National-Scale Near-Road Monitoring Findings in 2016

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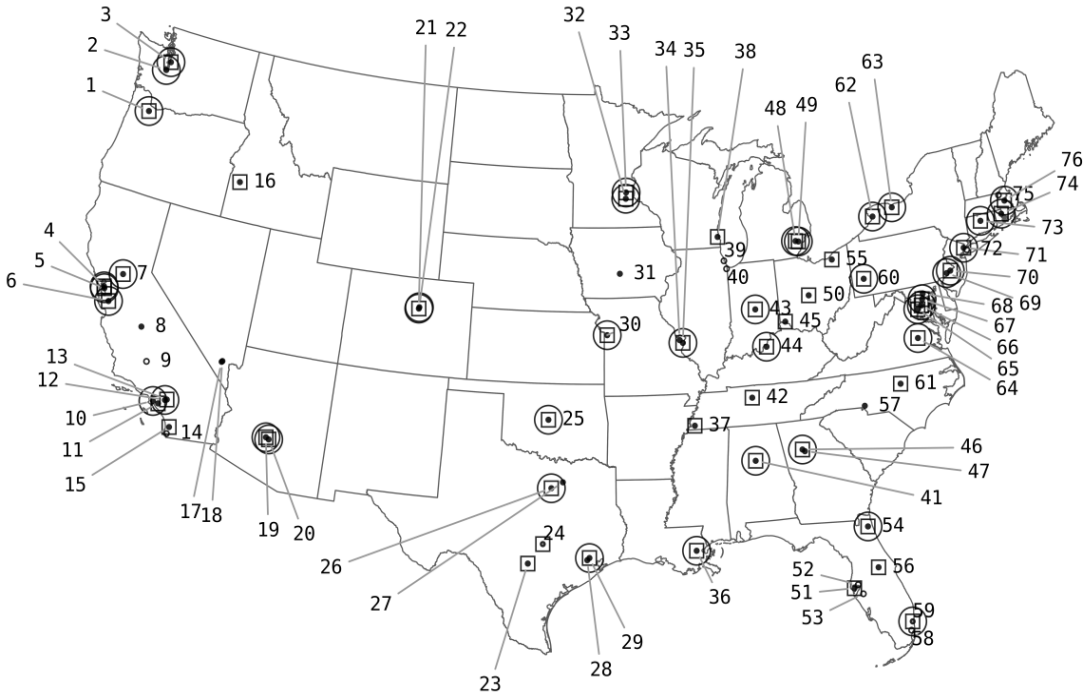
STi Sonoma Technology, Inc.

Washington State Department of Transportation

Near-Road Monitor Locations, May 2017



1 Portland-0005
2 Tacoma-0024
3 Seattle-0030
4 Berkeley-0013
5 Oakland-0012
6 San Jose-0006
7 Sacramento-0015
8 Fresno-2016
9 Bakersfield-NA
10 Long Beach-4008
11 Anaheim-0008
12 Ontario-0027
13 Ontario-0026
14 San Diego-NA
15 San Diego-1017
16 Meridian-0023
17 Las Vegas-1501
18 Las Vegas-1502
19 Phoenix-4020
20 Tempe-4019
21 Denver-0027
22 Denver-0028
23 San Antonio-1069
24 Austin-1068
25 Oklahoma City-0097
26 Fort Worth-1053
27 Dallas-1067
28 Houston-1066
29 Houston-1052
30 Kansas City-0042
31 Des Moines-6011
32 Lakeville-0480
33 Minneapolis-0962
34 St. Louis-0016
35 St. Louis-0094
36 New Orleans-0021
37 Memphis-0100
38 Milwaukee-0056
39 Chicago-0216
40 Lansing-0116
41 Birmingham-2059
42 Nashville-0040
43 Indianapolis-0087
44 Louisville-0075
45 Cincinnati-0048
46 Atlanta-0056
47 Atlanta-0003
48 Livonia-0095
49 Detroit-0093
50 Columbus-0038
51 St. Petersburg-0027
52 Tampa-1111
53 Tampa-0113
54 Jacksonville-0108
55 Cleveland-0073
56 Orlando-0009
57 Charlotte-0045
58 Miami-0035
59 Fort Lauderdale-0035
60 Wilkinsburg-1376
61 Raleigh-0021
62 Cheektowaga-0023
63 Rochester-0015
64 Richmond-0025
65 Springfield-0031
66 Washington DC-0051
67 Laurel-0006
68 Pikesville-0009
69 Philadelphia-0076
70 Philadelphia-0075
71 Fort Lee-0010
72 Queens-0125
73 Hartford-0025
74 Providence-0030
75 Chelmsford-NA
76 Boston-0044

- NO_2 68 locations
- CO 53 locations
- $PM_{2.5}$ 42 locations (8 sites had 3 complete yrs. of data)

Some locations have multiple monitors

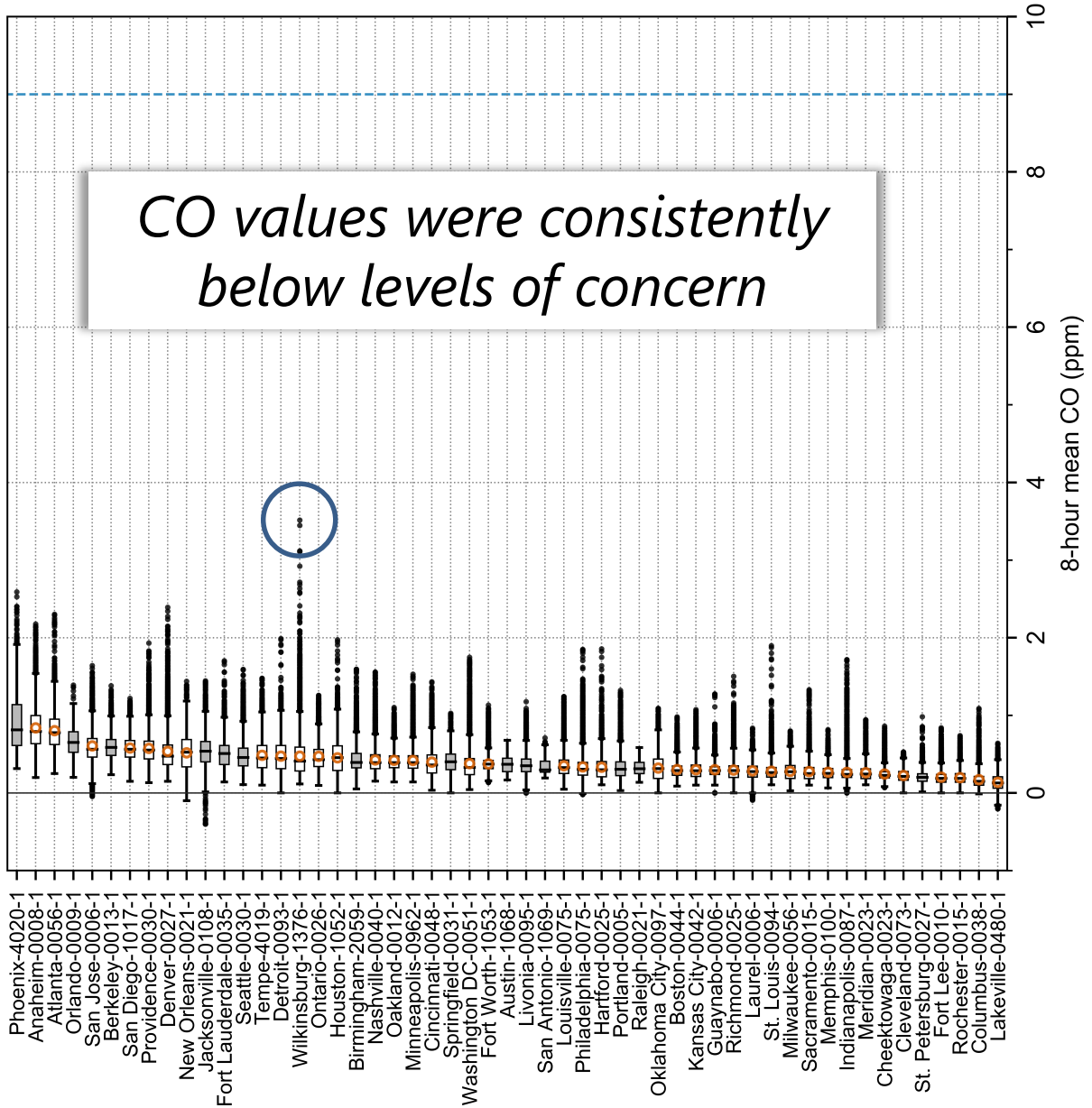
Pollutant Summary (1 of 2)

- NO_2
  - Overall, 1-hr values well under 100 ppb NAAQS
  - Annual averages well below 53 ppb NAAQS (closest: Ontario, CA, 31 ppb)
- CO
  - Concentrations extremely low vs. NAAQS
  - Range for 8-hr: -0.40 to 3.51 ppm (mean 0.39)

Pollutant Summary (2 of 2)

- $PM_{2.5}$
  - **24-hr NAAQS:** 10 sites > 35 µg/m^3; Ontario, CA only 98th percentile > 35 µg/m^3
  - **Annual NAAQS:** 3 sites below 12 µg/m^3 but within 1.5 µg/m^3; only Ontario (complete yr data) above
  - **Trends** (8 sites with 3-yr data): generally down
  - **Highest values** (sites with 3-yr data): Indianapolis
    - 11.6 µg/m^3 (annual mean)
    - 26.8 µg/m^3 (98th percentile)

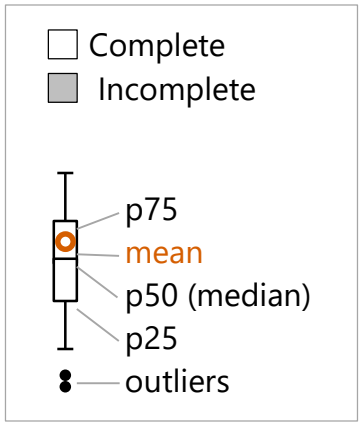
8-Hour CO



53 monitors
39 complete

NAAQS:
8-hr 9 ppm

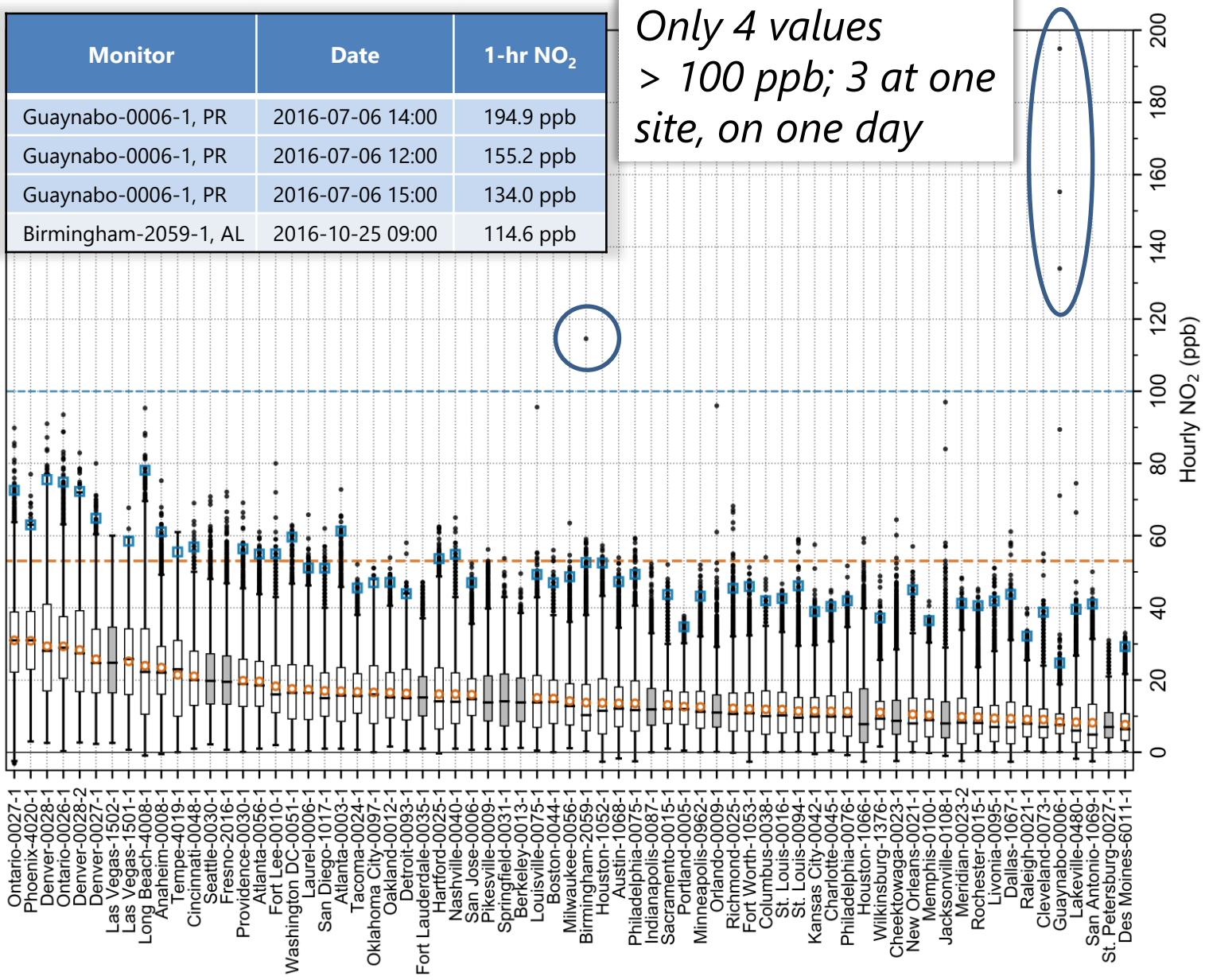
Highest value:
Wilkinsburg, PA: 3.5 ppm



NO_2

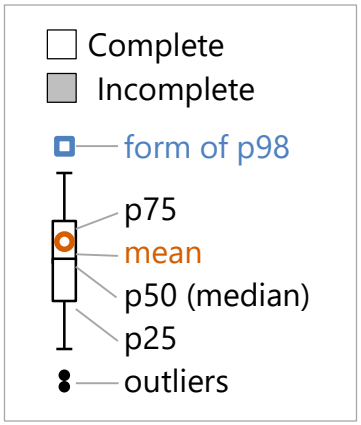
Monitor	Date	1-hr NO_2
Guaynabo-0006-1, PR	2016-07-06 14:00	194.9 ppb
Guaynabo-0006-1, PR	2016-07-06 12:00	155.2 ppb
Guaynabo-0006-1, PR	2016-07-06 15:00	134.0 ppb
Birmingham-2059-1, AL	2016-10-25 09:00	114.6 ppb

Only 4 values > 100 ppb; 3 at one site, on one day

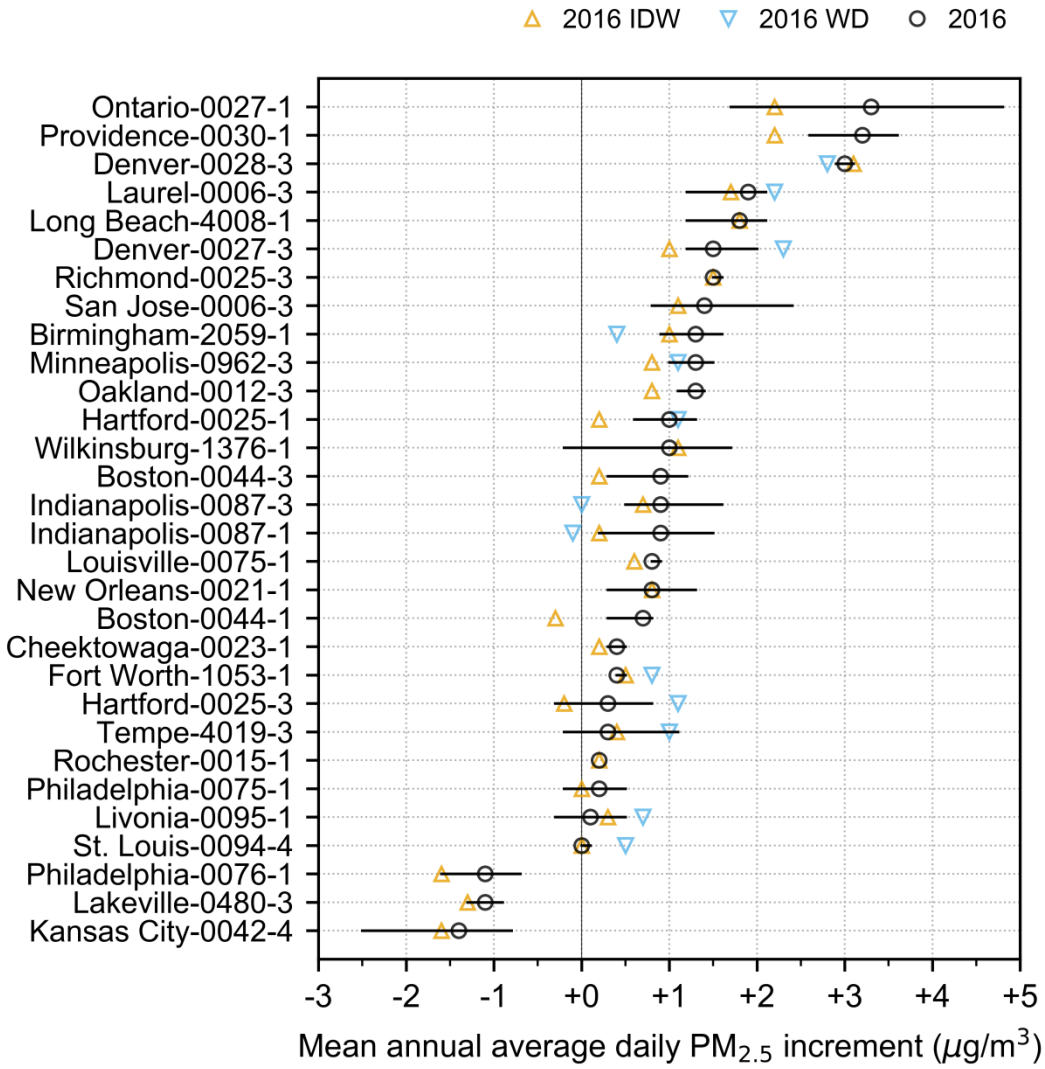


69 monitors
56 complete

NAAQS:
1-hr 100 ppb
Annual 53 ppb



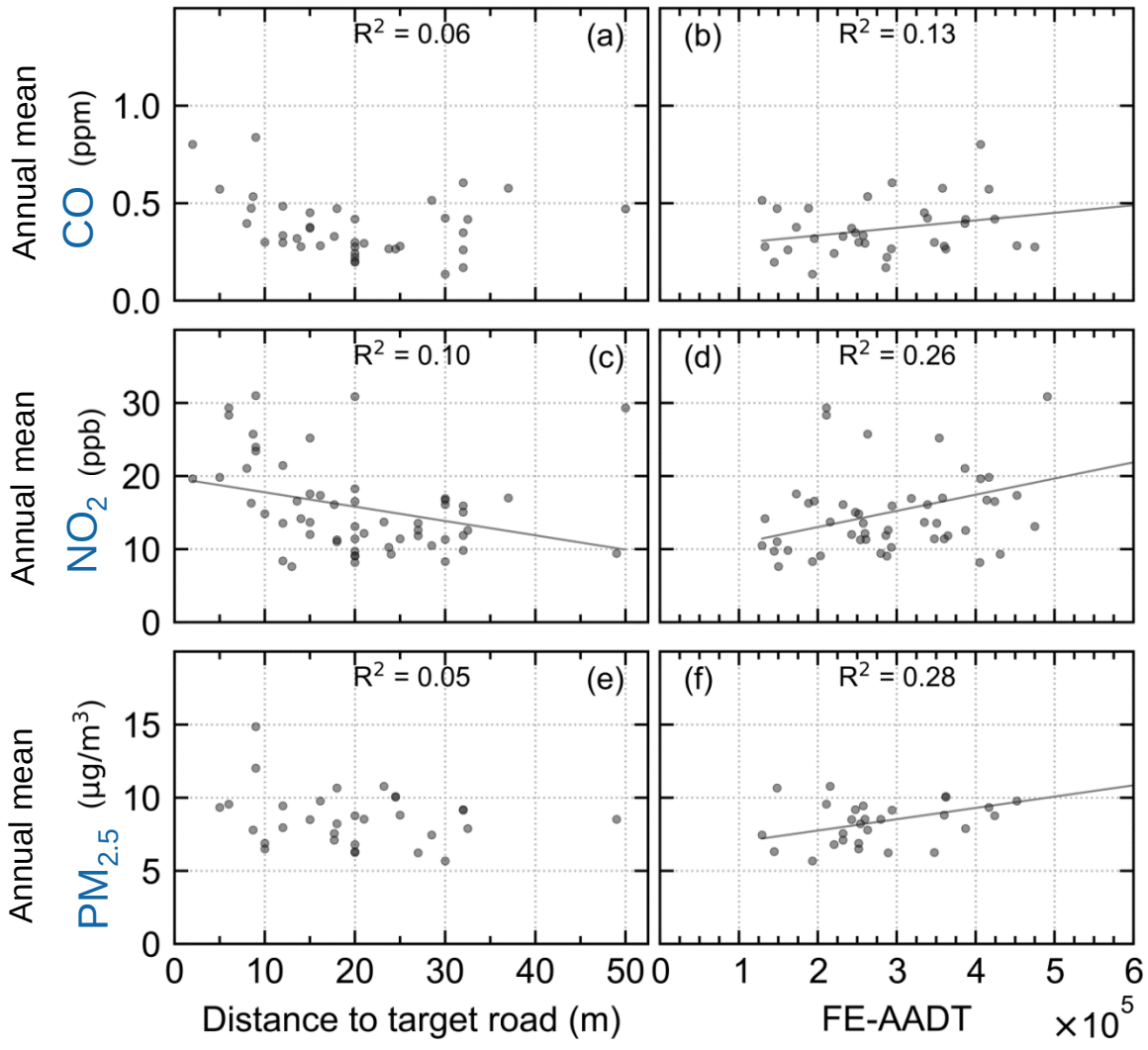
$PM_{2.5}$ Increment Results, 2016



- Mean increment 0.75 μg/m^3
- However, increment varies widely across sites

3 methods:
Inverse distance weighting (IDW)
Using a single upwind site (WD)
Using a combination of nearby sites (2016)

Relationships to Road Characteristics



Some 2016 observations, based on annual mean concentrations:

1. **CO and $PM_{2.5}$**: There was no relationship with distance from road.
2. **All pollutants:** There was a positive relationship between concentration and FE-AADT.

Lines show where relationships are significant, based on p-value ≤ 0.05

Research Needs

- NO_2 and CO are well below NAAQS; at what point should CO results trigger a change to conformity hot-spot analysis requirements?
- Will the (limited, ~8 areas) downward trending $PM_{2.5}$ values seen here be robust over time and geographic locations?
- As more data become available on $PM_{2.5}$ values, trends, and near-road increments, could that data be used to support screening-level (as opposed to quantitative) PM hot-spot analyses?

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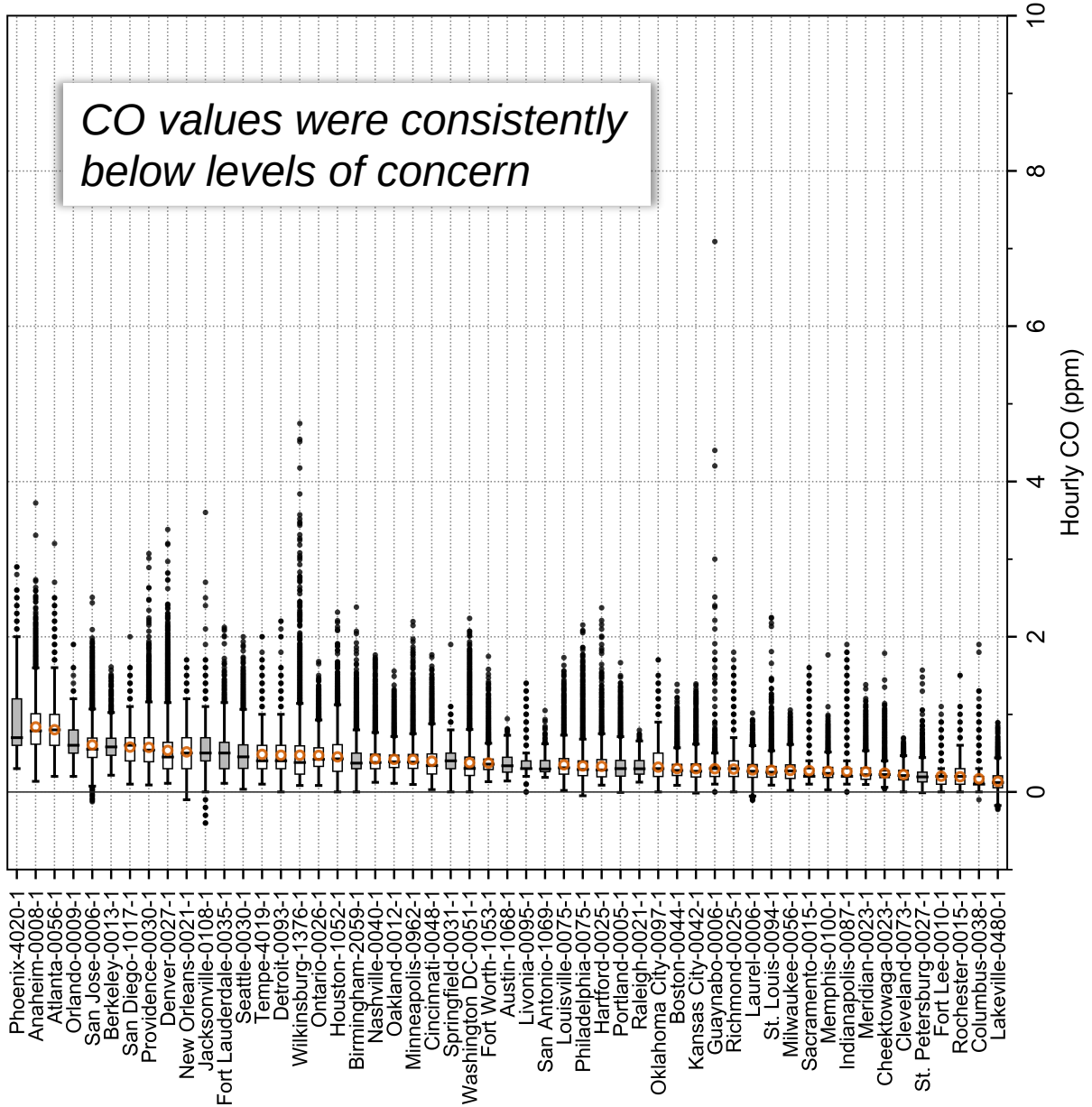
Supplemental Material

2016 Near-Road Monitoring Sites Completeness

Pollutant	Measured (n sites[a])	Complete[b] (n sites[a])
NO_2	68	55
CO	53	39
$PM_{2.5}$	42	28

[a]Number of unique sites by AQS ID (only one site is counted for any collocated monitors)
[b]Based on 75% completeness estimated by quarter

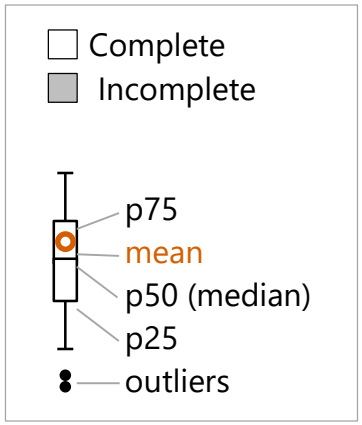
1-Hour CO



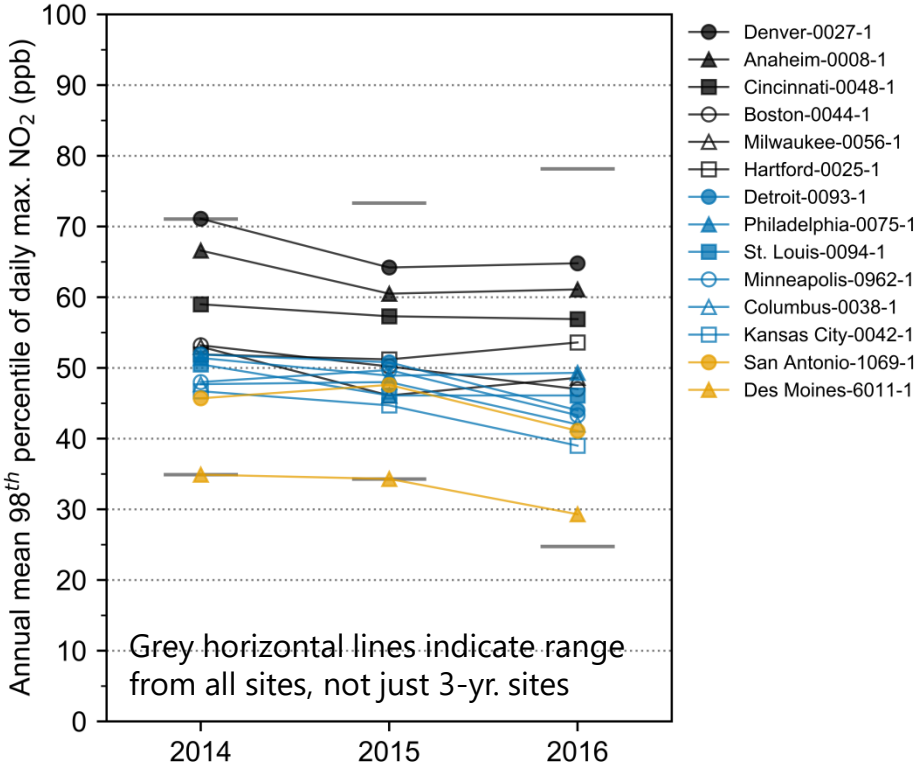
53 monitors
39 complete

NAAQS:
1-hr 35 ppm

Highest values:
Guaynabo, PR (7.1 ppm)
Wilkinsburg, PA (4.7 ppm)



3-Year Statistics: NO_2 (3-Year Sites)



Monitor	p98 (ppb)
Denver-0027-1, CO	66.7
Anaheim-0008-1, CA	62.7
Cincinnati-0048-1, OH	57.7
Hartford-0025-1, CT	52.2
Boston-0044-1, MA	50.1
Philadelphia-0075-1, PA	49.9
Milwaukee-0056-1, WI	49.2
Detroit-0093-1, MI	48.9
St. Louis-0094-1, MO	47.6
Minneapolis-0962-1, MN	47.0
Columbus-0038-1, OH	45.9
San Antonio-1069-1, TX	44.8
Kansas City-0042-1, MO	43.5
Des Moines-6011-1, IA	32.8

For the 14 sites with complete data in all 3 years, concentrations at most sites were generally trending downward over the 3 years.

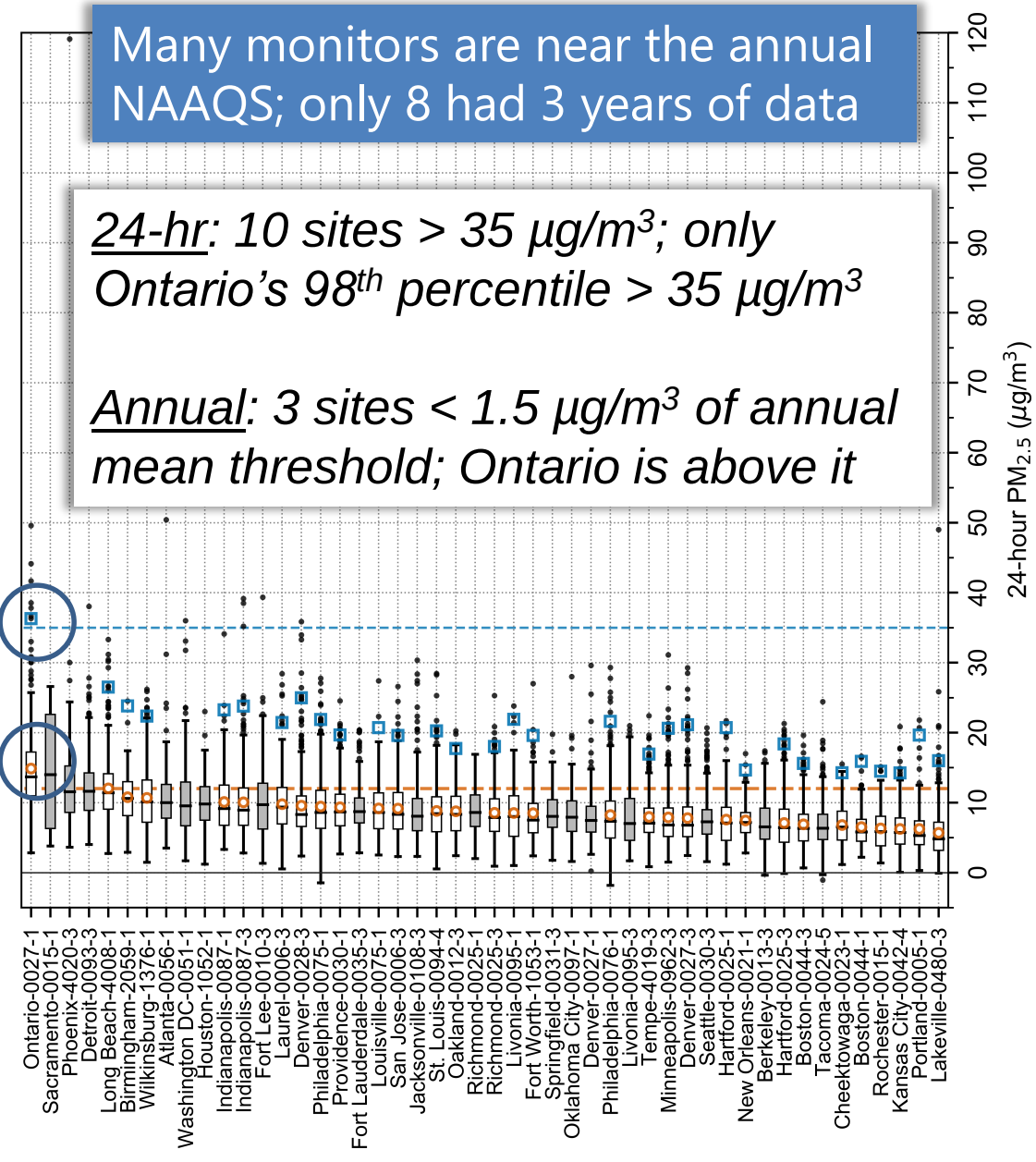
These findings are for research purposes and should not be used for determining attainment status.

$PM_{2.5}$

Many monitors are near the annual NAAQS; only 8 had 3 years of data

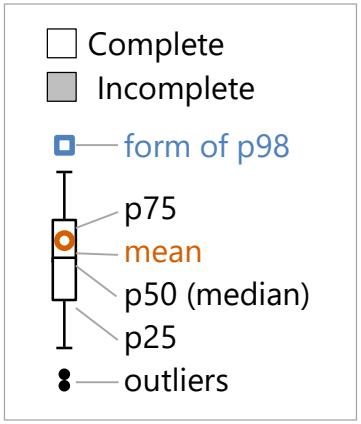
24-hr: 10 sites > 35 µg/m³; only Ontario's 98th percentile > 35 µg/m³

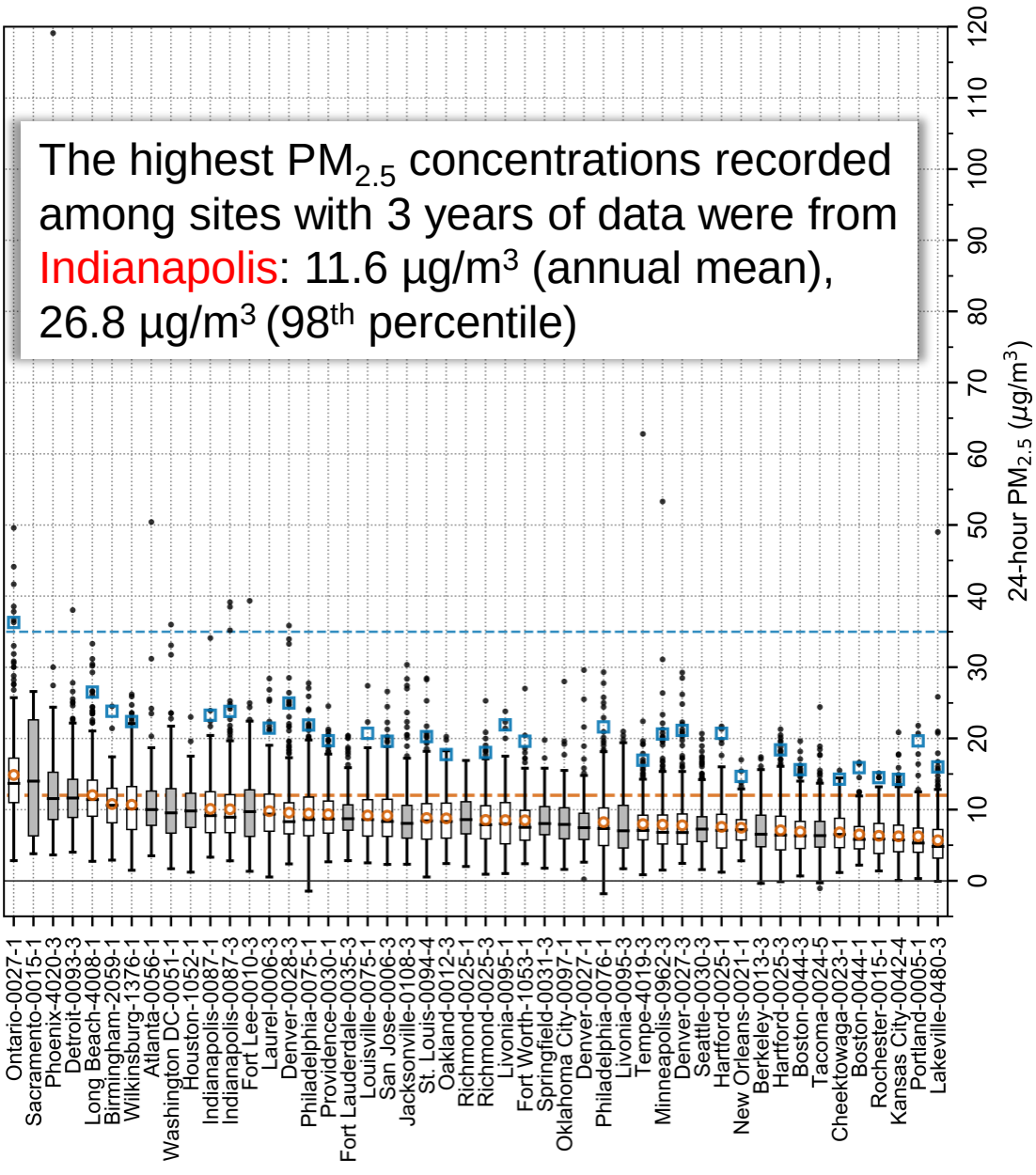
Annual: 3 sites < 1.5 µg/m³ of annual mean threshold; Ontario is above it



48 monitors
31 complete

NAAQS:
24-hr 35 µg/m³
annual 12.0 µg/m³

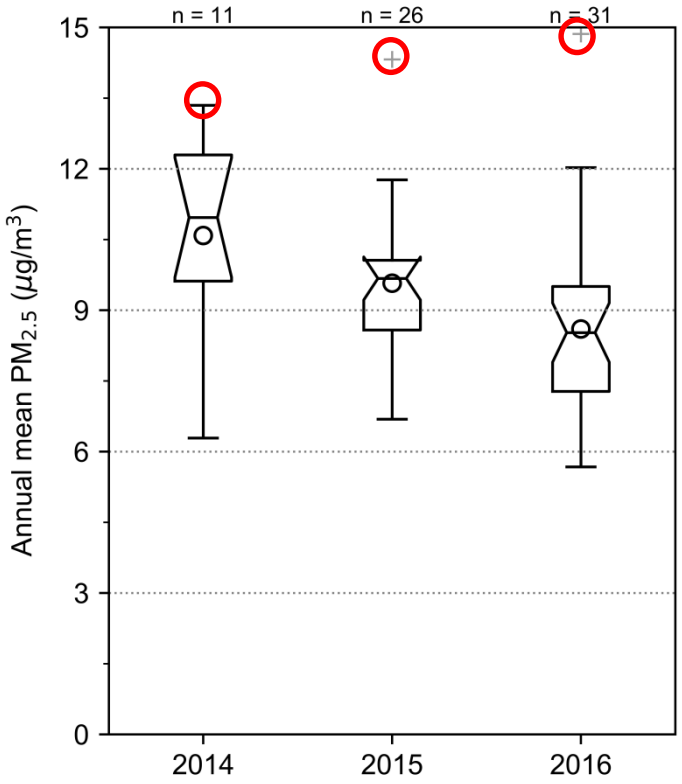


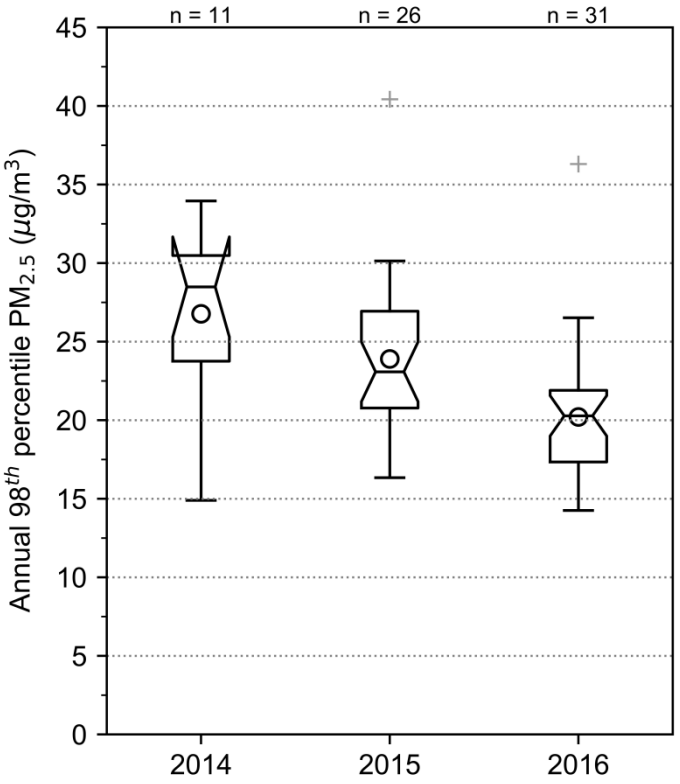


The highest $PM_{2.5}$ concentrations recorded among sites with 3 years of data were from Indianapolis: 11.6 µg/m^3 (annual mean), 26.8 µg/m^3 (98th percentile)

In 2016, 10 sites had $PM_{2.5}$ >35 g/m^3	Date	24-hr $PM_{2.5}$ (µg/m^3)
Phoenix-4020-3, AZ	2016-01-01	119.1
Tempe-4019-3, AZ	2016-01-01	62.8
Minneapolis-0962-3, MN	2016-05-07	53.3
Atlanta-0056-1, GA	2016-11-14	50.4
Ontario-0027-1, CA	2016-07-05	49.6
Lakeville-0480-3, MN	2016-05-07	49.0
Ontario-0027-1, CA	2016-12-14	44.1
Ontario-0027-1, CA	2016-01-17	41.7
Fort Lee-0010-3, NJ	2016-03-09	39.3
Indianapolis-0087-3, IN	2016-11-06	39.1
Ontario-0027-1, CA	2016-12-13	38.5
Indianapolis-0087-3, IN	2016-11-05	38.5
Detroit-0093-3, MI	2016-07-04	38.0
Ontario-0027-1, CA	2016-02-13	37.8
Ontario-0027-1, CA	2016-12-10	36.6
Ontario-0027-1, CA	2016-12-09	36.3
Washington DC-0051-1, DC	2016-11-25	36.0
Denver-0028-3, CO	2016-01-04	35.8
Indianapolis-0087-3, IN	2016-11-13	35.2

3-Year Statistics: $PM_{2.5}$ (All Sites)

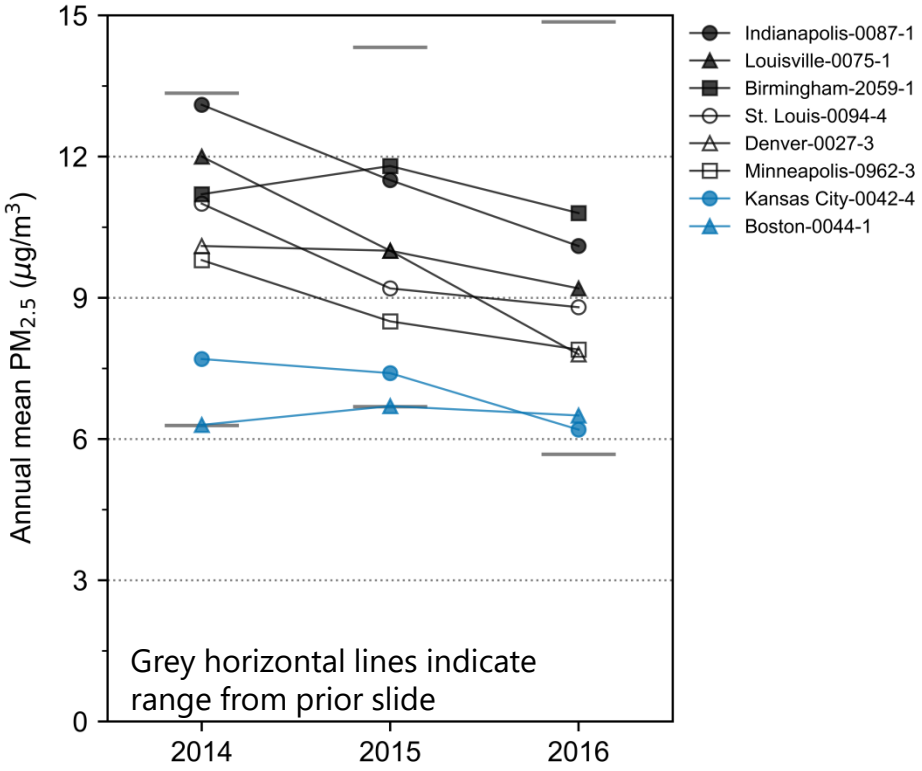


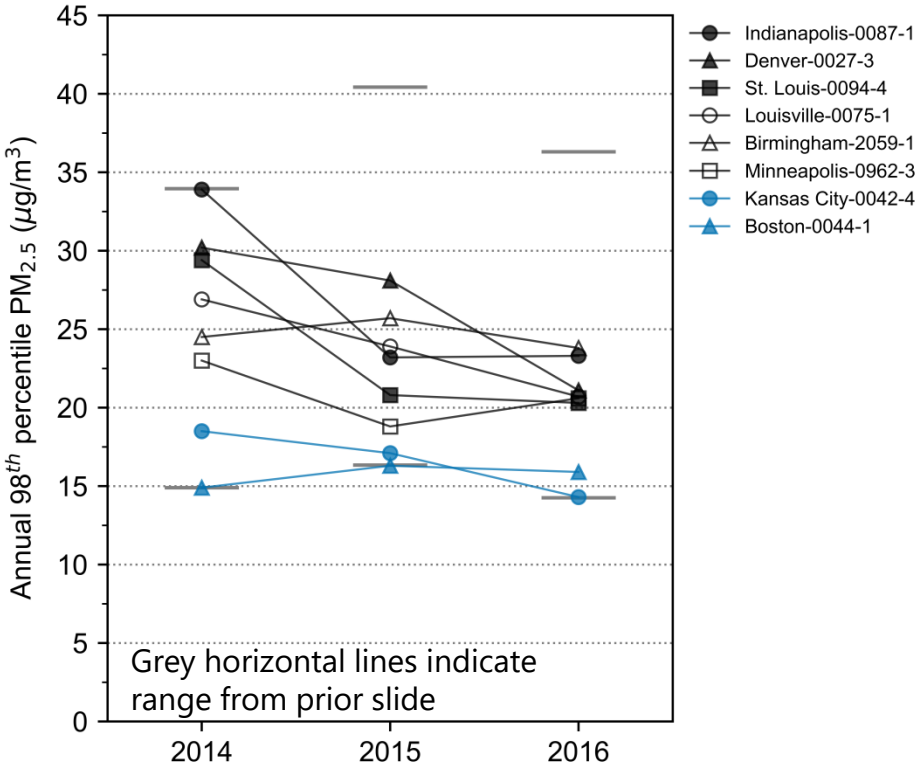


On average, $PM_{2.5}$ decreased across all sites with complete years of data. Outlier values (max. annual mean ○) increased from 2014 to 2016 as data from more sites became available.

These findings are for research purposes and should not be used for determining attainment status.

3-Year Statistics: $PM_{2.5}$ (3-Year Sites)

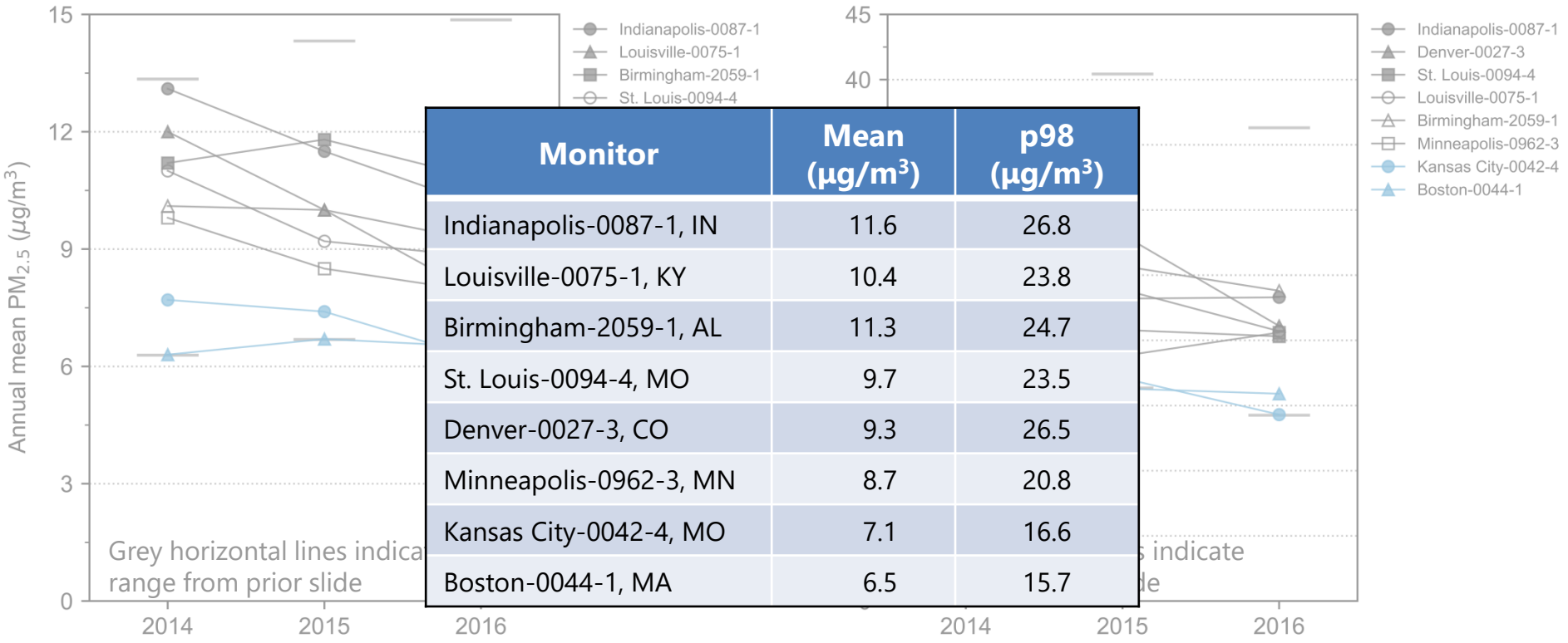




For the 8 sites with 3 years of complete $PM_{2.5}$ data, $PM_{2.5}$ was decreasing at most of them. However, in 2015-2016, these 8 sites did not represent the full range of $PM_{2.5}$ concentrations across all sites, and may not be representative of all near-road sites in those years.

These findings are for research purposes and should not be used for determining attainment status.

3-Year Statistics: $PM_{2.5}$ (3-Year Sites)



Monitor	Mean (µg/m³)	p98 (µg/m³)
Indianapolis-0087-1, IN	11.6	26.8
Louisville-0075-1, KY	10.4	23.8
Birmingham-2059-1, AL	11.3	24.7
St. Louis-0094-4, MO	9.7	23.5
Denver-0027-3, CO	9.3	26.5
Minneapolis-0962-3, MN	8.7	20.8
Kansas City-0042-4, MO	7.1	16.6
Boston-0044-1, MA	6.5	15.7

Data shown are the average of three years, for each site.

These findings are for research purposes and should not be used for determining attainment status.

Potential Future $PM_{2.5}$ Analysis

2015	2016	Potential Future Analysis (2017)
Atlanta-0056-1	Birmingham-2059-1	Birmingham-2059-1
Birmingham-2059-1	Boston-0044-1	Boston-0044-1
Boston-0044-1	Boston-0044-3	Cheektowaga-0023-1
Cheektowaga-0023-1	Cheektowaga-0023-1	Denver-0027-3
Denver-0027-1	Denver-0027-3	Hartford-0025-1
Denver-0027-3	Denver-0028-3	Indianapolis-0087-1
Fort Lee-0010-3	Fort Worth-1053-1	Kansas City-0042-4
Hartford-0025-1	Hartford-0025-1	Lakeville-0480-3
Indianapolis-0087-1	Hartford-0025-3	Livonia-0095-1
Kansas City-0042-4	Indianapolis-0087-1	Louisville-0075-1
Lakeville-0480-3	Indianapolis-0087-3	Minneapolis-0962-3
Livonia-0095-1	Kansas City-0042-4	New Orleans-0021-1
Louisville-0075-1	Lakeville-0480-3	Oakland-0012-3
Minneapolis-0962-3	Laurel-0006-3	Ontario-0027-1
New Orleans-0021-1	Livonia-0095-1	Philadelphia-0075-1
Oakland-0012-3	Long Beach-4008-1	Portland-0005-1
Ontario-0027-1	Louisville-0075-1	Providence-0030-1
Philadelphia-0075-1	Minneapolis-0962-3	Richmond-0025-3
Portland-0005-1	New Orleans-0021-1	San Jose-0006-3
Providence-0030-1	Oakland-0012-3	St. Louis-0094-4
Richmond-0025-3	Ontario-0027-1	Tempe-4019-3
San Jose-0006-3	Philadelphia-0075-1	
Seattle-0030-3	Philadelphia-0076-1	
St. Louis-0094-4	Portland-0005-1	
Tampa-1111-3	Providence-0030-1	
Tempe-4019-3	Richmond-0025-3	
	Rochester-0015-1	
	San Jose-0006-3	
	St. Louis-0094-4	
	Tempe-4019-3	
	Wilkinsburg-1376-1	

Sites that could be used for the next 3-year analysis (2015-2017) if $PM_{2.5}$ data are complete in 2017.