Ambient Air Toxics Measurements Analyses

Current patterns and trends of key HAPs

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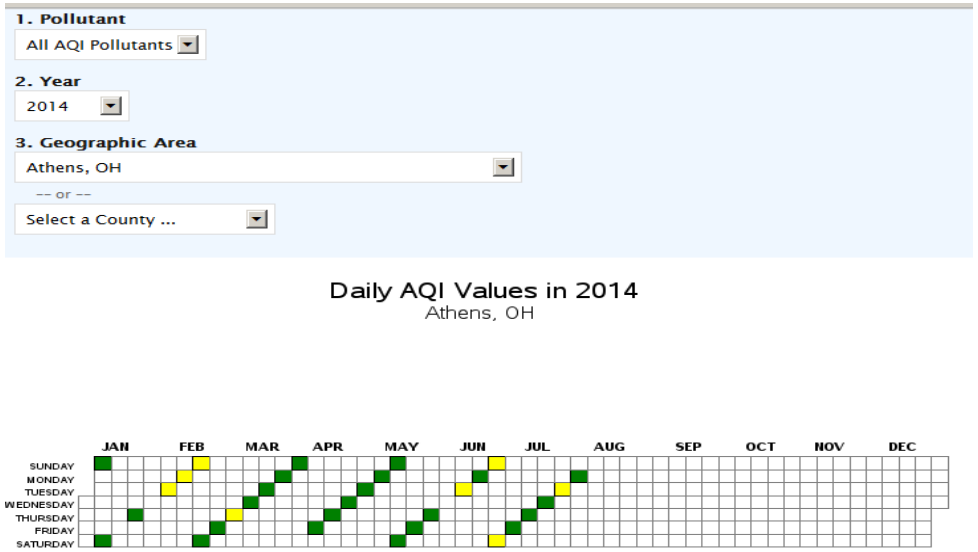
For more information see

1. Journal of the Air & Waste Management Association, accepted July 2015 (http://dx.doi.org/10.1080/10962247.2015.1076538)
2. AWMA 108th Annual Conference, Raleigh, NC June 22-25, 2015, Extended abstract
3. EPA's Report on the Environment (www.epa.gov/roe)

How do you use observations to convey potential health effects of air contaminants?

Criteria -

- Attainment/nonattainment status
- Look at the AQI (www3.epa.gov/airdata)



Toxics

- 187 HAPs + diesel PM
  - ~70 have cancer inhalation risks
  - ~100 have noncancer inhalation risks
  - Additional HAPs issues from deposition/ingestion, other pathways
- Abundance of ambient data toxics data?
  - >25,000 site/pollutant measurements with at least one year of complete data between 1990 and 2013
  - Less than half have data after 2010
  - Roughly half the data are below MDL
  - In 2011: ~200 monitors for BTEX, high concentration chlorinated VOCs, less for aldehydes, much less for other HAPs

Concentration benchmarks corresponding to a 1 in 1 million cancer risk or a hazard quotient of 1 for noncancer effects

Provides a way to provide context in examination of air toxics concentrations in the absence of national air quality standards.

	HEALTH BENCHMARKS * (ug/m3)	
Pollutant	1 per million cancer risk	Hazard Quotient = 1
Chromium (VI)	8E-05	0.1
Arsenic	2E-04	0.015
Beryllium	4E-04	0.02
Cadmium	6E-04	0.01
Benzo[a]Pyrene	6E-04	N/A
Ethylene Dibromide	2E-03	9
Nickel	2E-03	0.09
Ethylene Oxide	0.01	30
Acrylonitrile	0.01	2
Naphthalene	0.03	3
1,3-Butadiene	0.03	2
Ethylene Dichloride	0.04	2400
Formaldehyde	0.08	9.8
1,4-Dichlorobenzene	0.09	800
Vinyl Chloride	0.11	100
Benzene	0.13	30
Carbon Tetrachloride	0.17	100
Trichloroethylene	0.21	2
Ethyl Benzene	0.40	1000
Acetaldehyde	0.45	9
Tetrachloroethylene	3.8	40
Methylene Chloride	63	600
Chloroform	N/A	98
Toluene	N/A	5000
Lead	N/A	0.15
Manganese	N/A	0.3

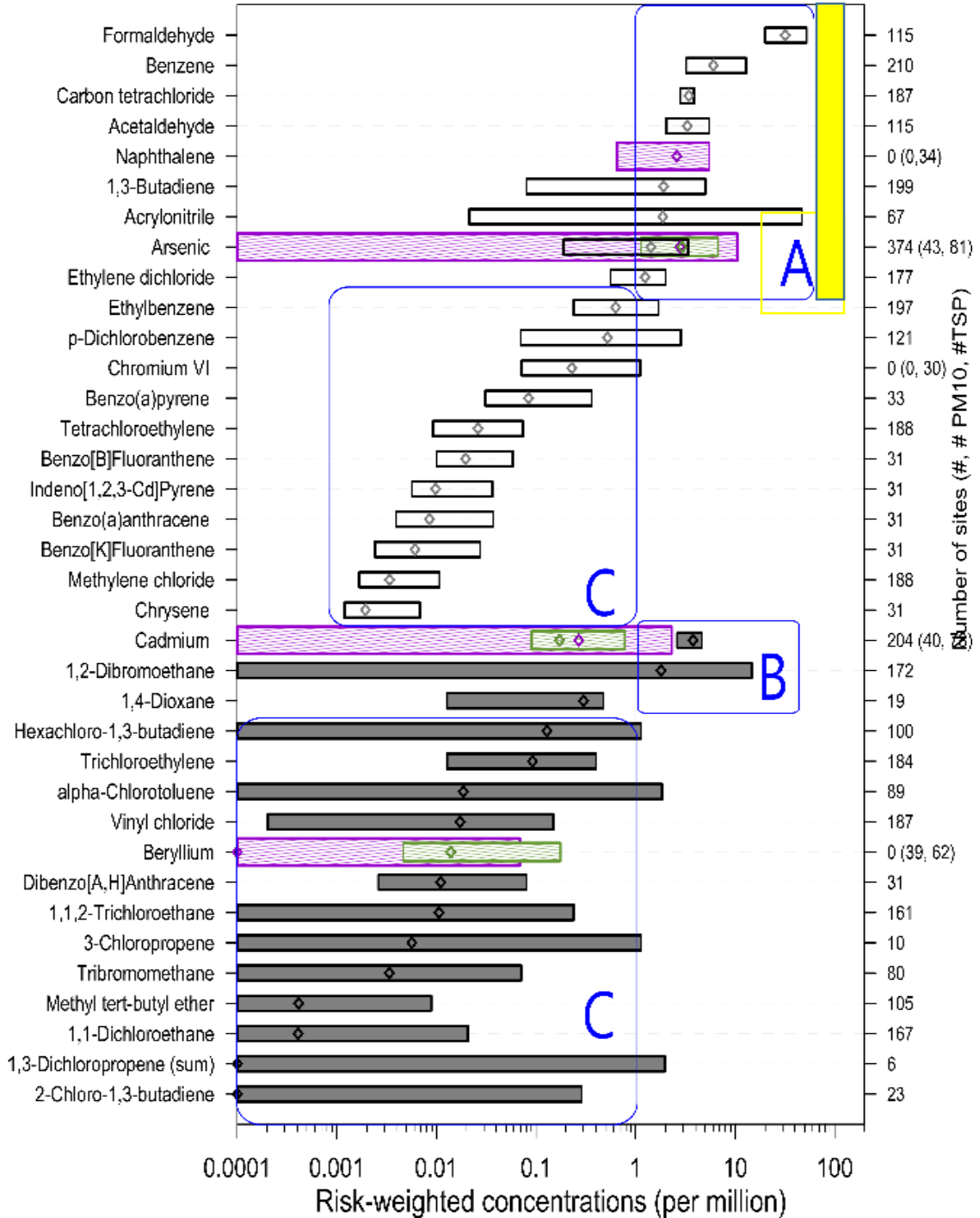
Highest risk HAPs, concentrations above MDL

*based on chronic inhalation unit risk estimates and reference concentrations used by EPA (last updated Spring 2014). Cancer benchmark adjusted upward by 1.6 for HAPs with mutagenic mode of action

Data Analysis Procedures

- Used Archive
  - Non detects treated as 0
  - Less than MDL treated as is
- Different Completeness approaches for annual statistics
  - 2010-2012 Risk weighted concentrations (next slide) required 11 days per quarter, at least 3 quarters, and at least 1 complete year between 2010 and 2012
  - Other analyses – required 75% of scheduled measurements for each quarter, at least 3 quarters
- Different POC averaging approaches
  - Averaged all POCS with same method code (Risk weighted concentrations)
  - Used POC with most completeness (Report on the Environment)
  - Average all POCS together except sub 24 hours vs 24 hours (all other plots)

Distribution of risk-weighted concentrations (annual means) 2010-2012



A: > 1per million, and >20% measurements above MDL

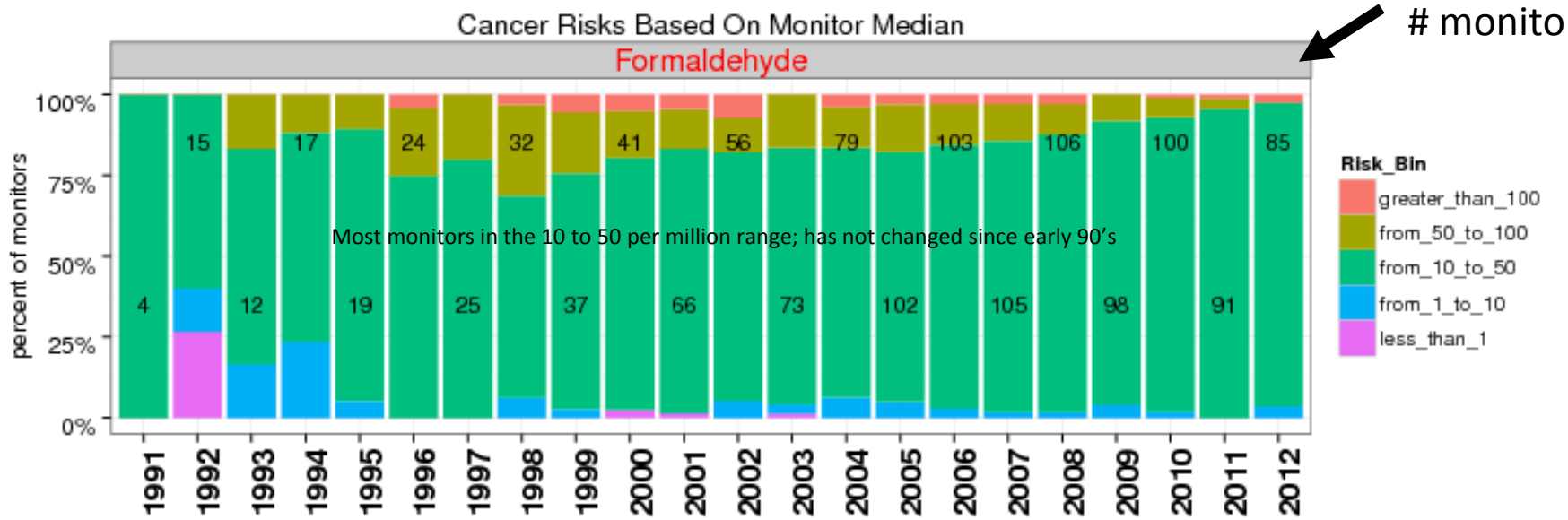
Formaldehyde
Benzene
Carbon Tetrachloride
Acetaldehyde
Naphthalene
1,3 butadiene
Arsenic
Acrylonitrile
Ethylene dichloride

B: > 1per million <20% above MDL

C: < 1per million

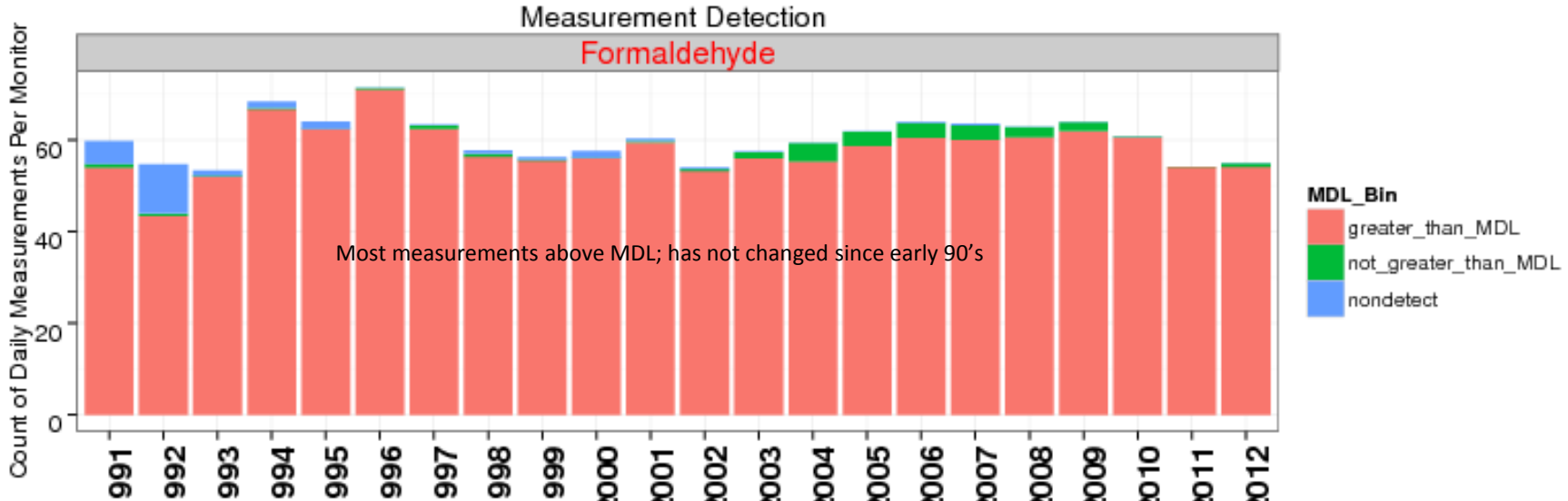
Determining Priority HAPs from the Monitoring Data/MDL

Cancer Weighted Concentrations based on Monitor Medians



monitors

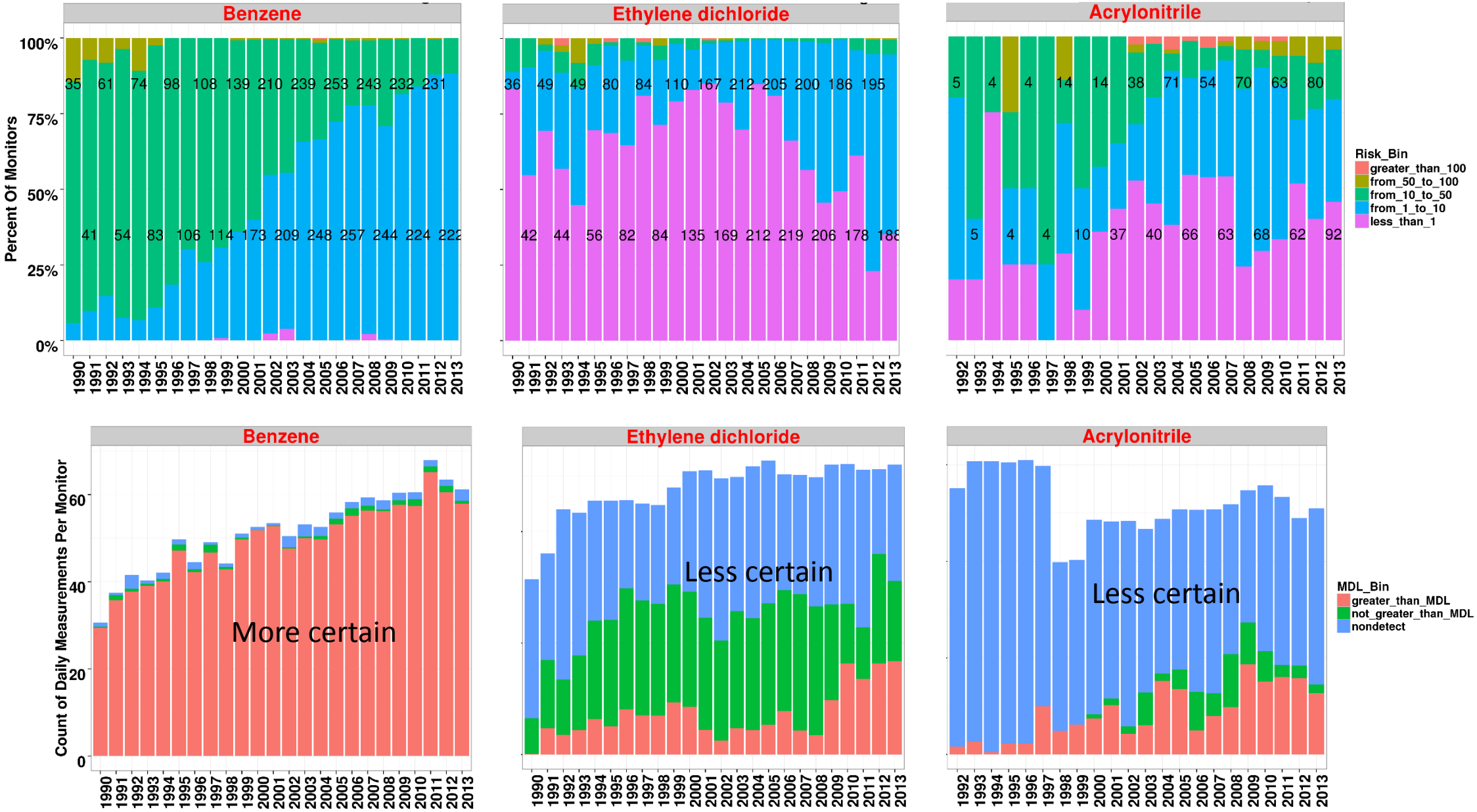
Most monitors in the 10 to 50 per million range; has not changed since early 90's



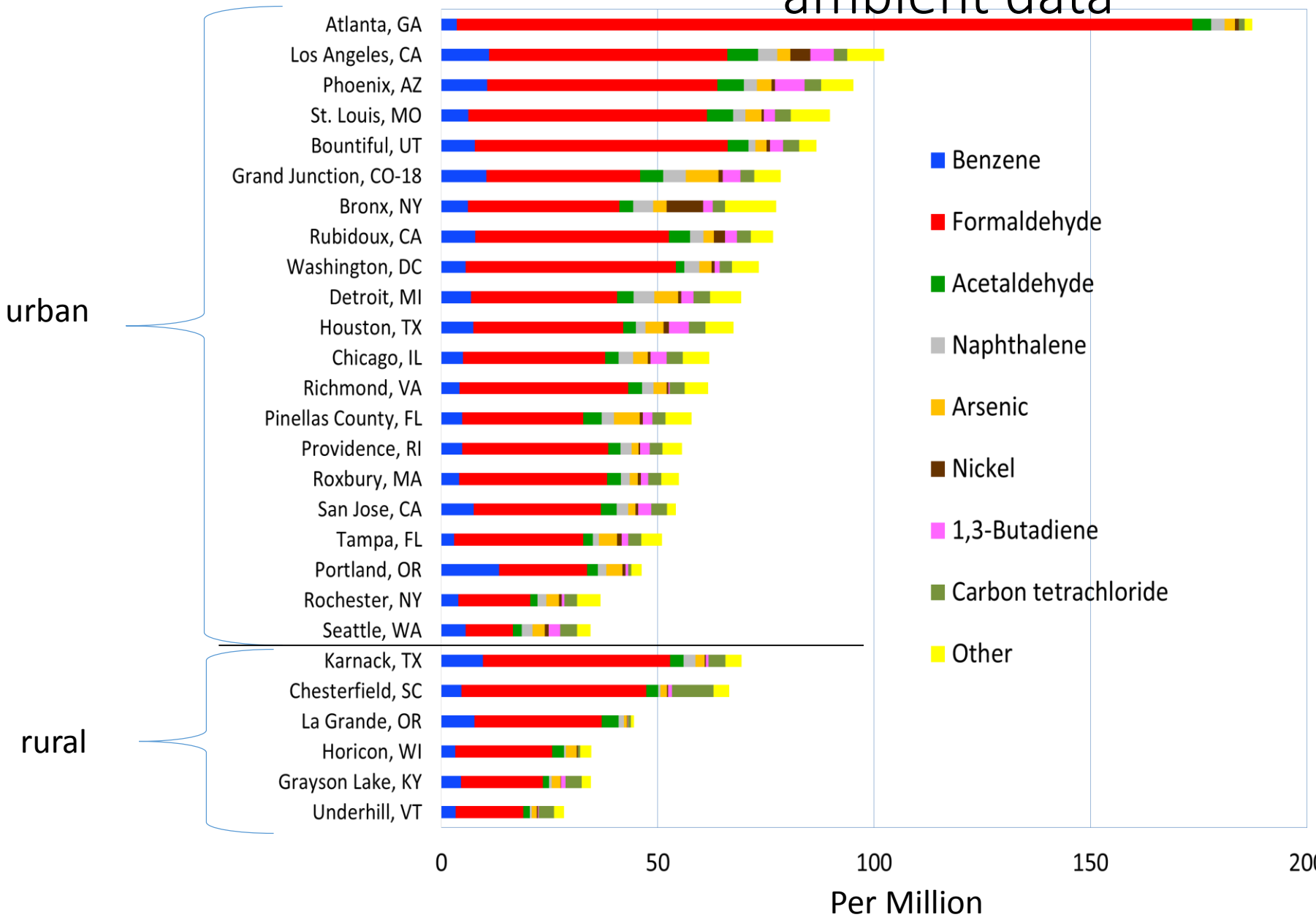
Most measurements above MDL; has not changed since early 90's

Determining Priority HAPs from the Monitoring Data/MDL

Cancer Weighted Concentrations based on Monitor Means



Cancer-Weighted Comparisons at NATTS sites based on 2011 ambient data



Most sites exceed 50 per million

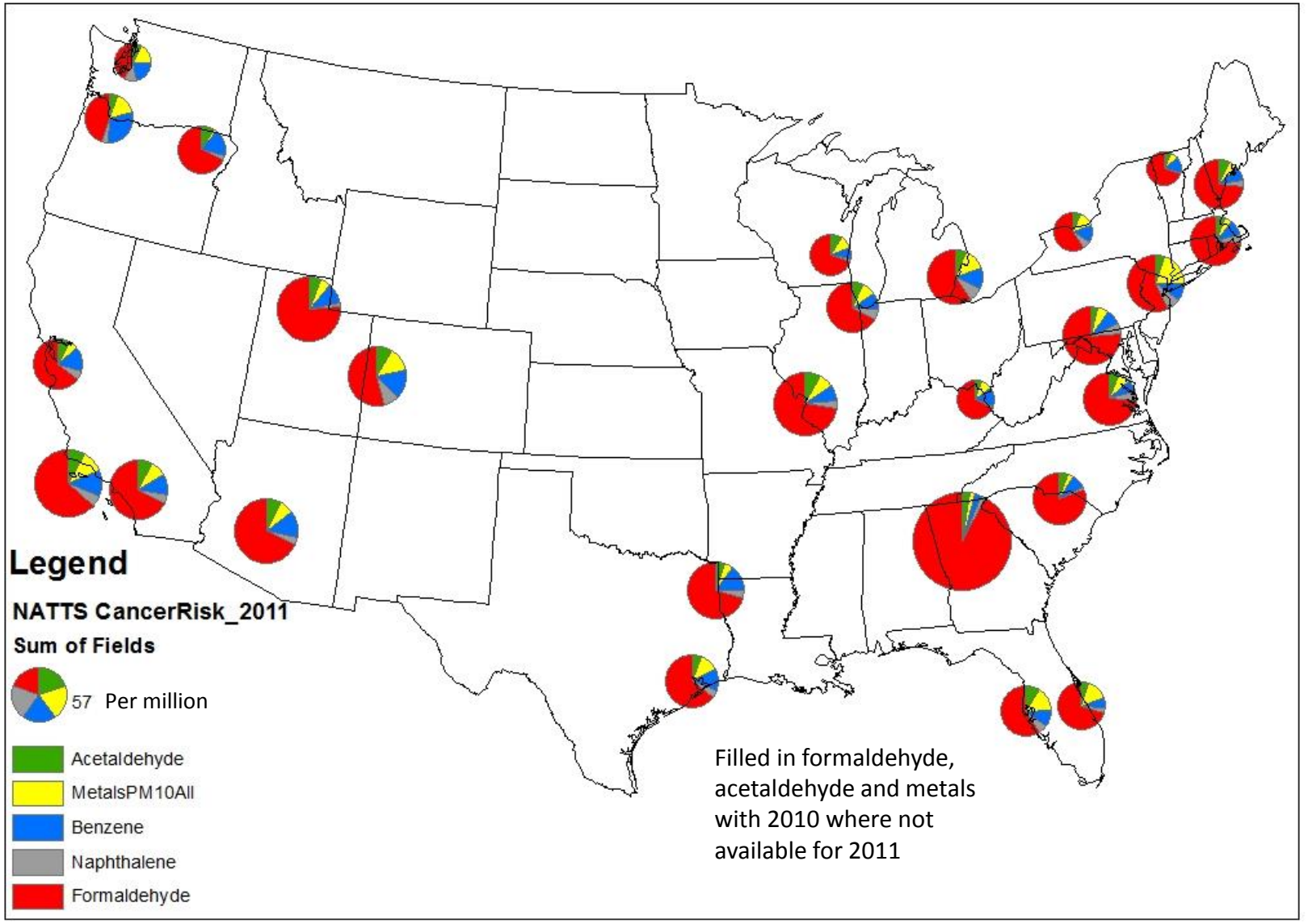
Formaldehyde range: 11 to 170 per million

Acetaldehyde range: 1.7 to 7 per million

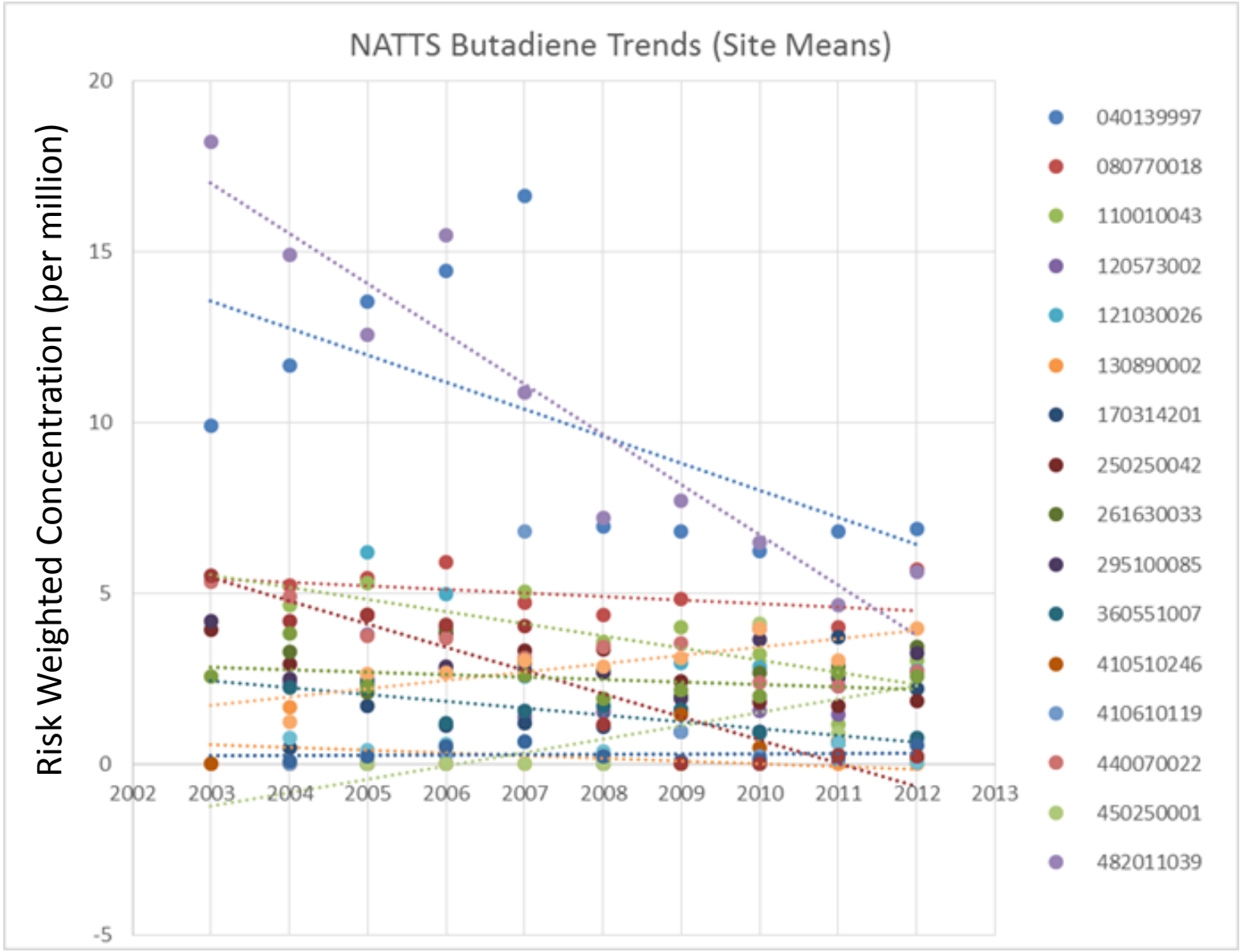
Benzene range: 3 to 13 per million

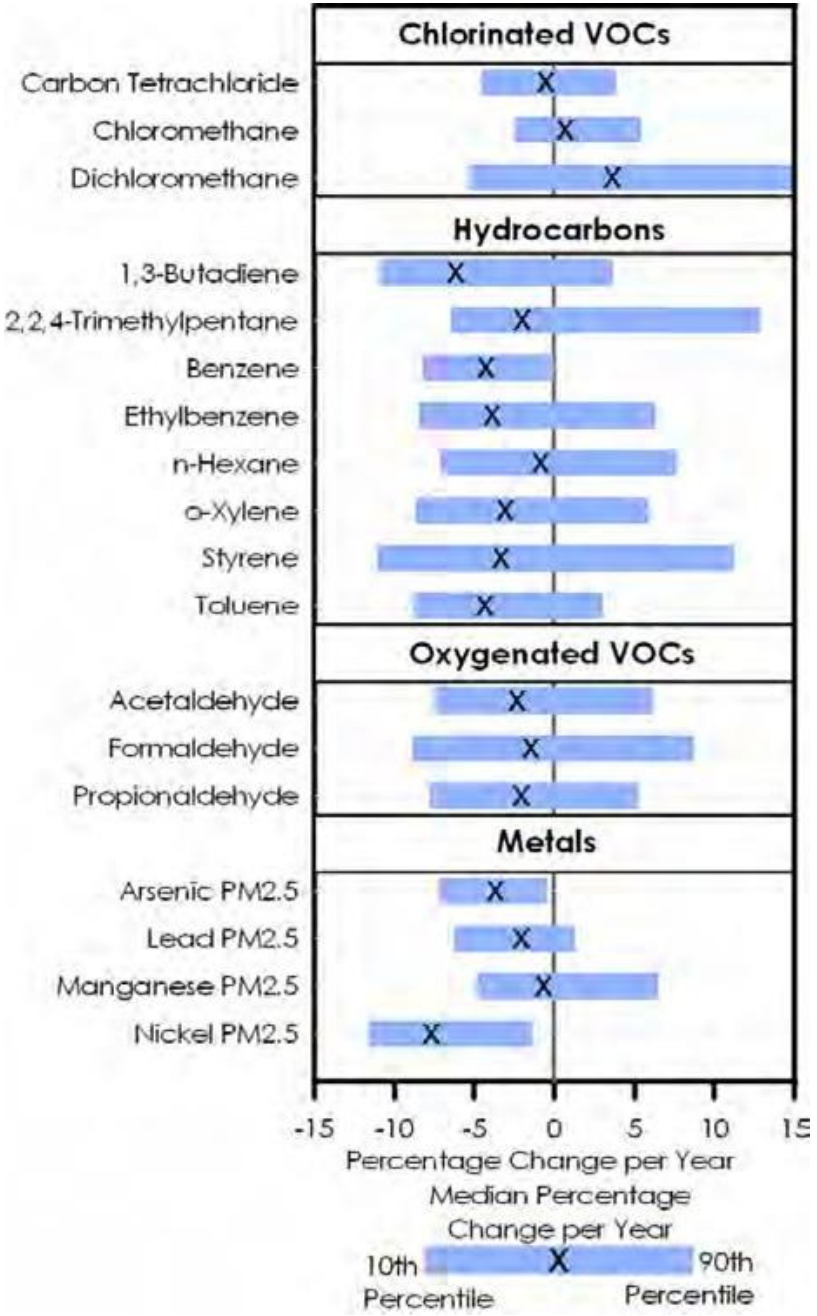
Other: sum of 32 cancer HAPs

Cancer risk at NATTS from the highest contributing HAPs (2011): No distinct spatial pattern



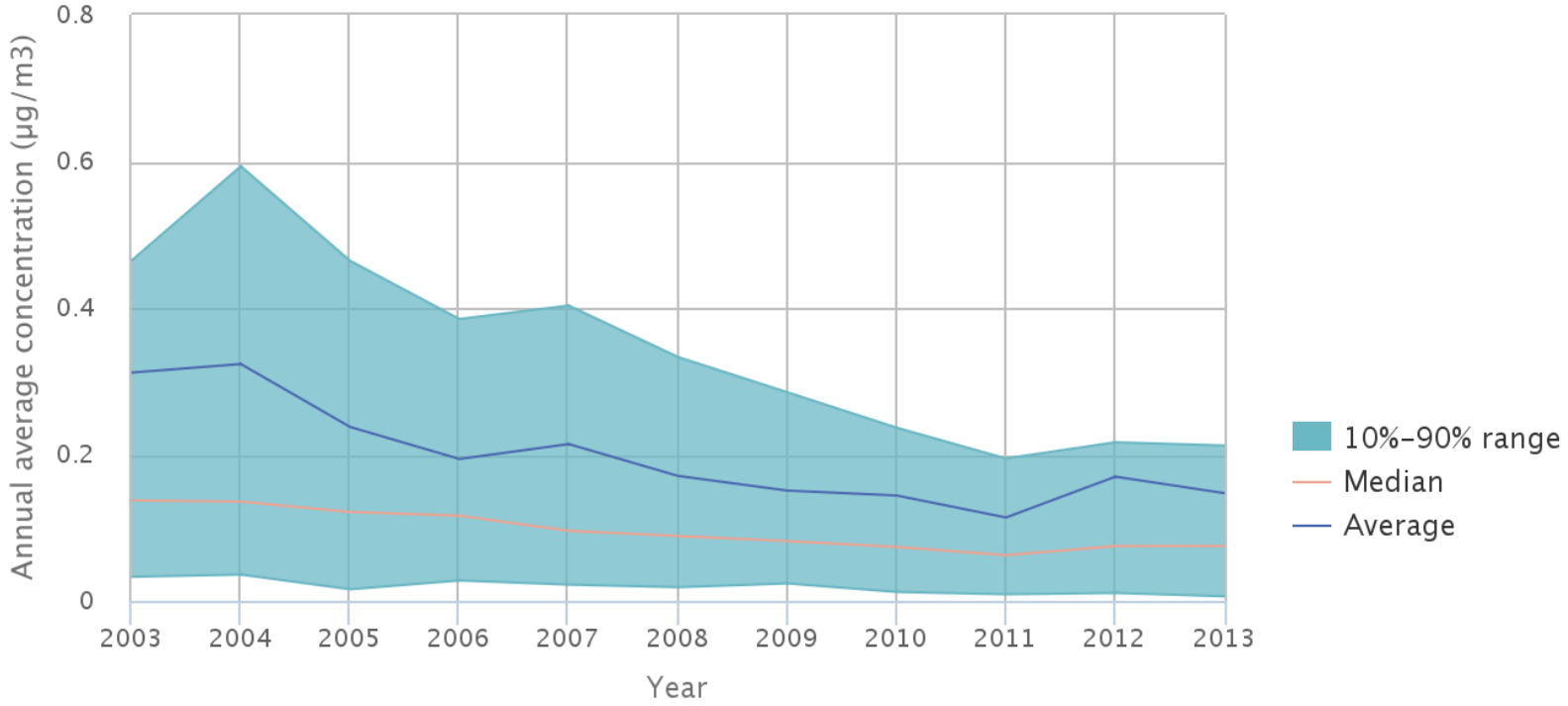
Trends


NATTS Butadiene Trends (Site Means)
Risk Weighted Concentration (per million)
20
15
10
5
0
-5
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
040139997
080770018
110010043
120573002
121030026
130890002
170314201
250250042
261630033
295100085
360551007
410510246
410610119
440070022
450250001
482011039


Chlorinated VOCs
Carbon Tetrachloride
Chloromethane
Dichloromethane
Hydrocarbons
1,3-Butadiene
2,2,4-Trimethylpentane
Benzene
Ethylbenzene
n-Hexane
o-Xylene
Styrene
Toluene
Oxygenated VOCs
Acetaldehyde
Formaldehyde
Propionaldehyde
Metals
Arsenic PM2.5
Lead PM2.5
Manganese PM2.5
Nickel PM2.5
-15
-10
-5
0
5
10
15
Percentage Change per Year
Median Percentage Change per Year
10th Percentile
90th Percentile

Report on the Environment- Air Toxics Trends environmental indicator www.epa.gov/roe

Exhibit 6. Ambient 1,3-butadiene concentrations in the U.S., 2003-2013



Coverage: 109 monitoring sites nationwide (out of a total of 246 sites measuring 1,3-butadiene in 2013) that have sufficient data to assess trends since 2003.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

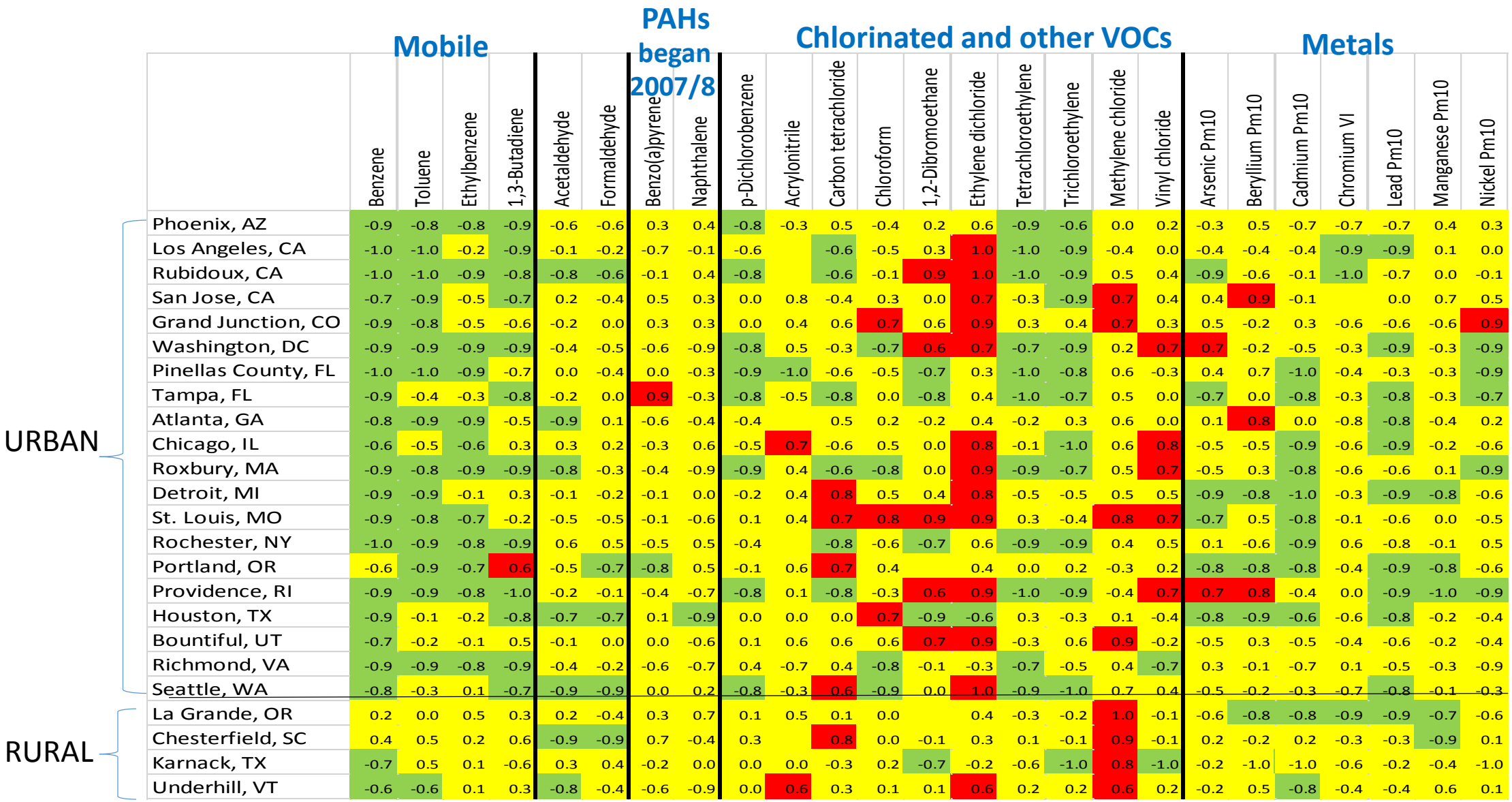
Data source: U.S. EPA, 2014

ROE Pollutants covered:

1,3 butadiene – 53% decrease
Acetaldehyde – 28% decrease
Benzene – 45% decrease
Carbon tetrachloride – 3% increase
Formaldehyde – 17% decrease
Tetrachloroethylene – 73% decrease

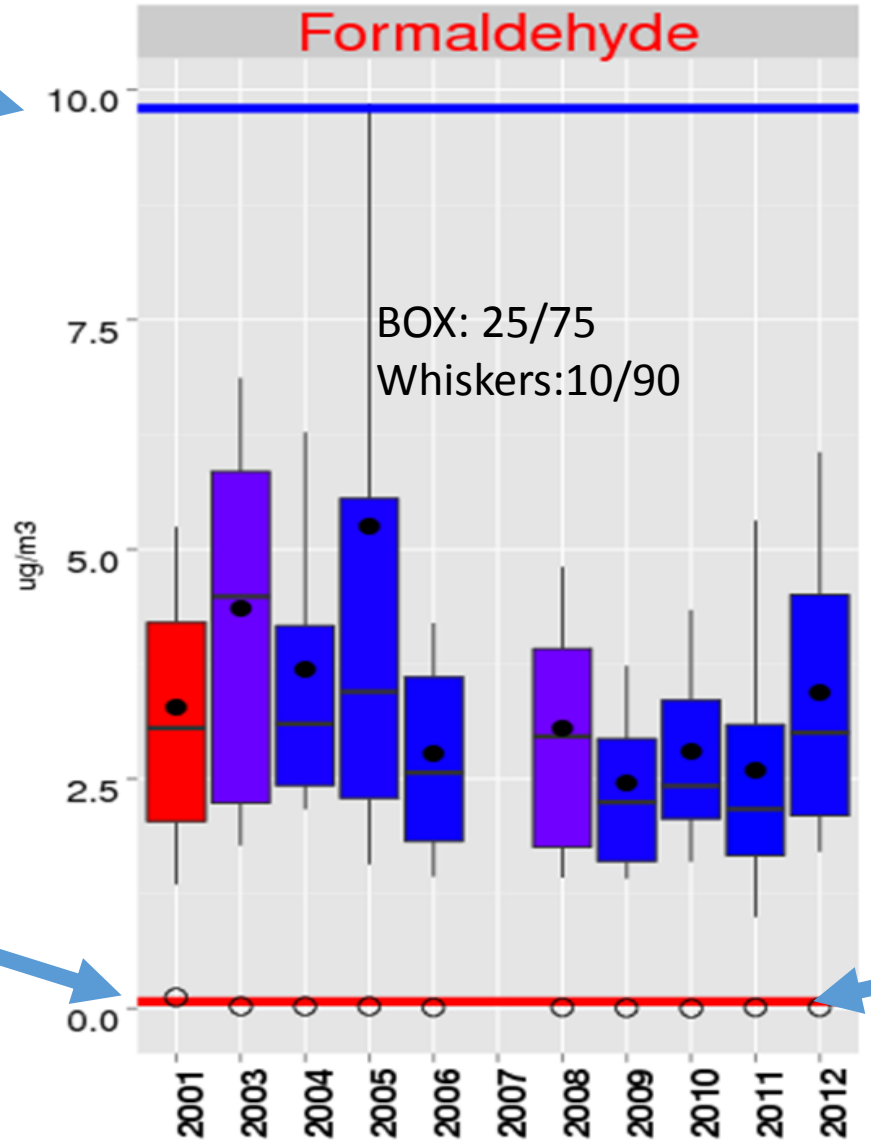
Arsenic (2005-2013)– 39% decrease
Hex chromium (2005-2012) – 45% decrease

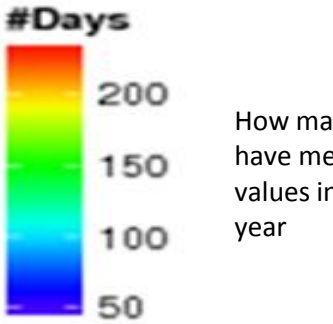
HAP Trends at NATTS (2003-2013) – based on annual site means



Challenges in Analyzing Trends At a Site- linking benchmark risks and MDLs- Example from Detroit

Noncancer benchmark (HQ=1)





How many days have measured values in that year

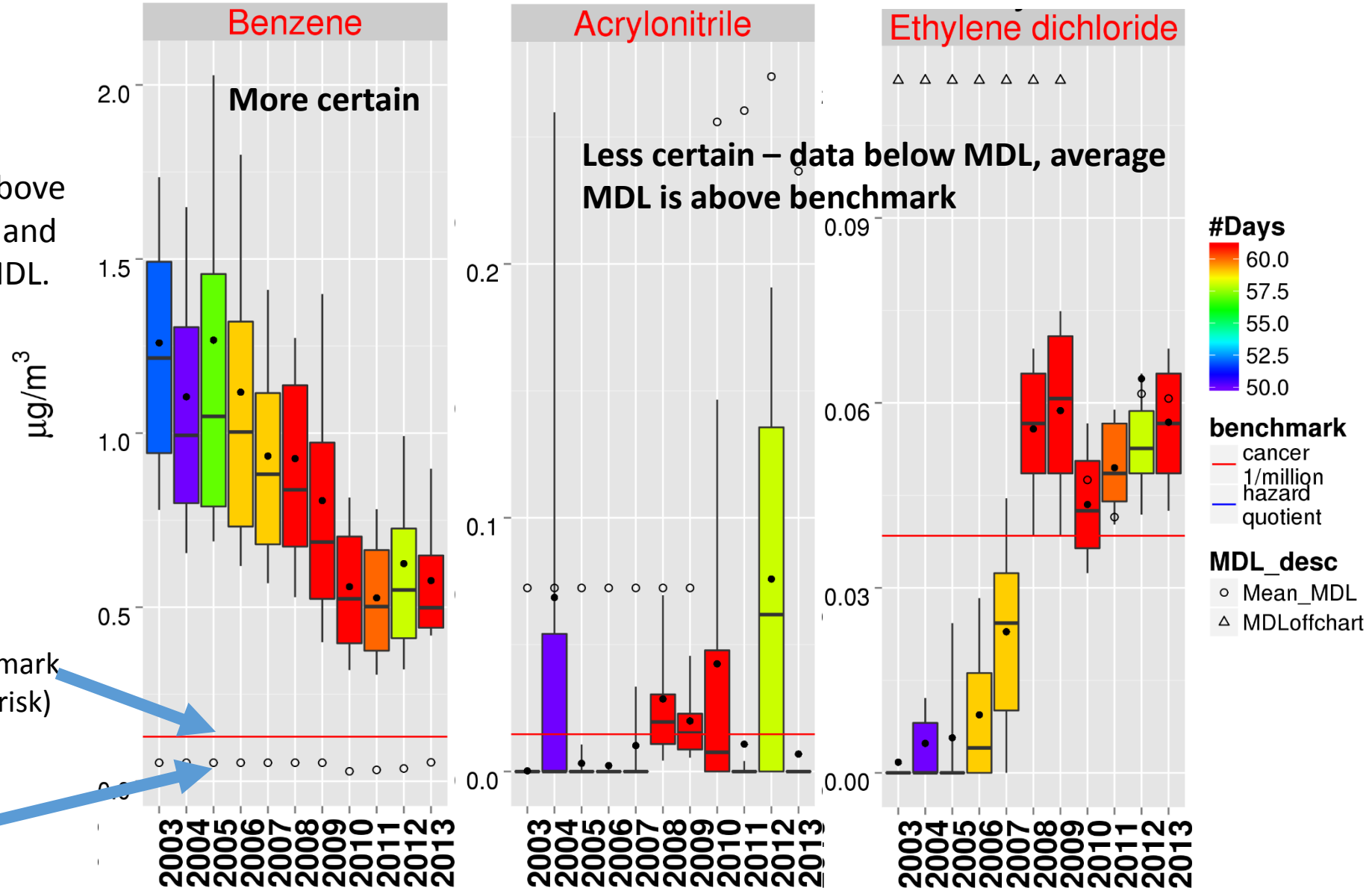
Cancer benchmark (1 per million risk)

Average MDL

Challenges in Analyzing Trends At a Site.. Continued

Benzene, Ethylene Dichloride and Acrylonitrile at Roxbury, MA

Benzene:
Benchmark above average MDL and data above MDL.



Cancer benchmark (1 per million risk)

Average MDL

Data Accessibility/Visualization

- Accessibility
  - AQS
  - Air toxics archive (www.epa.gov/amtic)
  - Air data (HAP report)
- Visualization
  - Rshiny
  - NATA

R-Shiny Application

shinyapps.io Powered by RStudio

Air Toxics

1st Plot

Choose a Pollutant: 1,3-Butadiene

NATTS Site?: NATTS

Choose a State: AZ

Choose a County: Maricopa(04013)

Choose a site ID: 040139997

2nd Plot

Choose a Pollutant: Benzene

NATTS Site?: NATTS

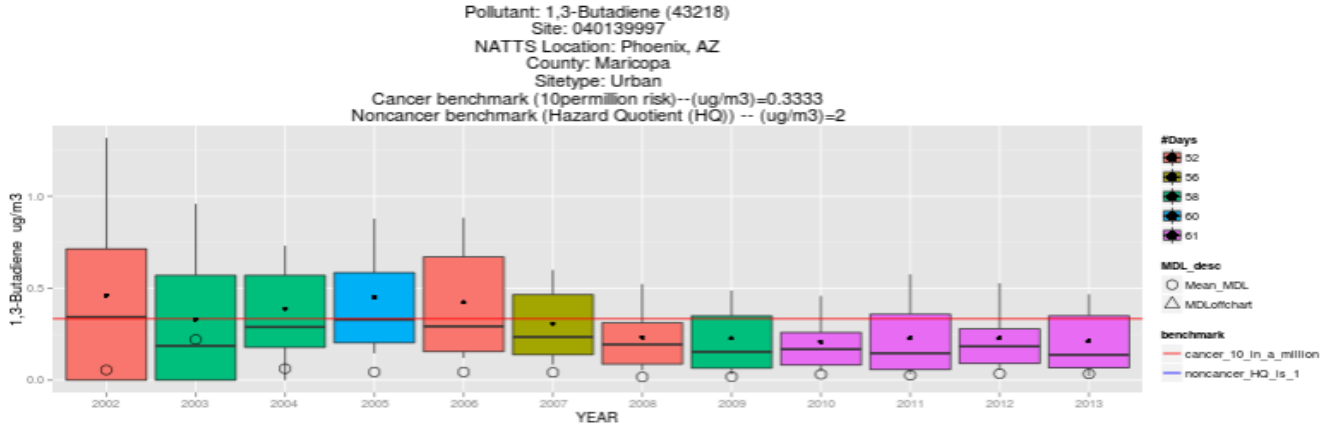
Choose a State: AZ

Choose a County: Maricopa(04013)

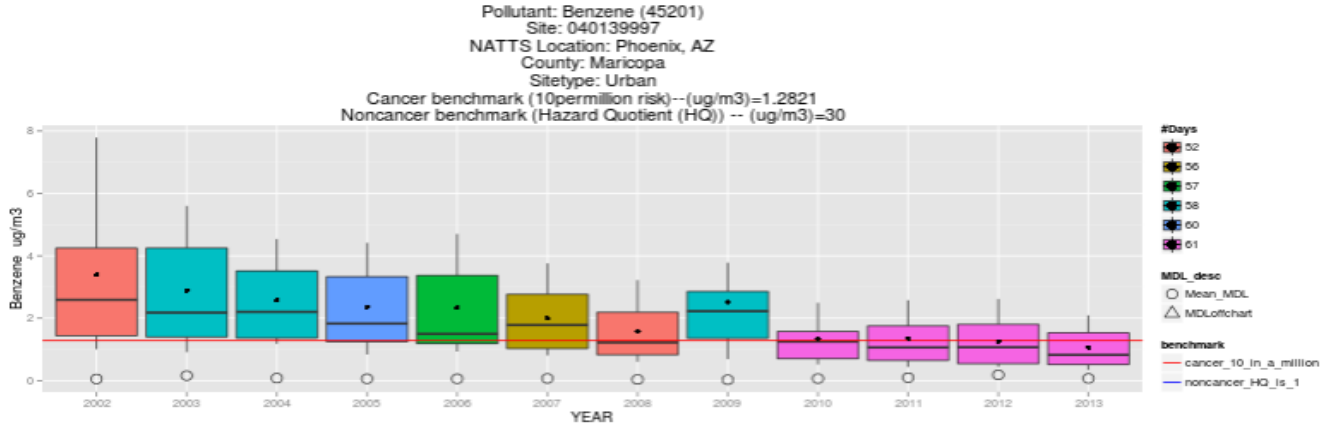
Background Info | Box Plots

Toxics Concentration Summary:

1st Plot

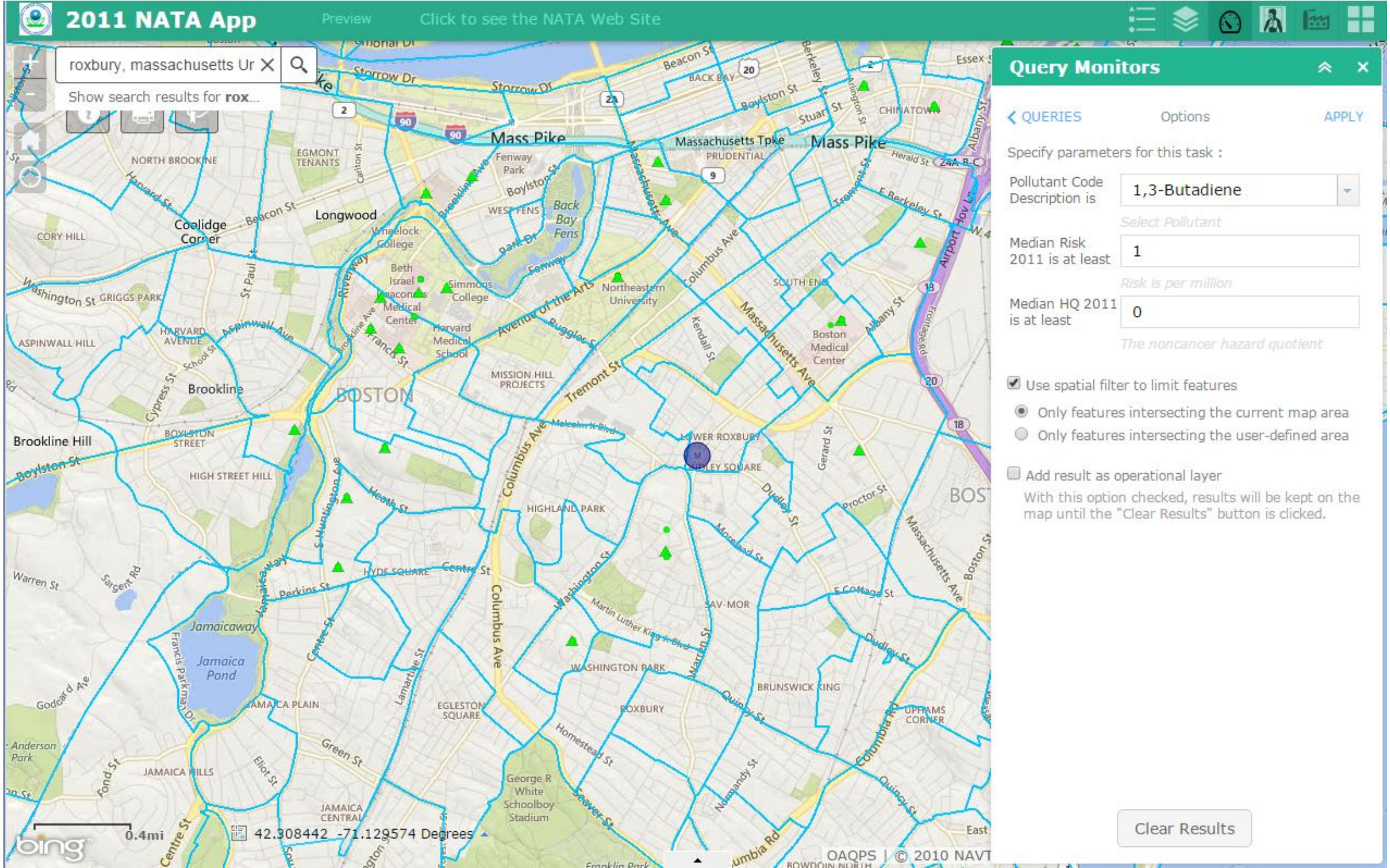


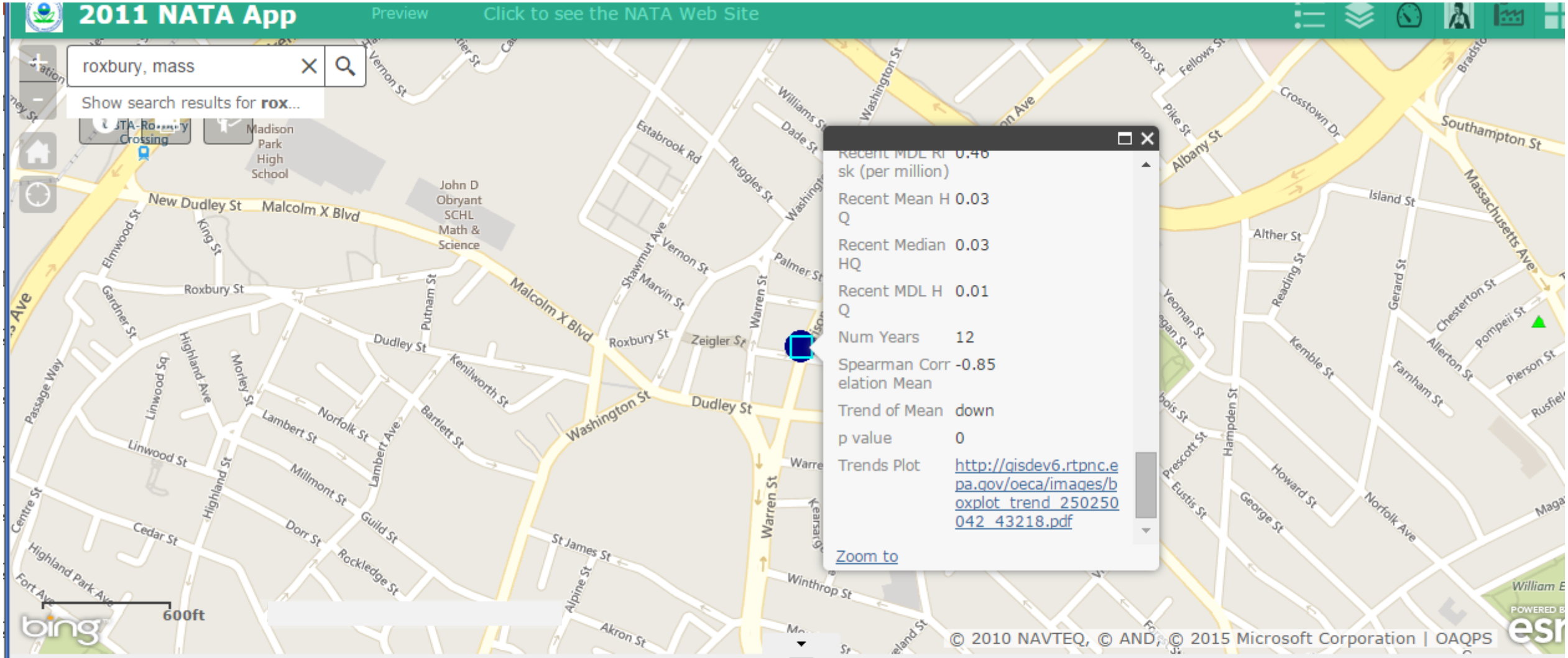
2nd Plot



NATA will include monitoring data

- Step 1 – Query by state, state/poll or risk/poll
- Step 2 – click on resultant monitor to see pop-up concentrations in 2011 and latest year, and whether trend of annual means is up, down or insignificant
- Step 3 – view trend – see distribution and how the values relate to the detection limit

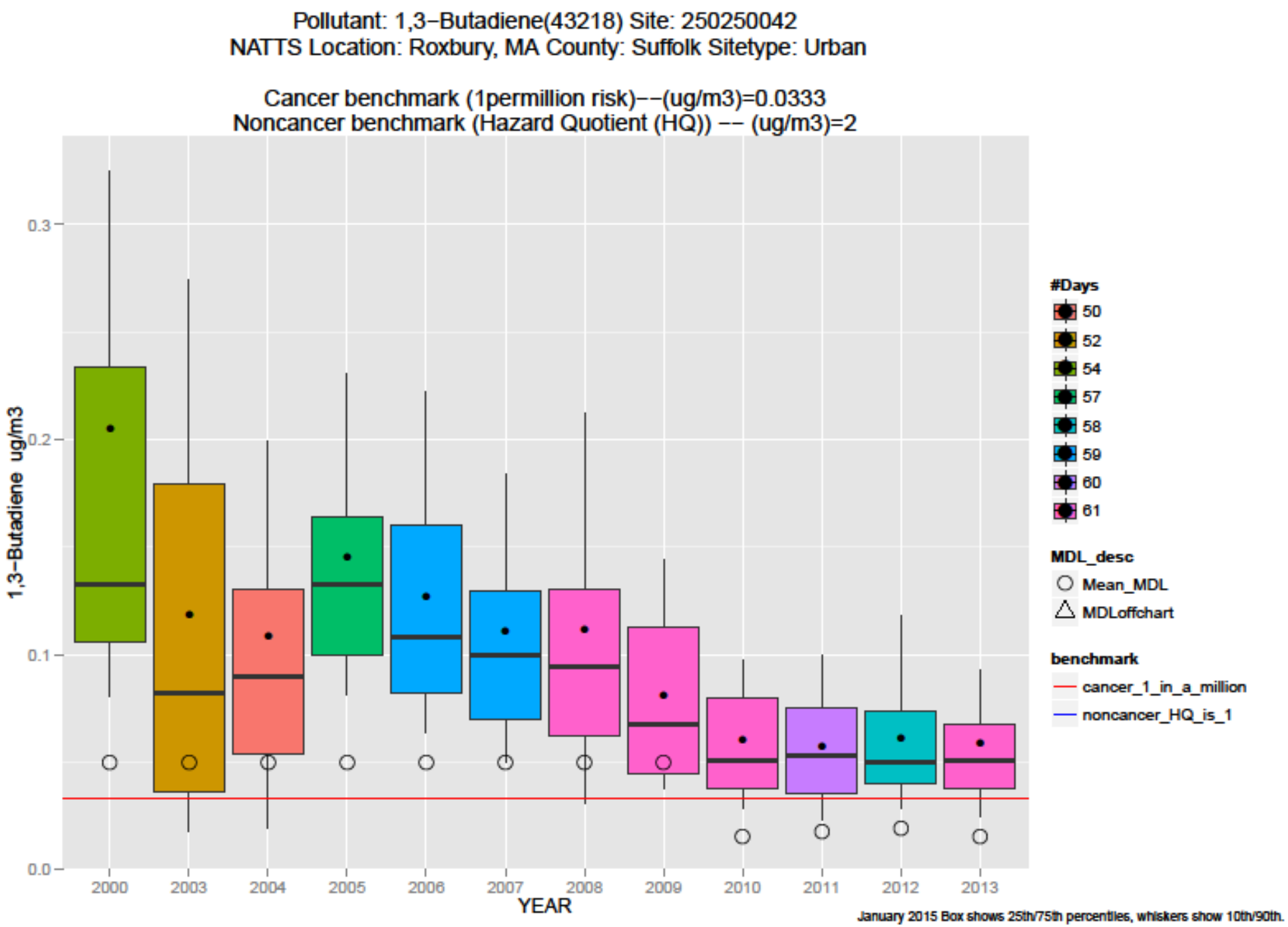

2011 NATA App
Preview
Click to see the NATA Web Site
roxbury, massachusetts Ur
Show search results for rox...
Query Monitors
QUERIES
Options
APPLY
Specify parameters for this task :
Pollutant Code Description is
1,3-Butadiene
Select Pollutant
Median Risk 2011 is at least
1
Risk is per million
Median HQ 2011 is at least
0
The noncancer hazard quotient
Use spatial filter to limit features
Only features intersecting the current map area
Only features intersecting the user-defined area
Add result as operational layer
With this option checked, results will be kept on the map until the "Clear Results" button is clicked.
Clear Results
Mass Pike
Massachusetts Tpke
BOSTON
Brookline
Brookline Hill
Longwood
Coolidge Corner
Jamaica Pond
Jamaicaway
LOWER ROXBURY
ROXBURY
WASHINGTON PARK
MISSION HILL PROJECTS
Boston Medical Center
Northeastern University
Simmons College
Wheelock College
Beth Israel Deaconess Medical Center
Harvard Medical School
George R White Schoolboy Stadium
0.4mi
42.308442 -71.129574 Degrees
OAQPS | © 2010 NAVT



Options | Filter by Map Extent | Zoom to | Clear Selection | Refresh

Facility-level | Total Cancer Risk | Query by State _Query Result

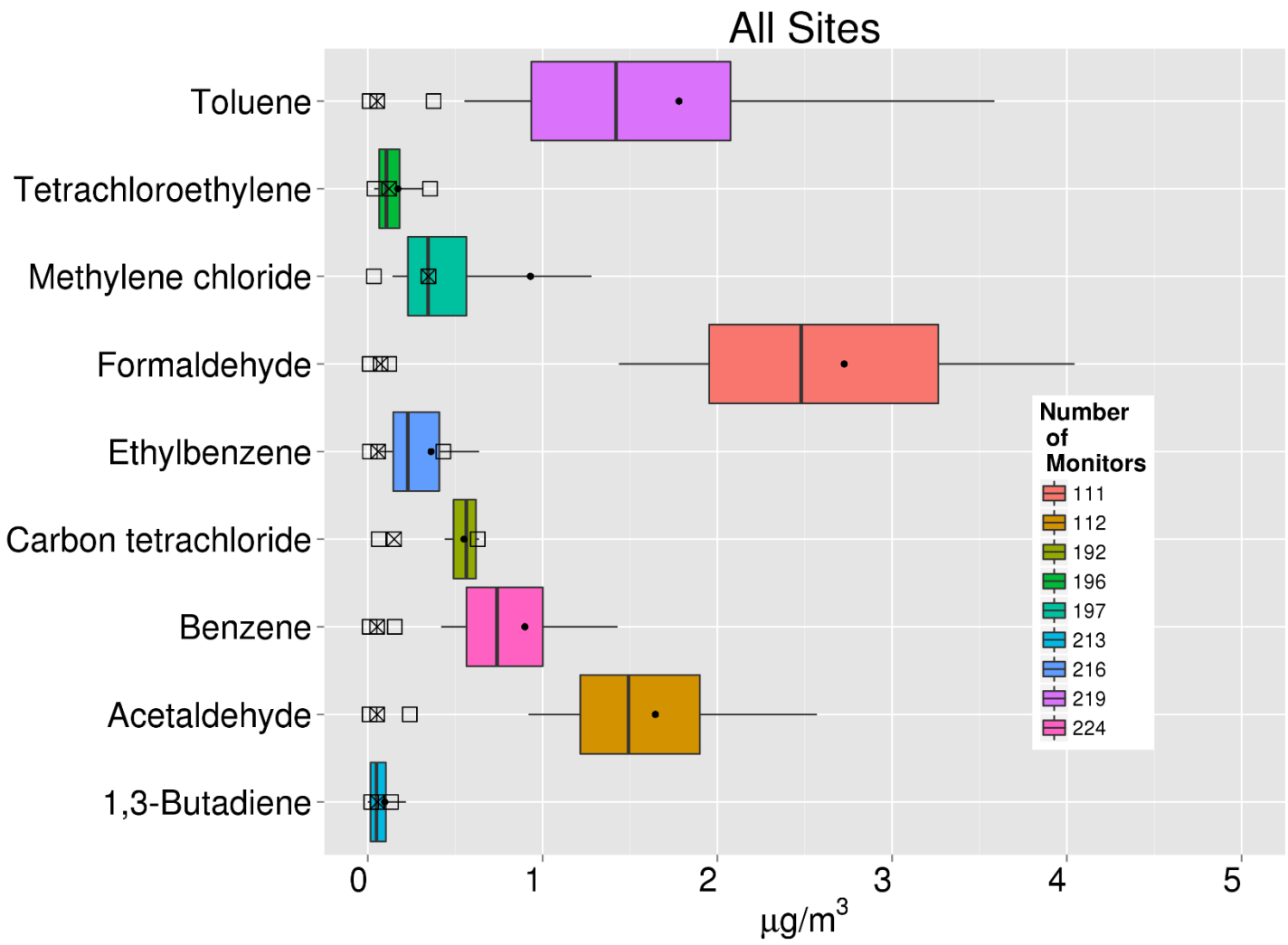
Pollutant Code Description	Duration	Max Conc 2011 (µg/m3)	Mean Conc 2011 (µg/m3)	Median Conc 2011 (µg/m3)	Mean MDL 2011 (µg/m3)	Variance 2011	% Less Than MDL 2011	Daily Count 2011	Mean Risk 2011 (per million)	Median Risk 2011 (per million)	Mean MDL Risk 2011 (per million)	M 20
1,3-Butadiene	24 HOURS	0.132737	0.057114	0.053095	0.017698	0.000823	2	60	1.71	1.59	0.53	0.

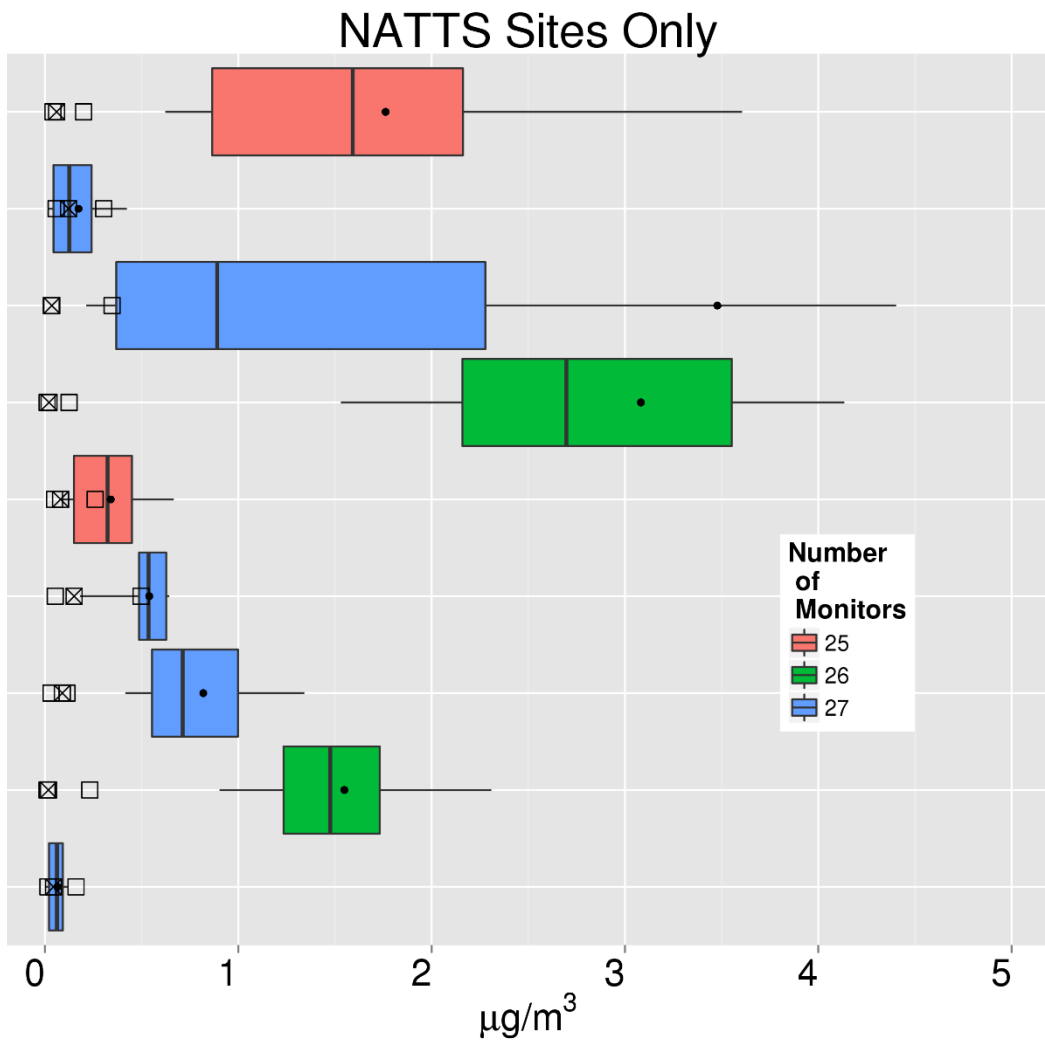

Pollutant: 1,3−Butadiene(43218) Site: 250250042
NATTS Location: Roxbury, MA County: Suffolk Sitetype: Urban
Cancer benchmark (1permillion risk)−−(ug/m3)=0.0333
Noncancer benchmark (Hazard Quotient (HQ)) −− (ug/m3)=2
1,3−Butadiene ug/m3
0.0
0.1
0.2
0.3
2000
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
YEAR
#Days
50
52
54
57
58
59
60
61
MDL_desc
Mean_MDL
MDLoffchart
benchmark
cancer_1_in_a_million
noncancer_HQ_is_1
January 2015 Box shows 25th/75th percentiles, whiskers show 10th/90th.

Summary

- Significant value in ambient air toxics data
  - Assess trends (unique role)
  - Identify HAPs of concern
  - Identify limitations, issues to focus on for monitoring program
  - Evaluate model results
- Opportunities/Challenges
  - Data dissemination/visualization
  - Analysis “rules” / standard procedures

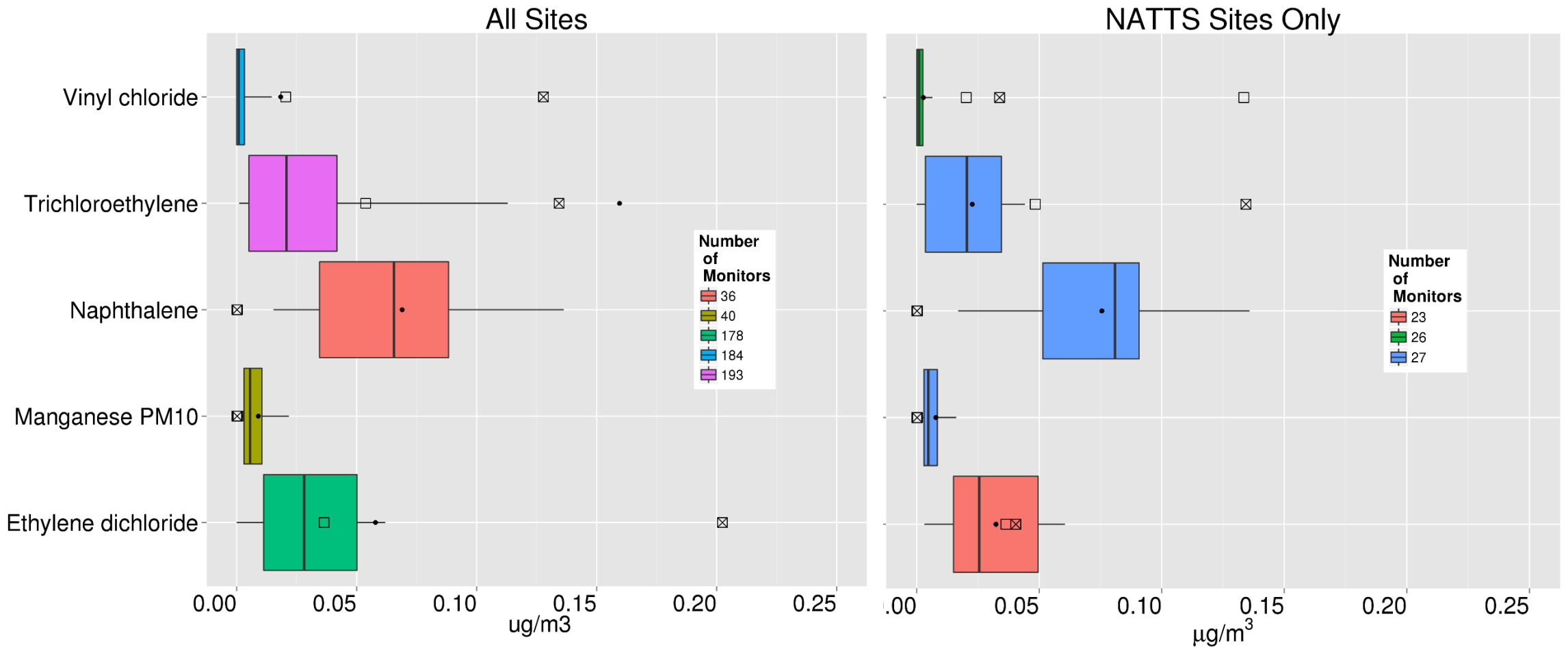
Extras



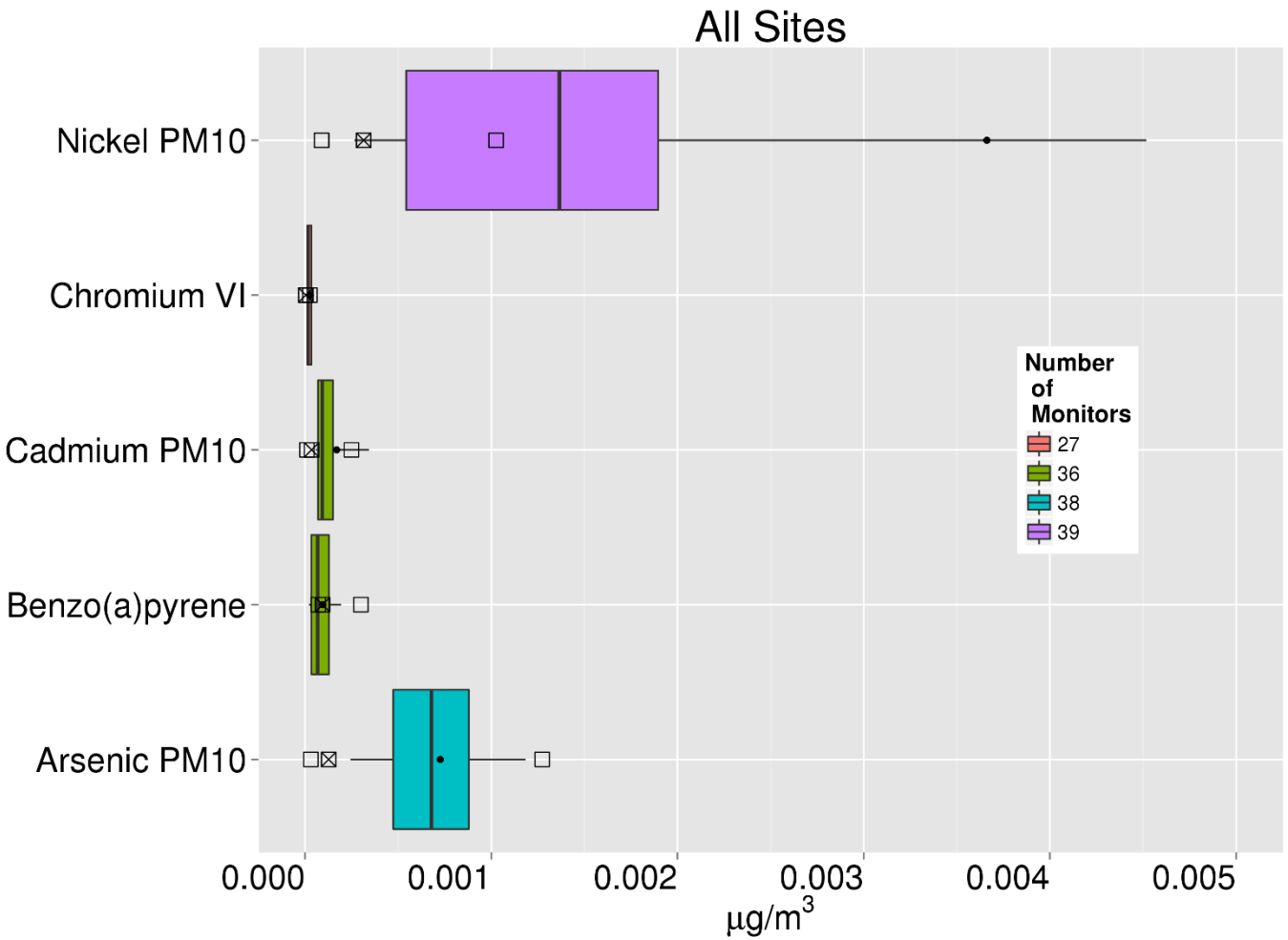


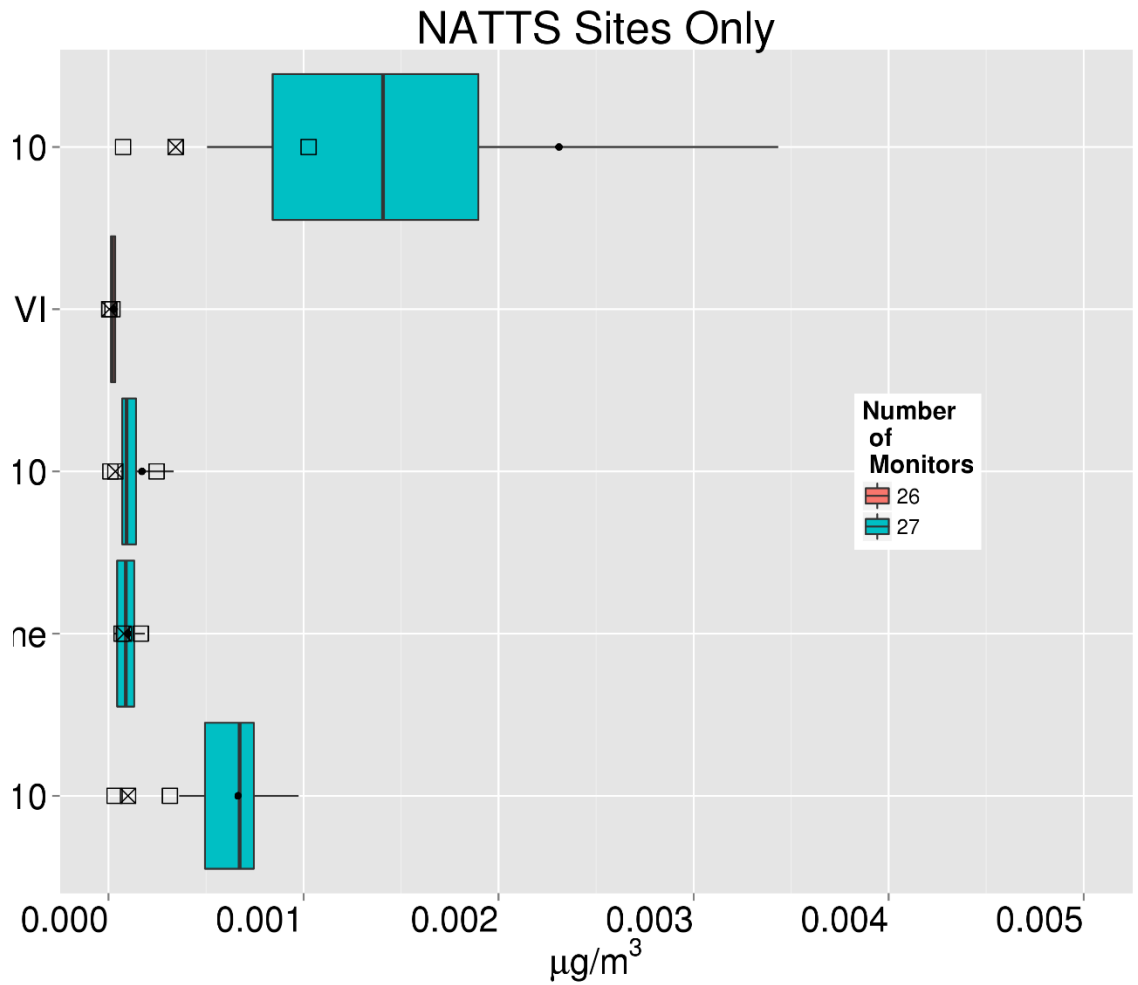
Distributions in 2011 (http://www.tandfonline.com/doi/pdf/10.1080/10962247.2015.1076538#.Vhsdwk3slD8)

- all sites vs NATTS are similar; relationship with MDL also similar
- Highest concentration HAPs – mobile sources, secondarily formed pollutants, ubiquitous pollutants, common chlorinated solvents



Distributions – all sites vs NATTS are similar; relationship with MDL also similar





Distributions – all sites vs NATTS are similar; relationship with MDL also similar
Highest concentration HAPs – mobile sources, secondarily formed pollutants, ubiquitous pollutants, common chlorinated solvents