Overview and Data Preparation

Hilary Hafner
Mike McCarthy
Sonoma Technology, Inc.
Petaluma, CA

Presented to:
Air Toxics Data Analysis Workshop
Rosemont, IL
October 4, 2007

905306-3236

Acknowledgments

- James Hemby, EPA OAQPS work assignment manager and collaborator
- Air quality analysts who performed much of this work: Jessica Charrier and Theresa O'Brien, STI
- Other STI staff that contributed: Sean Raffuse, Steve Brown, Katie Wade, Juli Rubin, Siana Alcorn, Hal Norman, Eric Gray, and publications staff

Overview

- History of national air toxics data analysis
- Phase V analysis objectives
  - Risk characterization
  - Trends and accountability
- Data preparation
- Data factoids

Background on National Data Analysis

- Phases I and II in 2000-2002 - Answered questions related to the design of the national air toxics monitoring network
  - Bortnick and Stetzer, Sources of variability in ambient air toxics monitoring data, 2002, *Atmos. Enviro.,*
  - Bortnick and Stetzer, Sampling frequency guidance for ambient air toxics monitoring, 2002, *JAWMA*
- Phase III in 2004 – Addressed data quality, utility, and applicability for answering policy relevant questions
  - Kenski et al., Lessons learned from air toxics data: a national perspective, 2005, *Enviro. Manag.*
  - McCarthy et al., Background concentrations of 18 air toxics for North America, 2006, *JAWMA*
- Phase IV in 2005-2006 – Assessed temporal and spatial variability in air toxics concentrations
  - Touma et al., Spatial and temporal variability of ambient air toxics data, 2006, *JAWMA*
  - McCarthy et al., Temporal variability of selected air toxics in the United States, 2007, *Atmos. Enviro.*

Phase V Analysis Objectives

- The Phase V analysis focused on two broad topic areas
  - Characterize concentrations using risk/hazard-weighting and categorical risk/hazard screening to better understand the relative importance of these pollutants to human health
  - Assess trends in air toxics concentrations and develop methods to provide links with specific control measures for accountability

Air Toxics Risk and Hazard Characterization Analyses

- Performed chronic risk and hazard screening
- Created risk- and hazard-weighted national concentration distributions
- Created risk- and hazard-weighted concentration maps
- Ranked our confidence in pollutants above levels of concern
- Performed acute hazard screening
- Assessed spatial variability as it pertains to risk-weighted concentrations
  - Within-city variability
  - NATTS urban-rural comparisons
  - Cumulative risk-weighted concentrations by site and city
  - Hot and cold spot analysis for benzene and arsenic $PM_{2.5}$
  - Comparison with ozone and $PM_{2.5}$ nonattainment areas

Air Toxics Trends and Accountability Analyses

- Investigated site level trends for all air toxics
  - Three specific trend periods – 1990-2006, 1995-2006, 2000-2006
  - Longest trend record of 5+ years
- Prepared national distributions in trends for all air toxics with at least 10 trend sites in one of the three trend periods
- Identified MDL issues associated with national $PM_{2.5}$ metals trends
- Developed and applied two methods for identifying and associating control measures with changing ambient concentrations
  - Top-down method – start with the ambient data and look for associated control measures; used to provide strong evidence on the efficacy of mobile source controls on air toxics concentrations.
  - Bottom-up method – start with the control measure and look for changes in ambient concentrations to provide evidence of its efficacy; used to try to identify decreases in metals concentrations as a result of a MACT control on hazardous waste incinerators and cement kilns.
- Extrapolated current rates of change for key risk-driving toxics to project when they might go below the 10^{-6} risk level
- Reanalyzed and classified diurnal and seasonal patterns in air toxics concentrations

IMPROVE = Interagency Monitoring of Protected Visual Environments
VIEWS = Visibility Information Exchange Web System
SEARCH = SouthEastern Aerosol Research and Characterization Study
SESARM = SouthEastern States Air Resources Managers

Data Acquisition

Acquired and processed data from 1990 through mid-2007

- EPA's Air Quality System (AQS)
  - AMP501 data from 1995 through 2006 available in September 2006
    - Updated with AMP501 data from 2000 through 2007 available in July 2007, which was used to update the trends and accountability analyses
  - Archived AMP501 data from 1990 through 1994 requested directly from EPA in October 2005
- IMPROVE speciated $PM_{2.5}$ data downloaded from VIEWS web site, <http://vista.cira.colostate.edu/views/> in September 2006
- SEARCH speciated $PM_{2.5}$ data downloaded from Atmospheric Research Analysis web site, <http://www.atmospheric-research.com/public/index.html> in September 2006
- The Legacy Air Toxics Archive from the Phase III national air toxics analysis project (Hafner and McCarthy, 2004)
- Data acquired from local and state air quality agencies as part of the SESARM toxics data analysis project

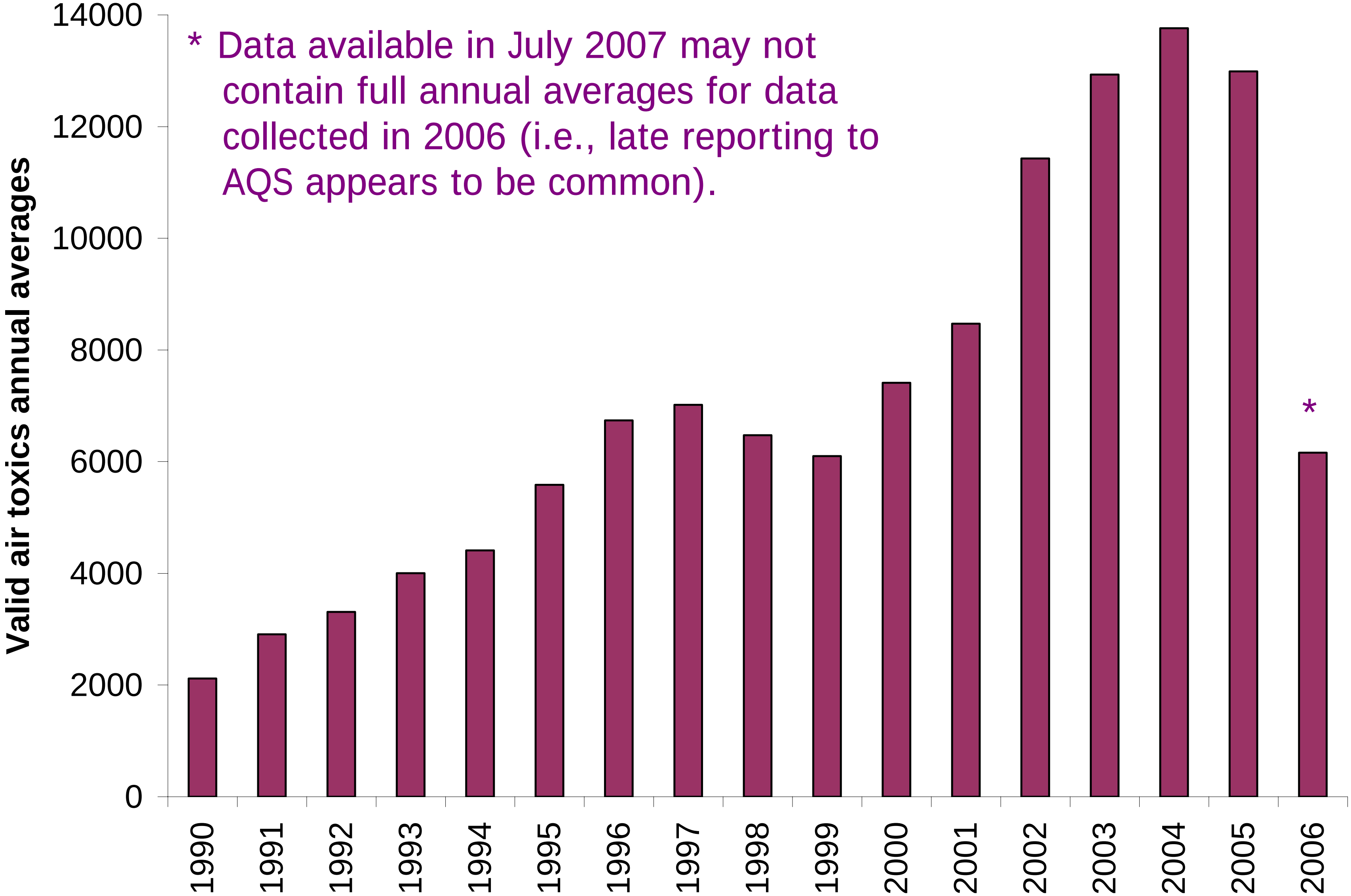
Database

- As part of several projects, an air quality archive (AQA) was developed as an analysis-ready database that includes data from AQS (1990-2006), IMPROVE and SEARCH data, and data from the legacy air toxics archive.
- This database contains nearly 1 billion raw data records, 27 million raw air toxics records, and complete validated and temporally aggregated data sets.
- Because of the size of this database, it is not yet available to a broad audience; we are working to determine the best way to disseminate the AQA.

Data Preparation

- 24-hr duration samples are the most common for air toxics measurements. 24-hr averages were aggregated to quarterly, annual, and site averages.
  - For the rare sites with subdaily duration samples (1-hr or 3-hr duration samples), daily averages were created using a 75% diurnal completeness criterion
  - Quarterly averages were created from daily averages
    - 75% completeness for expected sampling frequency (e.g., 12 out of 15 samples for 1-in-6-day sampling frequency)
    - Minimum of six samples required (1-in-12-day sampling frequency)
  - Annual averages were created from quarterly averages – 3 out of 4 quarterly averages were required (75% completeness)
  - Quarterly and annual averages were created using MDL/2 substituted values when concentrations were reported at or below the method detection limit (MDL).
    - For sites and pollutants with fewer than 15% of records reported above MDL, annual averages were treated as less certain. Annual mean concentrations for these sites and pollutants are likely below MDL, but quantification is not feasible.

Data Availability by Year



Air Toxics List

- **1,1,2,2-Tetrachloroethane**
- **1,1,2-Trichloroethane**
- **1,1-Dichloroethane**
- **1,1-Dichloroethylene**
- **1,2,4-Trichlorobenzene**
- **1,2-Dichloropropane**
- **1,3-Butadiene**
- **1,4-Dichlorobenzene**
- **2,2,4-Trimethylpentane**
- **Acetaldehyde**
- **Acetonitrile**
- **Acrolein**
- **Acrylonitrile**
- **Antimony (Tsp)**
- **Antimony Pm2.5 Lc**
- **Arsenic (Pm10) Stp**
- **Arsenic (Tsp)**
- **Arsenic Pm2.5 Lc**
- **Benzene**
- **Benzyl Chloride**
- **Beryllium (Pm10) Stp**
- **Beryllium (Tsp)**
- **Bromoform**
- **Bromomethane**
- **Cadmium (Pm10) Stp**
- **Cadmium (Tsp)**
- **Cadmium Pm2.5 Lc**
- **Carbon Disulfide**
- **Carbon Tetrachloride**
- **Chlorine Pm2.5 Lc**
- **Chlorobenzene**
- **Chloroethane**
- **Chloroform**
- **Chloromethane**
- **Chloroprene**
- **Chromium (Pm10) Stp**
- **Chromium (Tsp)**
- **Chromium Pm2.5 Lc**
- **Cobalt (Pm10) Stp**

- **Cobalt (Tsp)**
- **Cobalt Pm2.5 Lc**
- **Dichloromethane**
- **Ethyl Acrylate**
- **Ethylbenzene**
- **Ethylene Dibromide**
- **Ethylene Dichloride**
- **Formaldehyde**
- **Hexachlorobutadiene**
- **Isopropylbenzene**
- **Lead (Pm10) Stp**
- **Lead (Tsp)**
- **Lead Pm2.5 Lc**
- **M/P-Xylene**
- **Manganese (Pm10) Stp**
- **Manganese (Tsp)**
- **Manganese Pm2.5 Lc**
- **Mercury (Tsp)**
- **Mercury Pm2.5 Lc**
- **Methyl Chloroform**
- **Methyl Isobutyl Ketone**
- **Methyl Methacrylate**
- **Methyl Tert-Butyl Ether**
- **Naphthalene**
- **N-Hexane**
- **Nickel (Pm10) Stp**
- **Nickel (Tsp)**
- **Nickel Pm2.5 Lc**
- **O-Xylene**
- **Phosphorus Pm2.5 Lc**
- **Propionaldehyde**
- **Selenium (Pm10) Stp**
- **Selenium (Tsp)**
- **Selenium Pm2.5 Lc**
- **Styrene**
- **Tetrachloroethylene**
- **Toluene**
- **Trichloroethylene**
- **Vinyl Acetate**

- **Vinyl Chloride**
- 1,2-Dibromo-3-Chloropropane
- 1,3-Dichloropropene(Total)
- 1,4-Dioxane
- 2,4,5-Trichlorophenol
- 2,4,6-Trichlorophenol
- 2,4-Dinitrophaenol
- 2,4-Dinitrotoluene
- 3-Chloropropene
- 4,6-Dinitro-2-Methylphenol
- 4-Nitrophenol
- Aniline
- Antimony (Pm10) Stp
- Antimony Pm10 Lc
- Arsenic Pm10 Lc
- Beryllium Pm10 Lc
- Biphenyl
- Bis (2-Chloroethyl)Ether
- Bis(2-Ethylhexyl)Phthalate
- Cadmium Pm10 Lc
- Caprolactam
- Chlorine (Tsp)
- Chlorine Pm10 Lc
- Chromium (Coarse Particulate)
- Chromium Pm10 Lc
- Cobalt Pm10 Lc
- Dibenzofuran
- Dimethyl Phthalate
- Di-N-Butyl Phthalate
- Ethylene Oxide
- Heptachlor
- Hexachlorobenzene
- Hexachlorocyclopentadiene
- Hexachloroethane
- Isophorone
- Lead Pm10 Lc
- Lindane
- Manganese (Coarse Particulate)
- Manganese Pm10 Lc

- Mercury (Pm10) Stp
- Mercury (Vapor)
- Mercury Pm10 Lc
- Methanol
- Methoxychlor
- M-Xylene
- Nickel (Coarse Particulate)
- Nickel Pm10 Lc
- Nitrobenzene
- O-Cresol
- P-Cresol
- Pentachlorophenol
- Phenol
- Phosphorus (Tsp)
- Phosphorus Pm10 Lc
- P-Xylene
- Selenium Pm10 Lc
- Xylene(S)
- *1,1-Dimethyl hydrazine*
- *1,2-Diphenylhydrazine*
- *1,2-Epoxybutane*
- *1,2-Propylenimine*
- *1,3-Propane sultone*
- *2,3,7,8-Tetrachlorodibenzo-p-dioxin*
- *2,4-D, salts and esters*
- *2,4-Toluene diamine*
- *2,4-Toluene diisocyanate*
- *2-Acetylaminofluorene*
- *2-Chloroacetophenone*
- *2-Nitropropane*
- *3,3-Dichlorobenzidene*
- *3,3-Dimethoxybenzidine*
- *3,3'-Dimethyl benzidine*
- *4,4-Methylene bis(2-chloroaniline)*
- *4,4-Methylenedianiline*
- *4-Aminobiphenyl*
- *4-Nitrobiphenyl*
- *Acetamide*
- *Acetophenone*

- *Acrylamide*
- *Acrylic acid*
- *Asbestos*
- *Benzidine*
- *Benzotrichloride*
- *beta-Propiolactone*
- *Bis(chloromethyl)ether*
- *Calcium cyanamide*
- *Captan*
- *Carbaryl*
- *Carbonyl sulfide*
- *Catechol*
- *Chloramben*
- *Chlordane*
- *Chloroacetic acid*
- *Chlorobenzilate*
- *Chloromethyl methyl ether*
- *Coke Oven Emissions*
- *Cresols/Cresylic acid*
- *Cyanide Compounds1*
- *DDE*
- *Diazomethane*
- *Dichlorvos*
- *Diethanolamine*
- *Diethyl sulfate*
- *Dimethyl aminoazobenzene*
- *Dimethyl carbamoyl chloride*
- *Dimethyl formamide*
- *Dimethyl sulfate*
- *Epichlorohydrin*
- *Ethyl carbamate (Urethane)*
- *Ethylene glycol*
- *Ethylene imine (Aziridine)*
- *Ethylene thiourea*
- *Fine mineral fibers3*
- *Hexamethylene-1,6-diisocyanate*
- *Hexamethylphosphoramide*
- *Hydrazine*
- *Hydrochloric acid*

- *Hydrogen fluoride*
- *Hydrogen sulfide*
- *Hydroquinone*
- *Maleic anhydride*
- *m-Cresol*
- *Methyl hydrazine*
- *Methyl iodide (Iodomethane)*
- *Methyl isocyanate*
- *Methylene diphenyl diisocyanate*
- *N,N-Diethyl aniline*
- *N-Nitrosodimethylamine*
- *N-Nitrosomorpholine*
- *N-Nitroso-N-methylurea*
- *o-Anisidine*
- *o-Toluidine*
- *Parathion*
- *Pentachloronitrobenzene*
- *Phosgene*
- *Phosphine*
- *Phthalic anhydride*
- *Polychlorinated biphenyls*
- *Polycylic Organic Matter4*
- *p-Phenylenediamine*
- *Propoxur (Baygon)*
- *Propylene oxide*
- *Quinoline*
- *Quinone*
- *Radionuclides (including radon)*
- *Styrene oxide*
- *Titanium tetrachloride*
- *Toxaphene*
- *Triethylamine*
- *Trifluralin*
- *Vinyl bromide*

Lots of data: > 20 monitoring sites with sufficient data to create a valid annual average between 2003-2005, up to 434 sites

Little data: < 20 monitoring sites with sufficient data to create a valid annual average between 2003-2005, between 1-17 sites

No Data: No valid annual averages between 2003-2005

UATMP Target Compounds

1,1,2,2-Tetrachloroethane	Beryllium PM10	Cobalt PM2.5	Methyl Methacrylate
1,1,2-Trichloroethane	Beryllium TSP	Dichloromethane	Methyl Tert-Butyl Ether
1,1-Dichloroethane	Bromoform	Ethyl Acrylate	Naphthalene
1,1-Dichloroethylene	Bromomethane	Ethylbenzene	N-Hexane
1,2,4-Trichlorobenzene	Cadmium PM10	Ethylene Dibromide	Nickel PM10
1,2-Dichloropropane	Cadmium TSP	Ethylene Dichloride	Nickel TSP
1,3-Butadiene	Cadmium PM2.5	Formaldehyde	Nickel PM2.5
1,4-Dichlorobenzene	Carbon Disulfide	Hexachlorobutadiene	O-Xylene
2,2,4-Trimethylpentane	Carbon Tetrachloride	Isopropylbenzene	Phosphorus PM2.5
Acetaldehyde	Chlorine PM2.5	Lead PM10	Propionaldehyde
Acetonitrile	Chlorobenzene	Lead TSP	Selenium PM10
Acrolein	Chloroethane	Lead PM2.5	Selenium TSP
Acrylonitrile	Chloroform	M/P-Xylene	Selenium PM2.5
Antimony TSP	Chloromethane	Manganese PM10	Styrene
Antimony PM2.5	Chloroprene	Manganese TSP	Tetrachloroethylene
Arsenic PM10	Chromium PM10	Manganese PM2.5	Toluene
Arsenic TSP	Chromium TSP	Mercury TSP	Trichloroethylene
Arsenic PM2.5	Chromium PM2.5	Mercury PM2.5	Vinyl Acetate
Benzene	Cobalt PM10	Methyl Chloroform	Vinyl Chloride
Benzyl Chloride	Cobalt TSP	Methyl Isobutyl Ketone	1,3-Dichloropropene

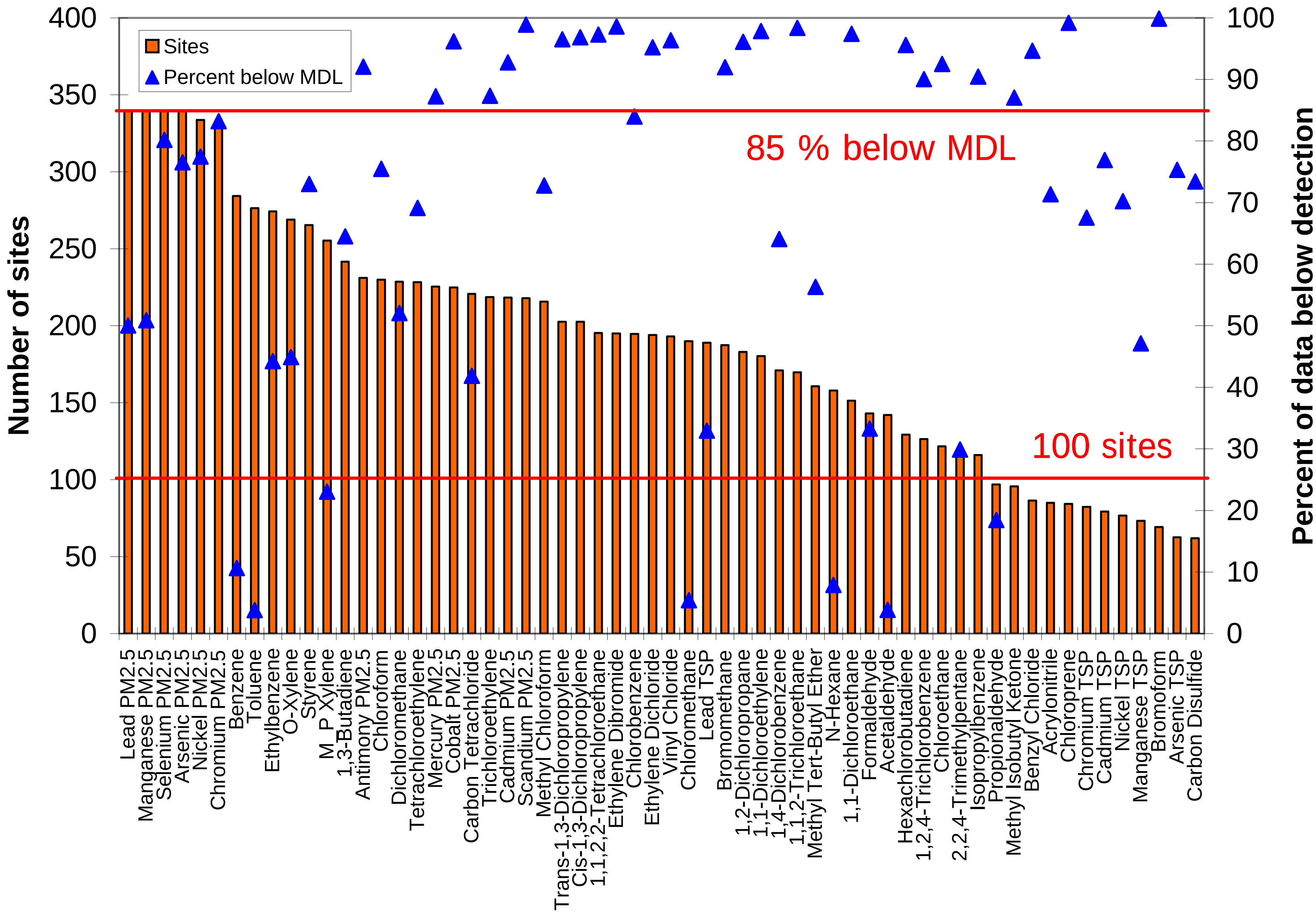
Lots of data: > 20 monitoring sites with sufficient data to create a valid annual average between 2003-2005, up to 434 sites
Little data: < 20 monitoring sites with sufficient data to create a valid annual average between 2003-2005, between 1-17 sites

http://www.epa.gov/ttn/airs/airsaqs/manuals/parmcodesbyclasscode.htm

NATTS Target Compounds

1,2-Dichloropropane **1,3-Butadiene** **Acetaldehyde** **Acrolein** **Benzene** **Carbon Tetrachloride** **Chloroform** **Dichloromethane** **Formaldehyde** **Tetrachloroethylene** **Trichloroethylene** **Vinyl Chloride**	**Arsenic PM10** **Beryllium PM10** **Cadmium PM10** **Chromium PM10** **Lead PM10** **Manganese PM10** **Nickel PM10**

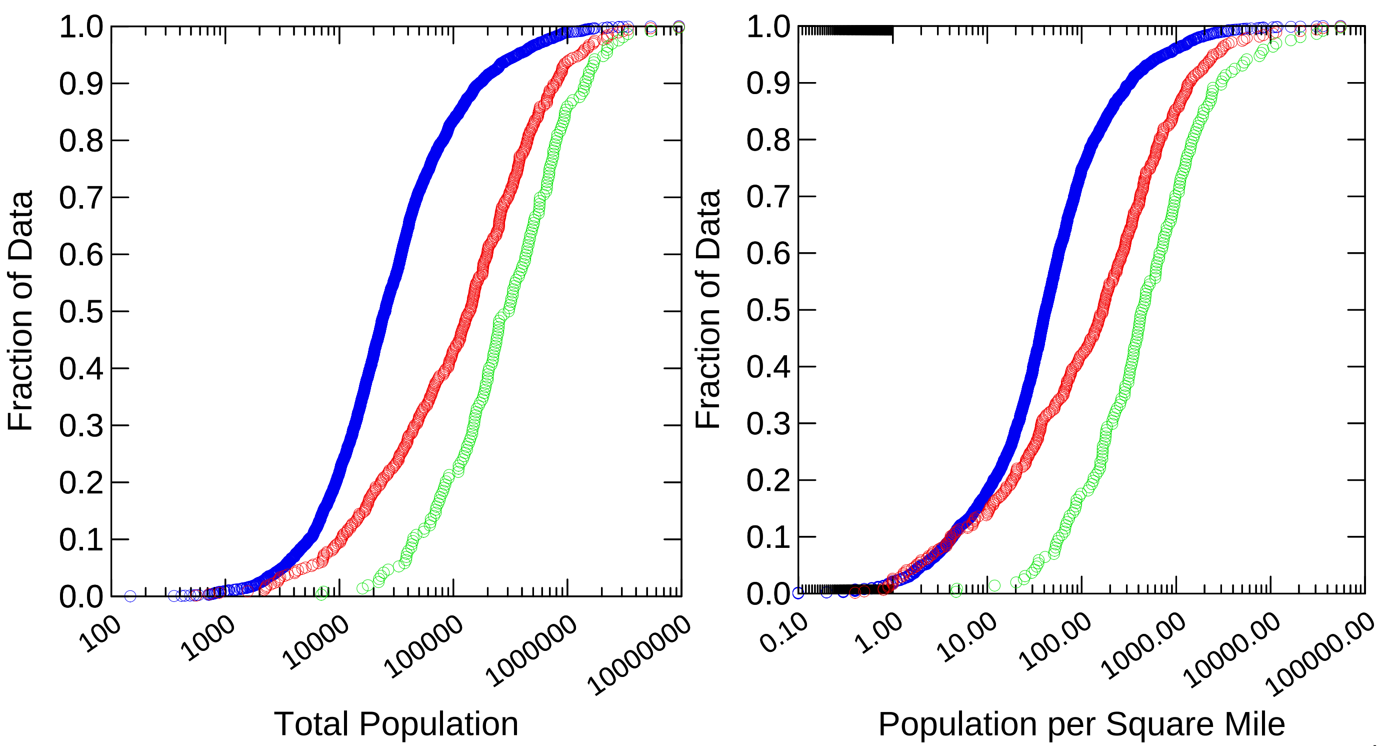
2003-2005 Data Quality and Quantity



How Representative Is the Current Monitoring Network of the United States?

Air toxics are primarily measured in urban counties:

- Urban areas are where most people live and where most air toxics are emitted (VOCs are representative of top 10% of populated counties; metals are representative of top 20%).
- The current monitoring network is not representative of the rural U.S.

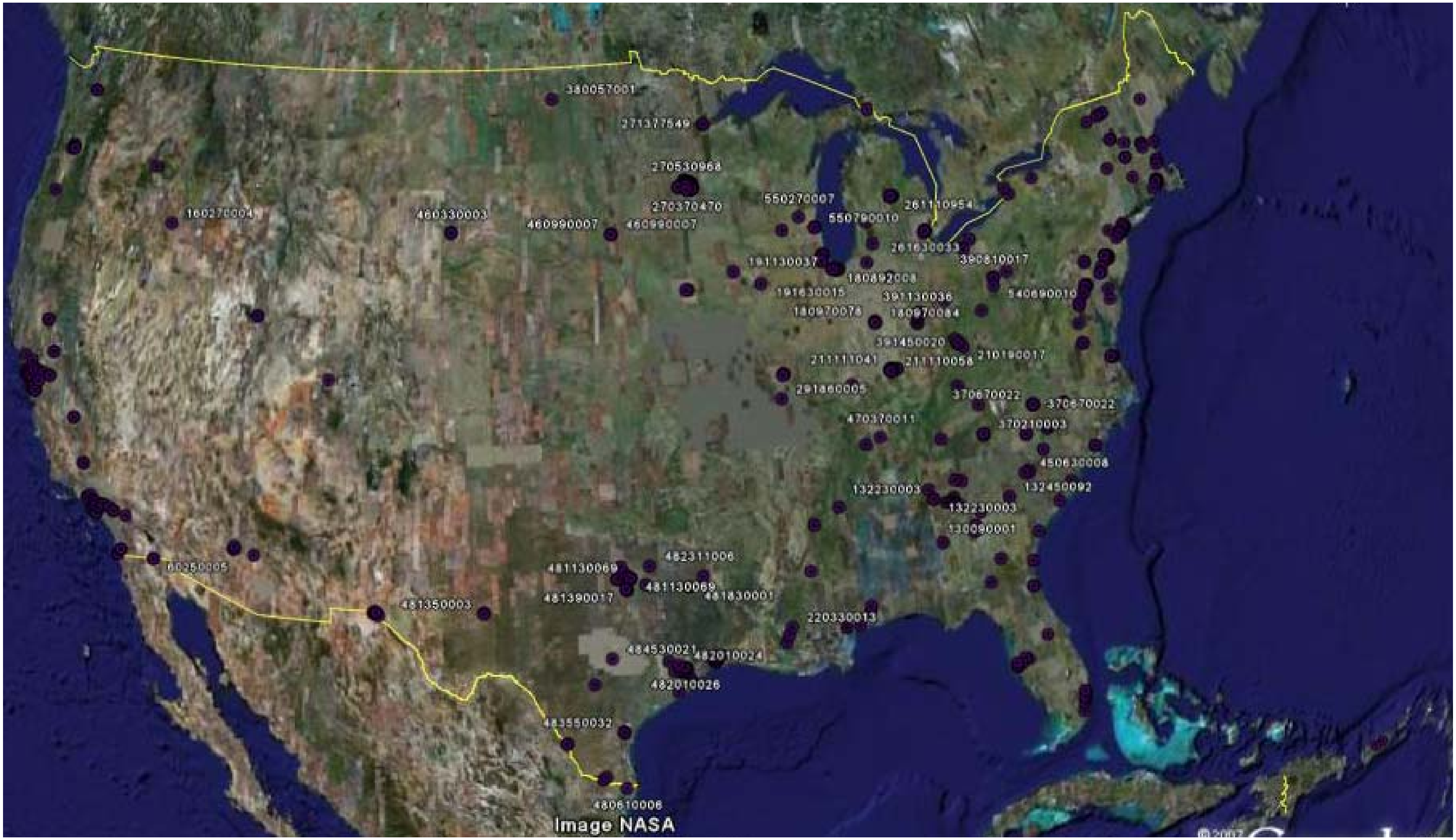


Blue = U.S. counties
Red = Subset of counties with metals measurements
Green = Subset of counties with VOC measurements

VOC = volatile organic compound

Toxics Monitoring Sites 2003-2005

Toxic VOC Monitoring Sites 2003-2005



References

Bortnick and Stetzer, Sources of variability in ambient air toxics monitoring data, 2002, *Atmos. Enviro.,*

Bortnick and Stetzer, Sampling frequency guidance for ambient air toxics monitoring, 2002, *JAWMA*

Hafner and McCarthy, Legacy air toxics archive, Phase III of national air toxics analysis project, 2004

Kenski et al., Lessons learned from air toxics data: a national perspective, 2005, *Enviro. Manag.*

McCarthy et al., Background concentrations of 18 air toxics for North America, 2006, *JAWMA*

McCarthy et al., Temporal variability of selected air toxics in the United States, 2007, *Atmos. Enviro.*

Touma et al., Spatial and temporal variability of ambient air toxics data, 2006, *JAWMA*