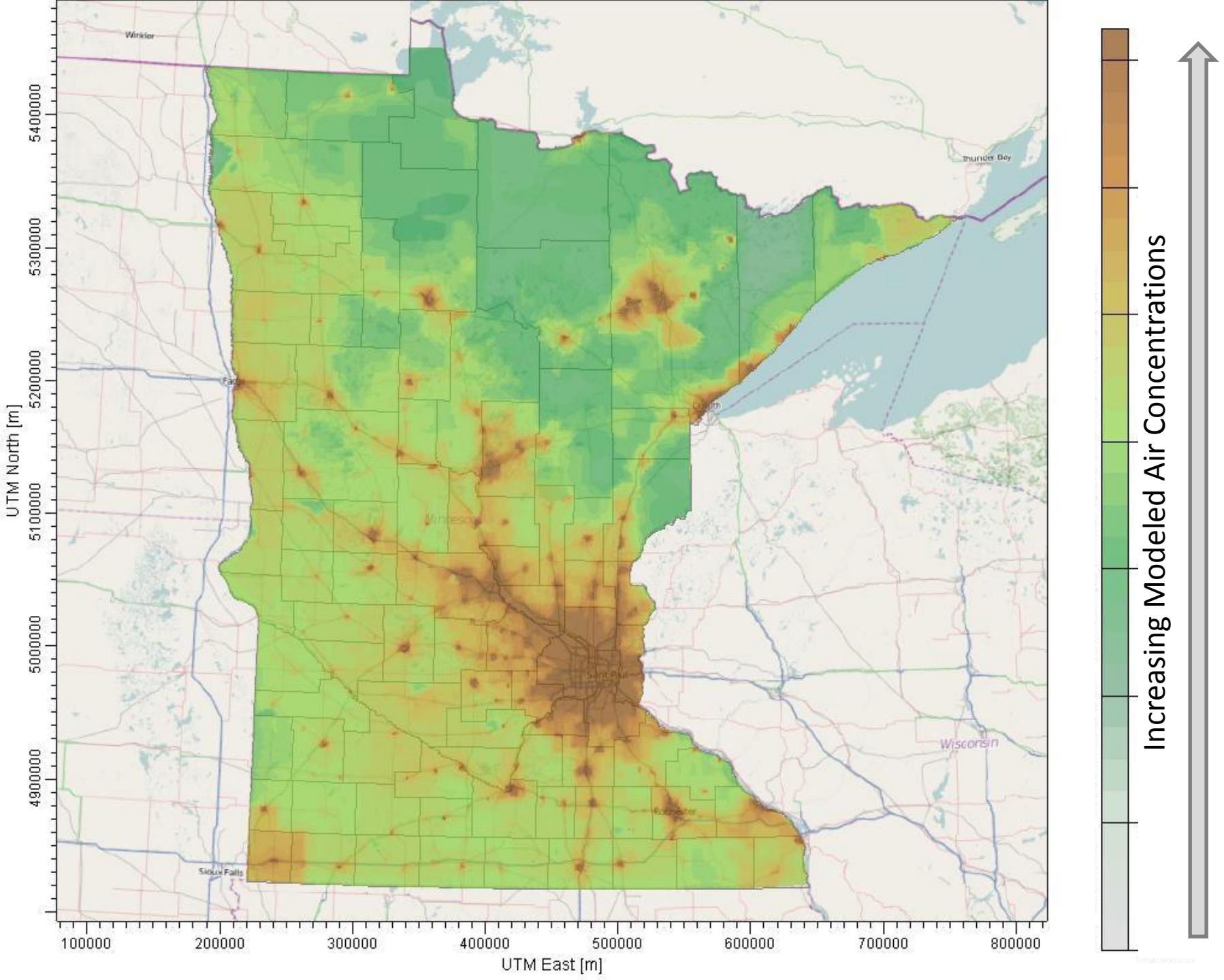
A multi-source, air pollution risk model

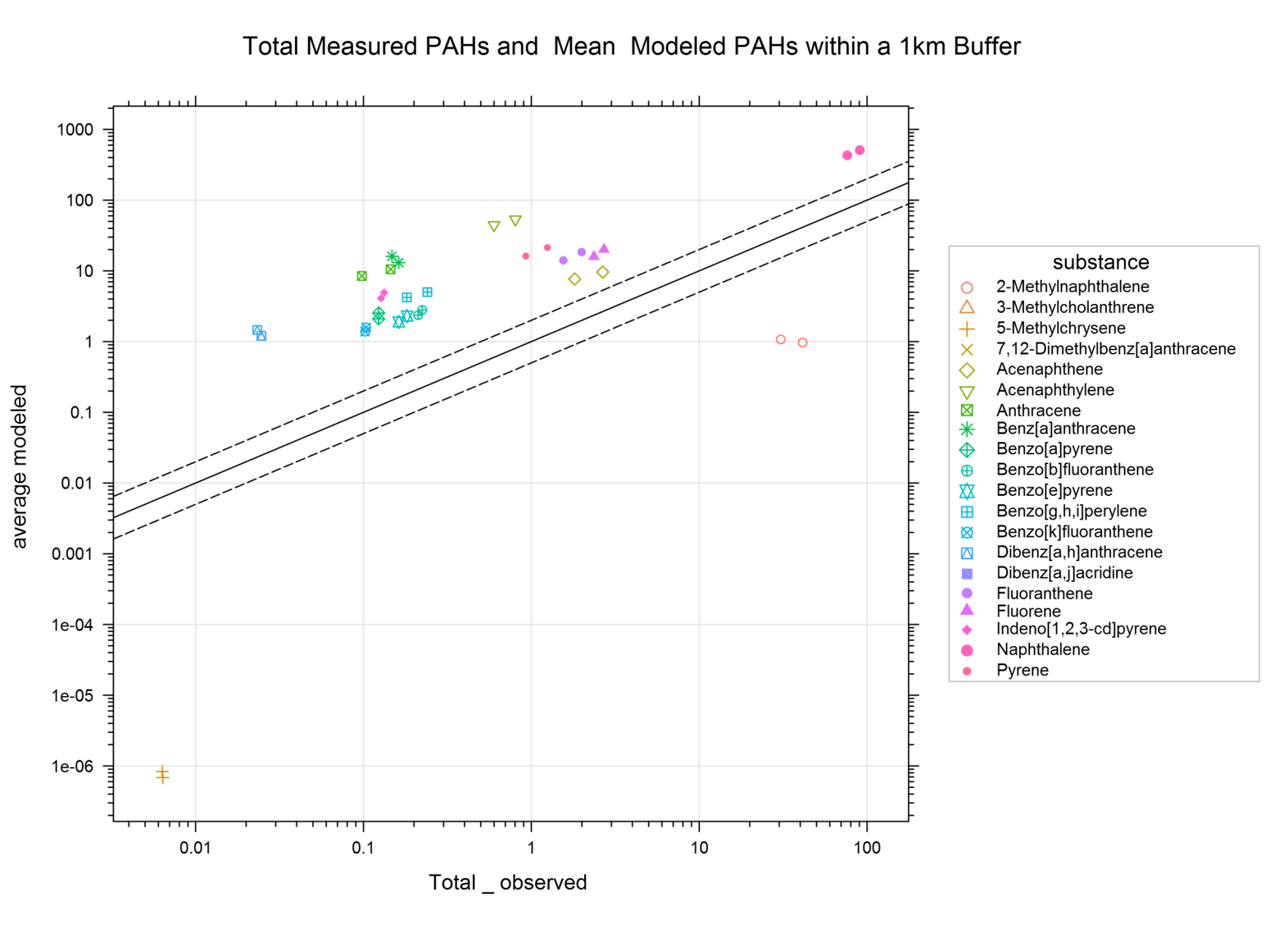
Developed by

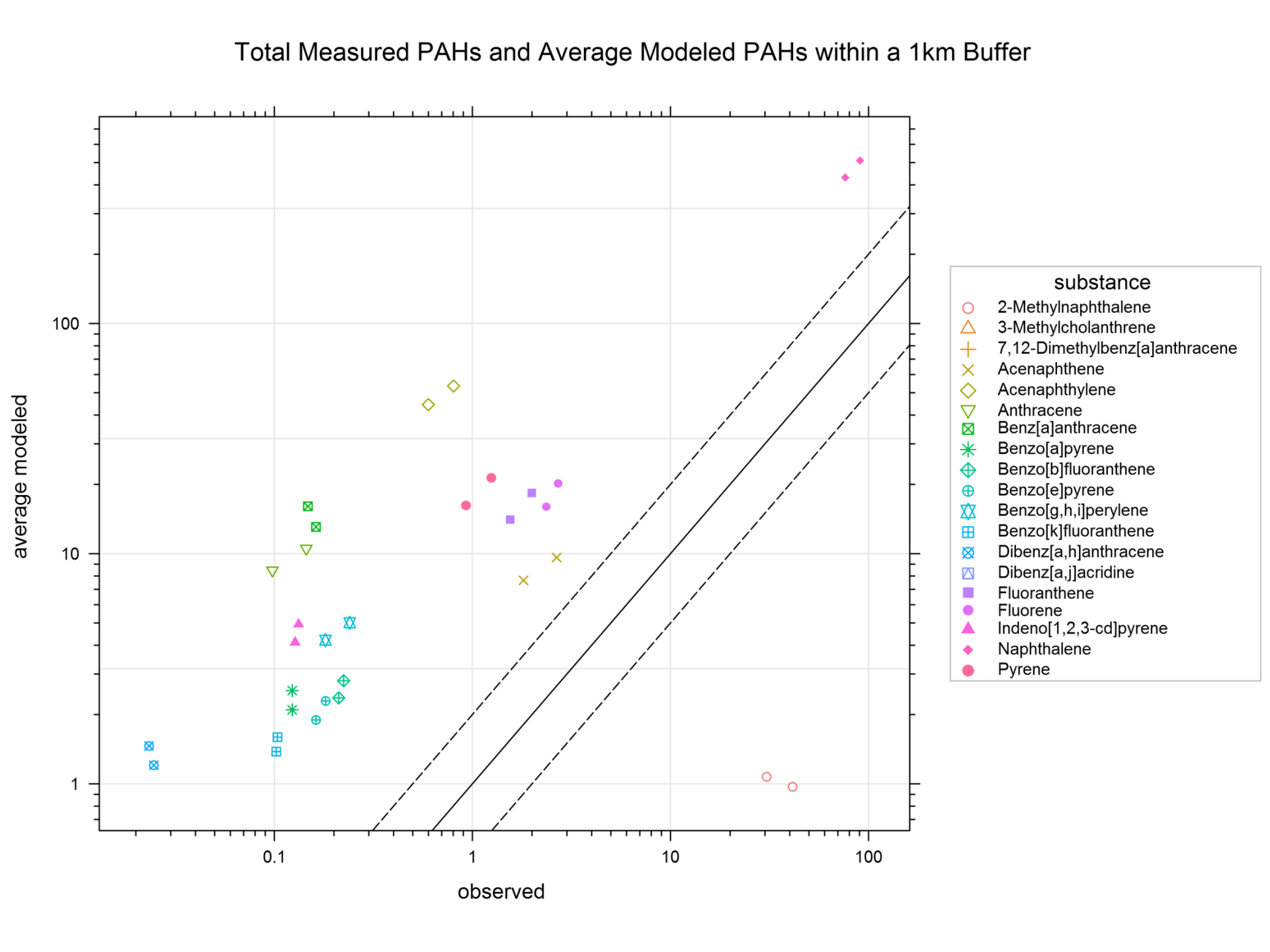
Lakes Environmental Consultants, Ontario

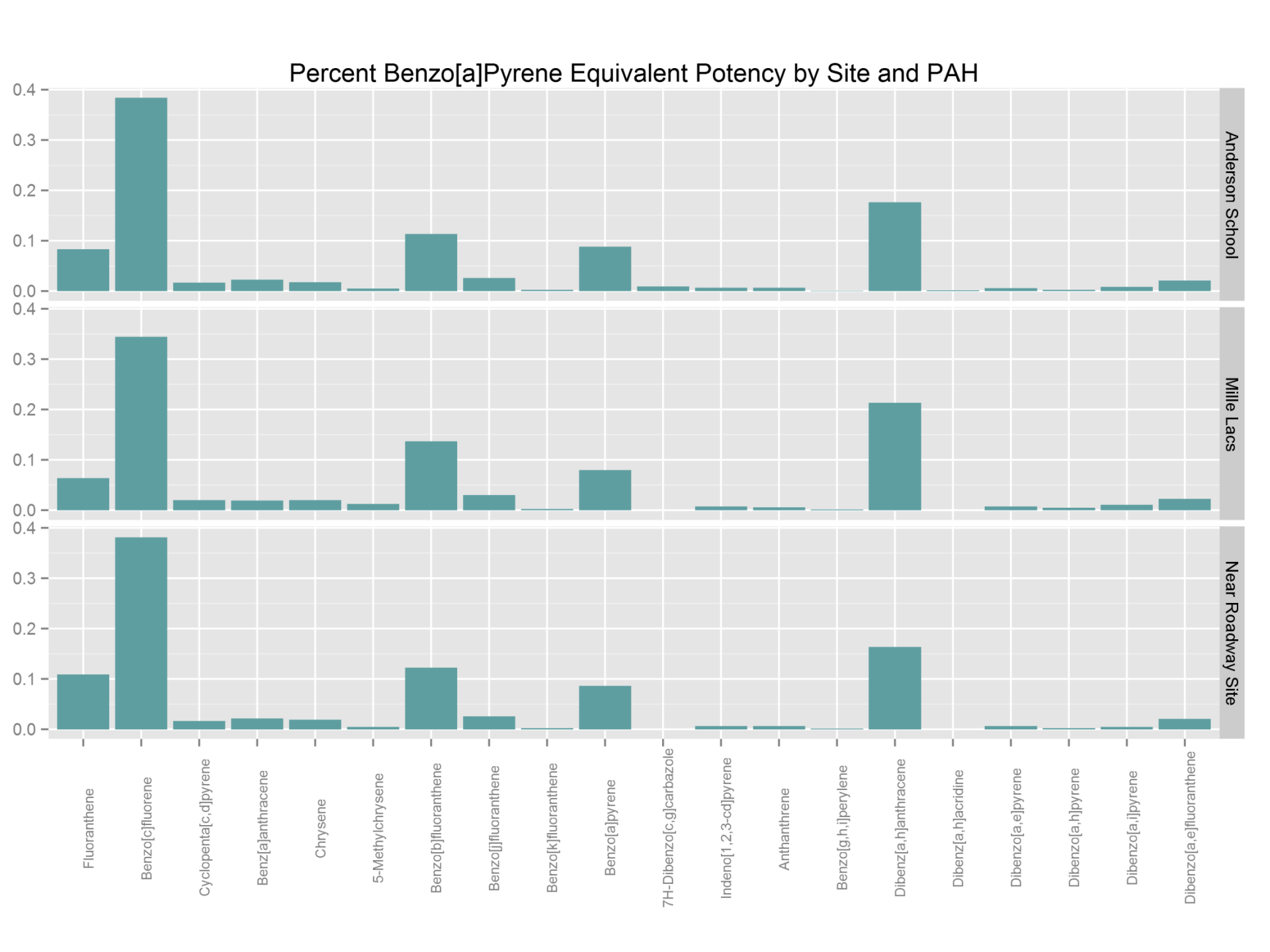
and

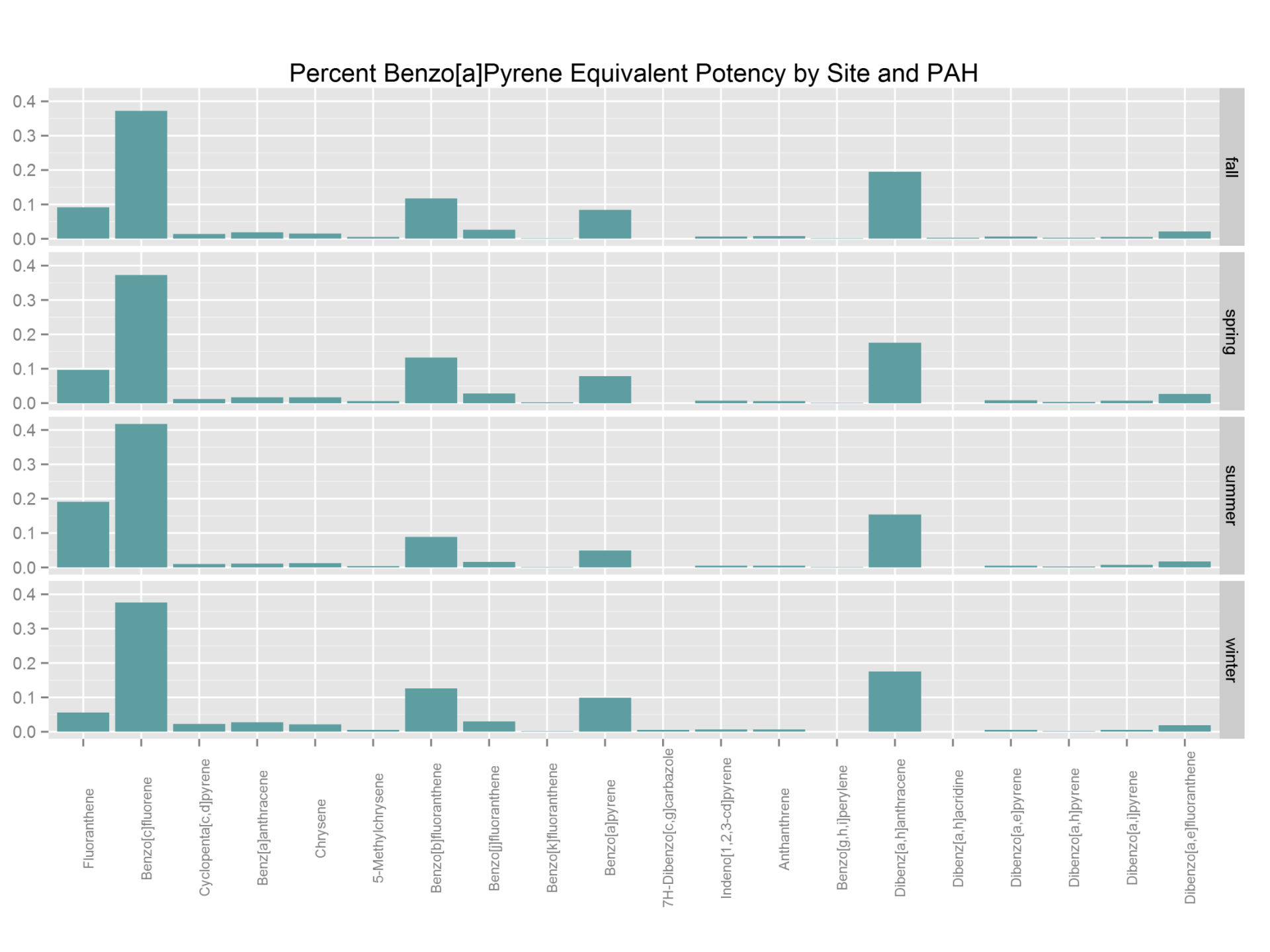
Minnesota Pollution Control Agency


Winnipeg
Thunder Bay
Duluth
Minneapolis
Saint Paul
Wisconsin
Rochester
Sioux Falls
UTM North [m]
5400000
5300000
5200000
5100000
5000000
4900000
100000
200000
300000
400000
500000
600000
700000
800000
UTM East [m]
Increasing Modeled Air Concentrations

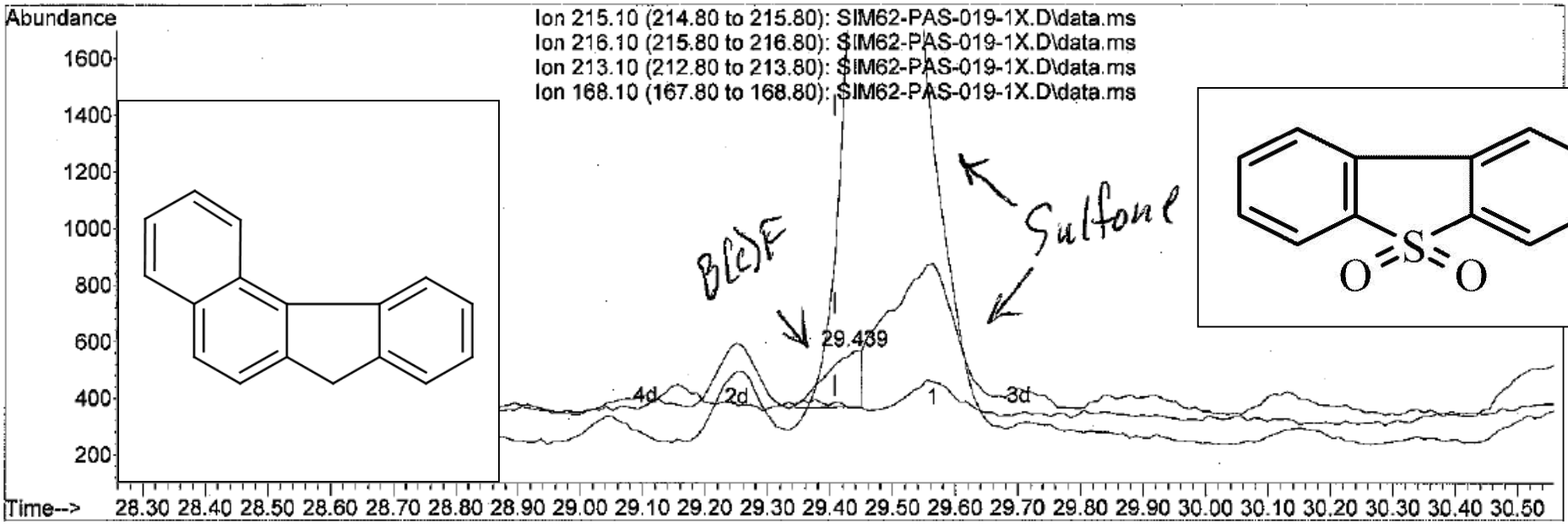

Total Measured PAHs and Mean Modeled PAHs within a 1km Buffer
average modeled
Total _ observed
1000
100
10
1
0.1
0.01
0.001
1e-04
1e-05
1e-06
0.01
0.1
1
10
100
substance
2-Methylnaphthalene
3-Methylcholanthrene
5-Methylchrysene
7,12-Dimethylbenz[a]anthracene
Acenaphthene
Acenaphthylene
Anthracene
Benz[a]anthracene
Benzo[a]pyrene
Benzo[b]fluoranthene
Benzo[e]pyrene
Benzo[g,h,i]perylene
Benzo[k]fluoranthene
Dibenz[a,h]anthracene
Dibenz[a,j]acridine
Fluoranthene
Fluorene
Indeno[1,2,3-cd]pyrene
Naphthalene
Pyrene


Total Measured PAHs and Average Modeled PAHs within a 1km Buffer
average modeled
observed
100
10
1
0.1
1
10
100
substance
2-Methylnaphthalene
3-Methylcholanthrene
7,12-Dimethylbenz[a]anthracene
Acenaphthene
Acenaphthylene
Anthracene
Benz[a]anthracene
Benzo[a]pyrene
Benzo[b]fluoranthene
Benzo[e]pyrene
Benzo[g,h,i]perylene
Benzo[k]fluoranthene
Dibenz[a,h]anthracene
Dibenz[a,j]acridine
Fluoranthene
Fluorene
Indeno[1,2,3-cd]pyrene
Naphthalene
Pyrene

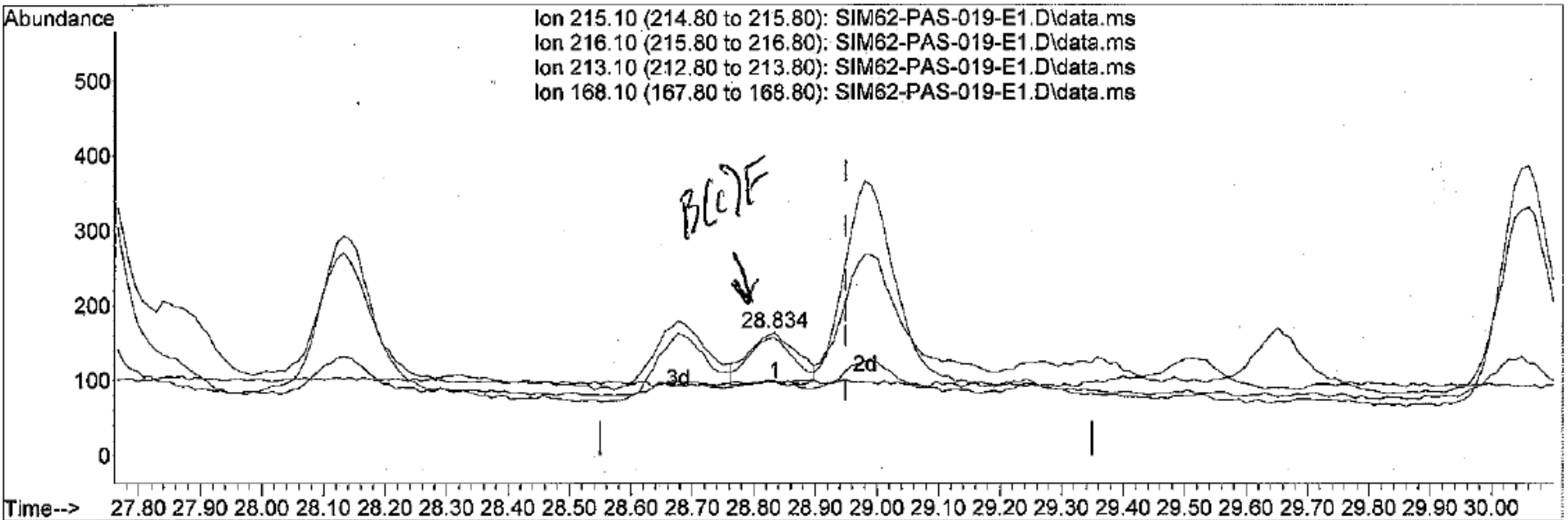

Percent Benzo[a]Pyrene Equivalent Potency by Site and PAH
Anderson School
Mille Lacs
Near Roadway Site
0.0
0.1
0.2
0.3
0.4
Fluoranthene
Benzo[c]fluorene
Cyclopenta[c,d]pyrene
Benz[a]anthracene
Chrysene
5-Methylchrysene
Benzo[b]fluoranthene
Benzo[j]fluoranthene
Benzo[k]fluoranthene
Benzo[a]pyrene
7H-Dibenzo[c,g]carbazole
Indeno[1,2,3-cd]pyrene
Anthanthrene
Benzo[g,h,i]perylene
Dibenz[a,h]anthracene
Dibenz[a,h]acridine
Dibenzo[a,e]pyrene
Dibenzo[a,h]pyrene
Dibenzo[a,i]pyrene
Dibenzo[a,e]fluoranthene

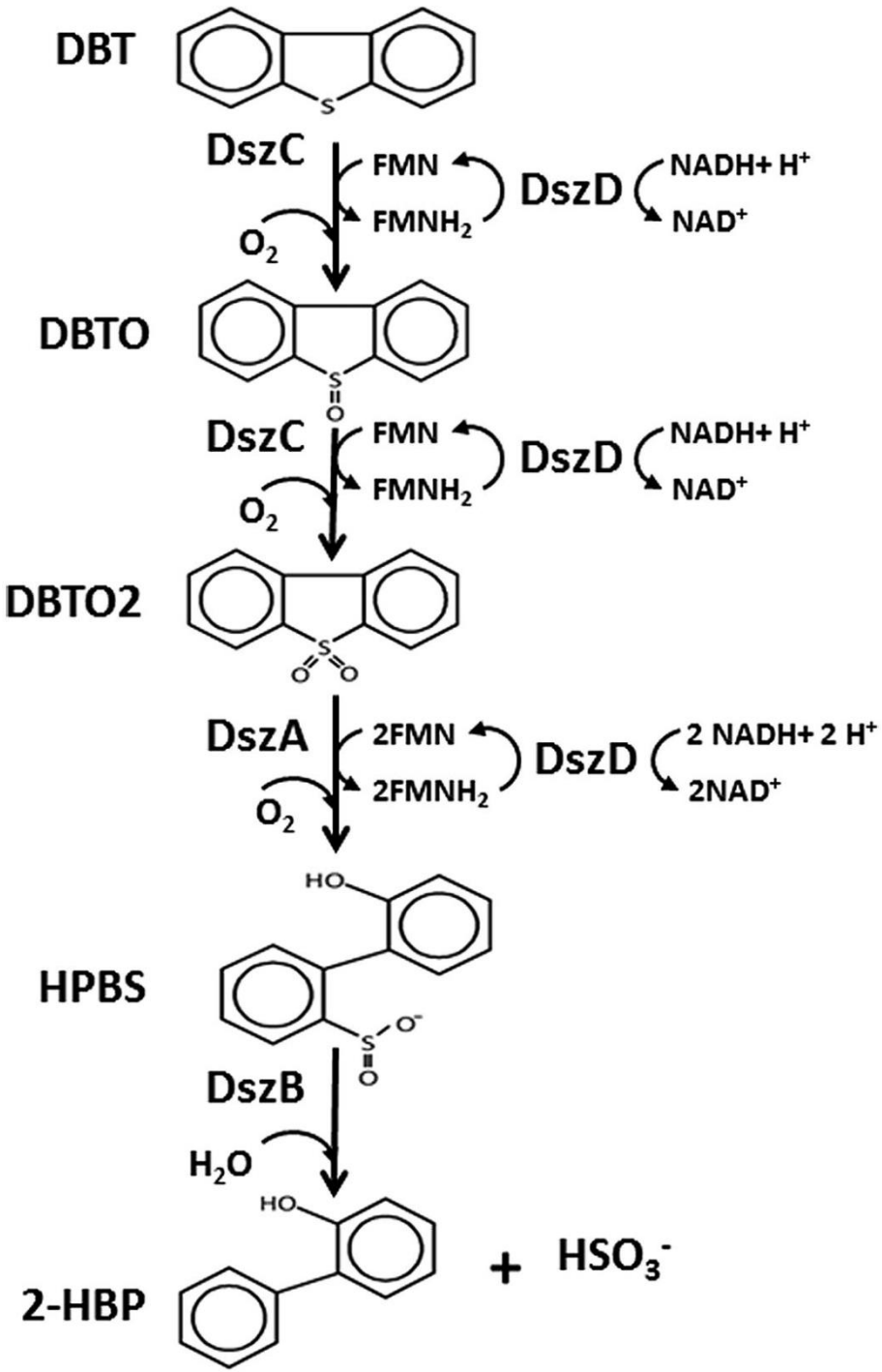

Percent Benzo[a]Pyrene Equivalent Potency by Site and PAH
0.4
0.3
0.2
0.1
0.0
fall
spring
summer
winter
Fluoranthene
Benzo[c]fluorene
Cyclopenta[c,d]pyrene
Benz[a]anthracene
Chrysene
5-Methylchrysene
Benzo[b]fluoranthene
Benzo[j]fluoranthene
Benzo[k]fluoranthene
Benzo[a]pyrene
7H-Dibenzo[c,g]carbazole
Indeno[1,2,3-cd]pyrene
Anthanthrene
Benzo[g,h,i]perylene
Dibenz[a,h]anthracene
Dibenz[a,h]acridine
Dibenzo[a,e]pyrene
Dibenzo[a,h]pyrene
Dibenzo[a,i]pyrene
Dibenzo[a,e]fluoranthene

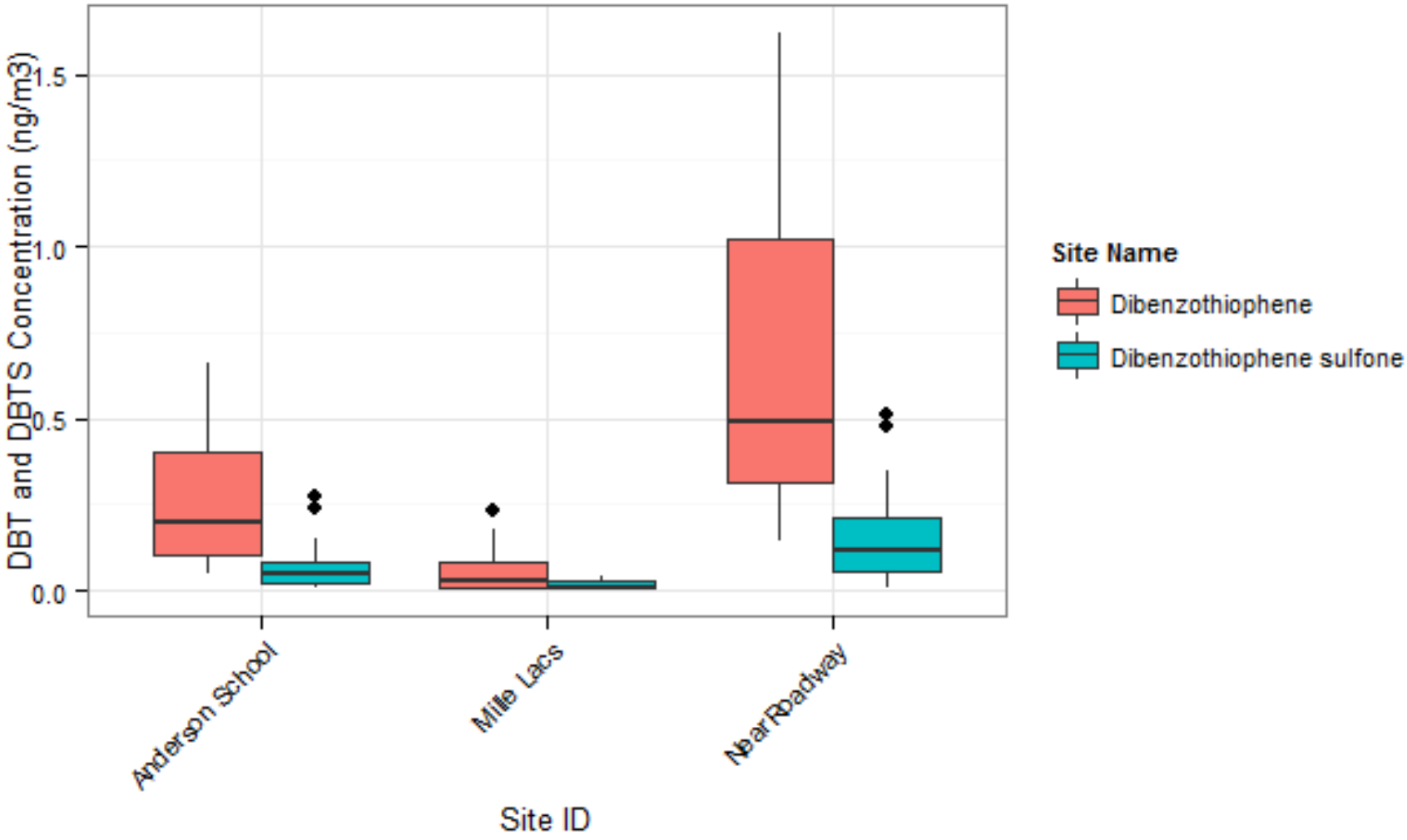
BEFORE CLEAN-UP

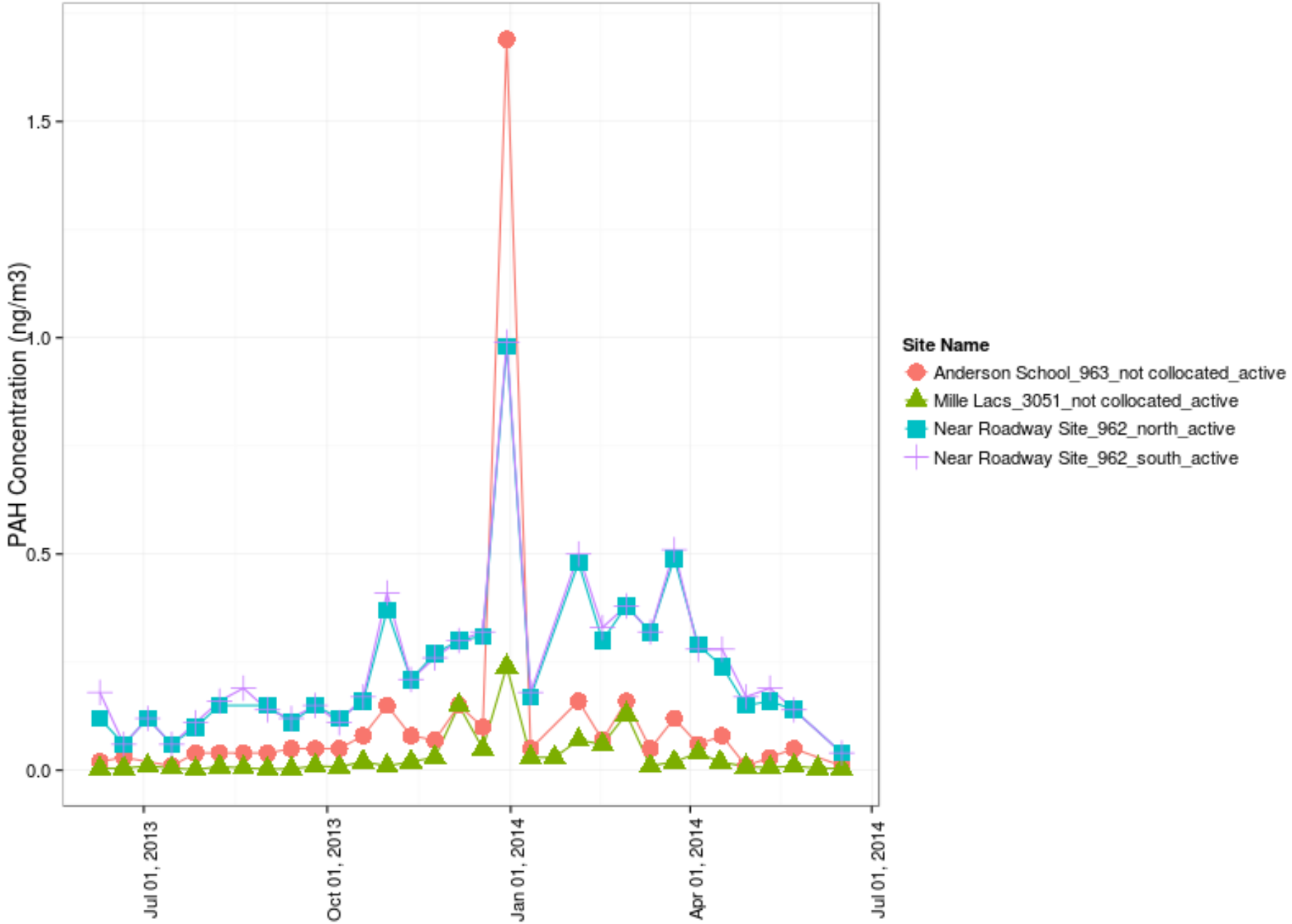


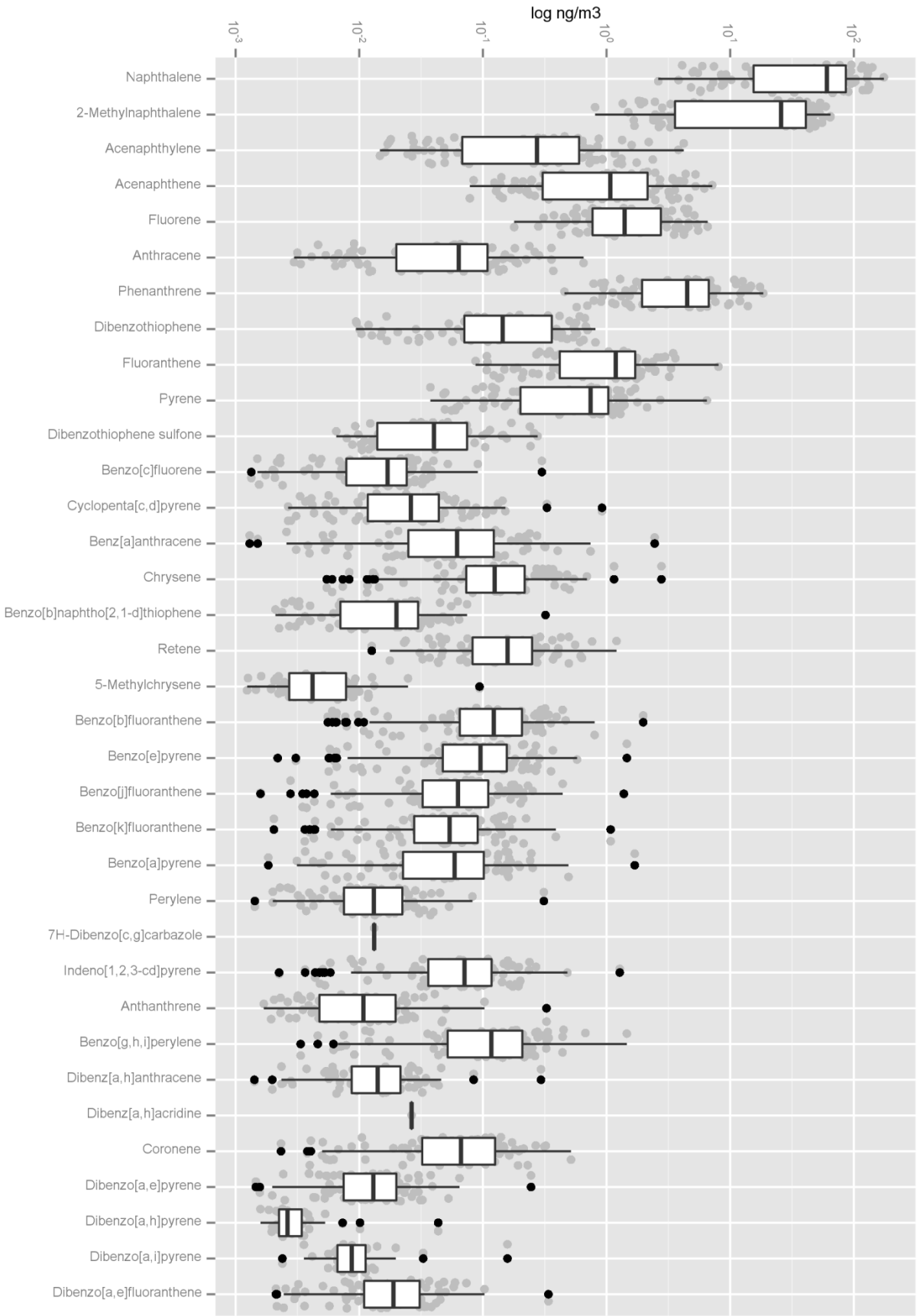
AFTER CLEAN-UP

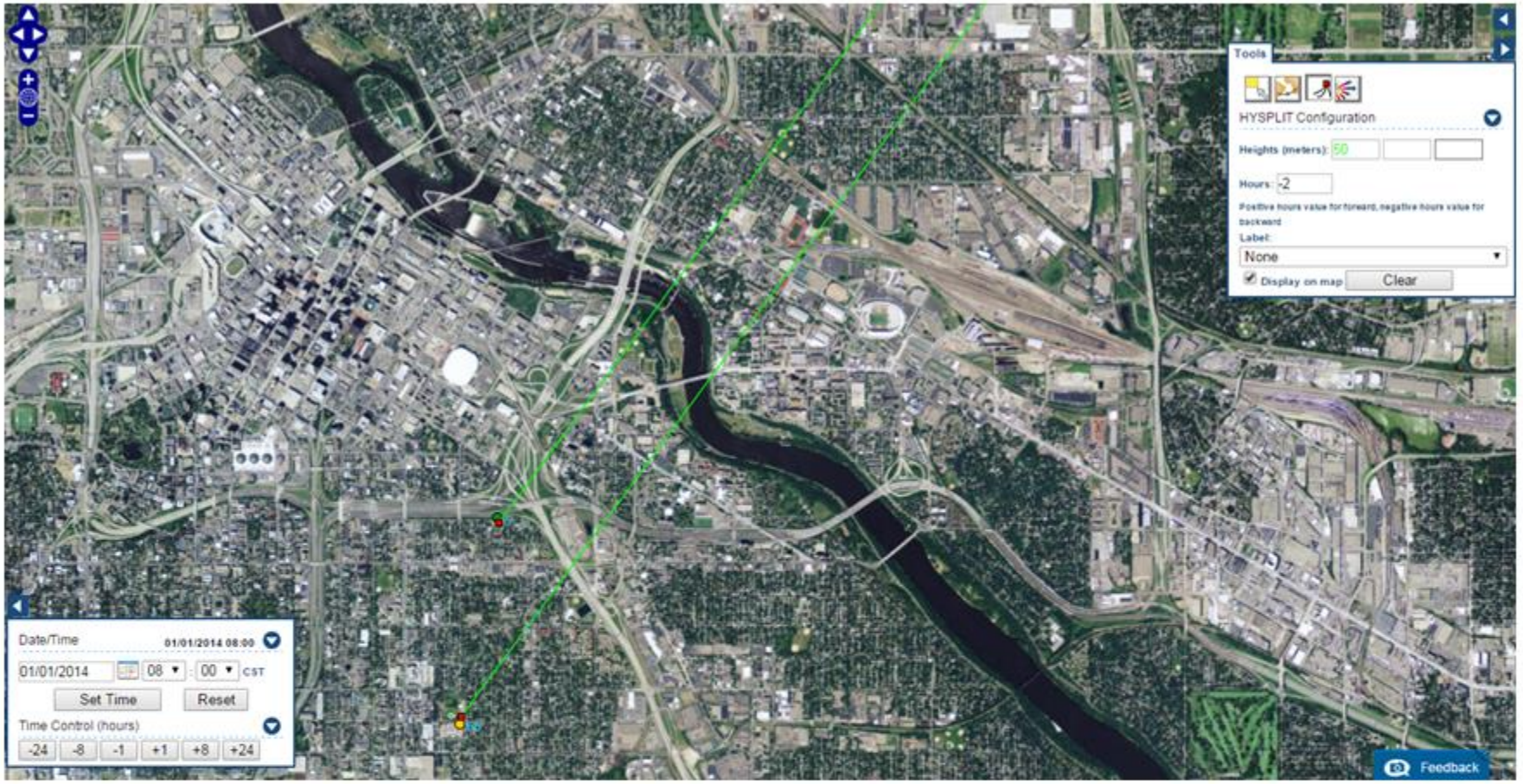


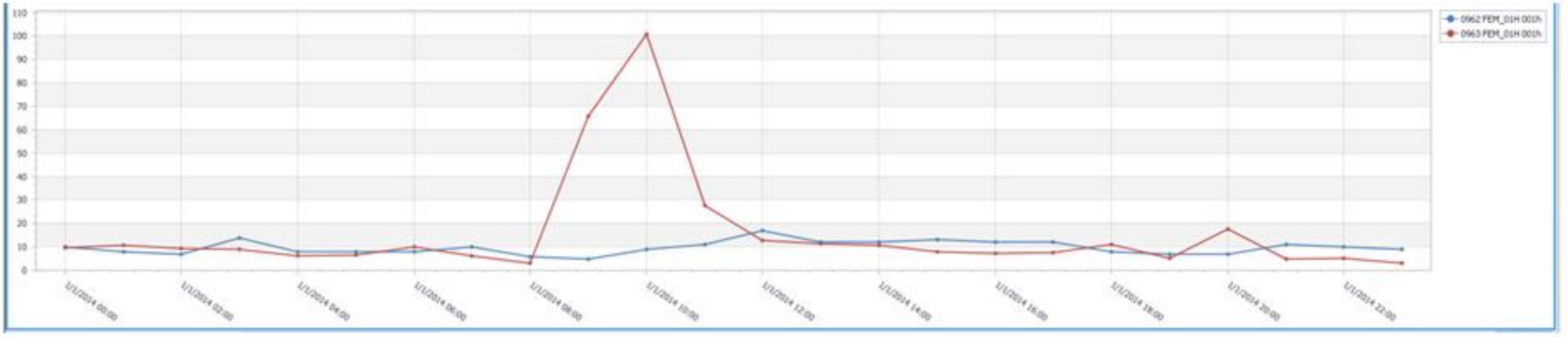

DBT
DszC
FMN
FMNH2
DszD
NADH+ H+
NAD+
O2
DBTO
DszC
FMN
FMNH2
DszD
NADH+ H+
NAD+
O2
DBTO2
DszA
2FMN
2FMNH2
DszD
2 NADH+ 2 H+
2NAD+
O2
HPBS
DszB
H2O
2-HBP
+
HSO3-


DBT and DBTS Concentration (ng/m3)
1.5
1.0
0.5
0.0
Anderson School
Mille Lacs
NearRoadway
Site ID
Site Name
Dibenzothiophene
Dibenzothiophene sulfone


PAH Concentration (ng/m3)
1.5
1.0
0.5
0.0
Jul 01, 2013
Oct 01, 2013
Jan 01, 2014
Apr 01, 2014
Jul 01, 2014
Site Name
Anderson School_963_not collocated_active
Mille Lacs_3051_not collocated_active
Near Roadway Site_962_north_active
Near Roadway Site_962_south_active


log ng/m3
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Naphthalene
2-Methylnaphthalene
Acenaphthylene
Acenaphthene
Fluorene
Anthracene
Phenanthrene
Dibenzothiophene
Fluoranthene
Pyrene
Dibenzothiophene sulfone
Benzo[c]fluorene
Cyclopenta[c,d]pyrene
Benz[a]anthracene
Chrysene
Benzo[b]naphtho[2,1-d]thiophene
Retene
5-Methylchrysene
Benzo[b]fluoranthene
Benzo[e]pyrene
Benzo[j]fluoranthene
Benzo[k]fluoranthene
Benzo[a]pyrene
Perylene
7H-Dibenzo[c,g]carbazole
Indeno[1,2,3-cd]pyrene
Anthanthrene
Benzo[g,h,i]perylene
Dibenz[a,h]anthracene
Dibenz[a,h]acridine
Coronene
Dibenzo[a,e]pyrene
Dibenzo[a,h]pyrene
Dibenzo[a,i]pyrene
Dibenzo[a,e]fluoranthene


Tools
HYSPLIT Configuration
Heights (meters): 50
Hours: -2
Positive hours value for forward, negative hours value for backward
Label:
None
Display on map
Clear
Date/Time
01/01/2014 08:00
01/01/2014
08
00
CST
Set Time
Reset
Time Control (hours)
-24
-8
-1
+1
+8
+24
Feedback


0962 PEM_01H 001h
0963 PEM_01H 001h

Thanks!
Questions?

PAHs in Air Project Website: http://www.pca.state.mn.us/yqq4pfk

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Grant # XA00E00976

Passive Monitors: donated by Oregon State University, Simonich Environmental Chemistry Laboratory