Summary of Previous Data Analyses / Lessons Learned

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STI

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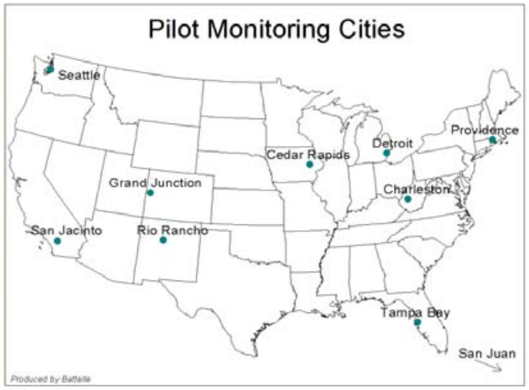
Background

- Since 1960, air toxics have been measured at several hundred sites by state, local, and tribal air pollution control agencies, but little exploration of the data at a national scale had been performed.
- In 2000, a data analysis project was undertaken to guide development of a national air toxics monitoring program.
- Since 2000, the EPA and the states have worked together to establish the National Air Toxics Trend Sites (NATTS) program and numerous community-scale monitoring studies.

Previous Data Analyses

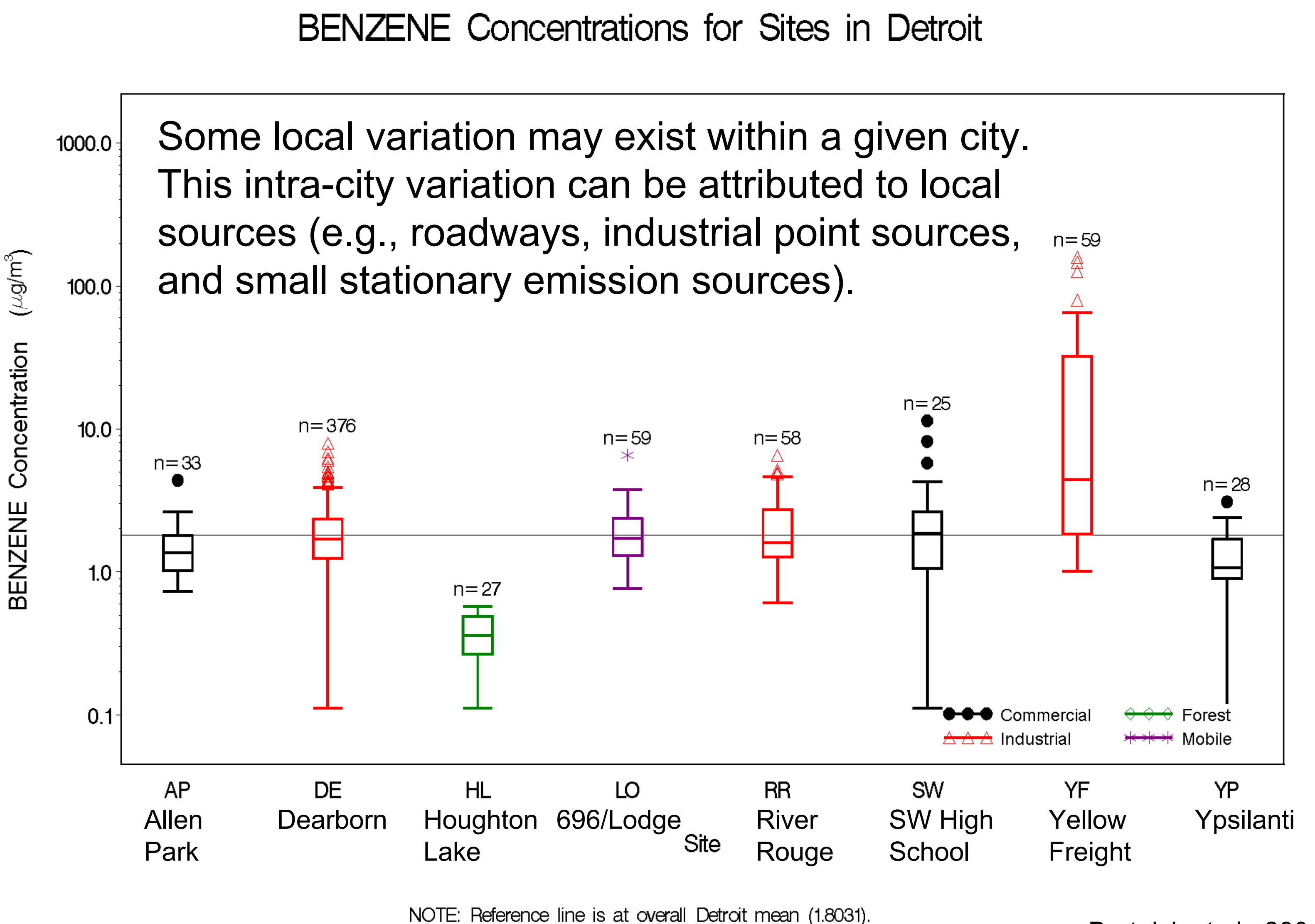


- Phase I (2001): Analyses and Network Design Recommendations
  - Battelle/STI used historical (1990-2000) data
- Phase II (2003): Analyses and Network Design Recommendations
  - Battelle/STI used Pilot City (2001-2002) data
- Phase III (2004): Air Toxics Data Analysis Workbook addressing policy relevant questions
  - STI used historical and Pilot City data

Phases I-II Data Analyses

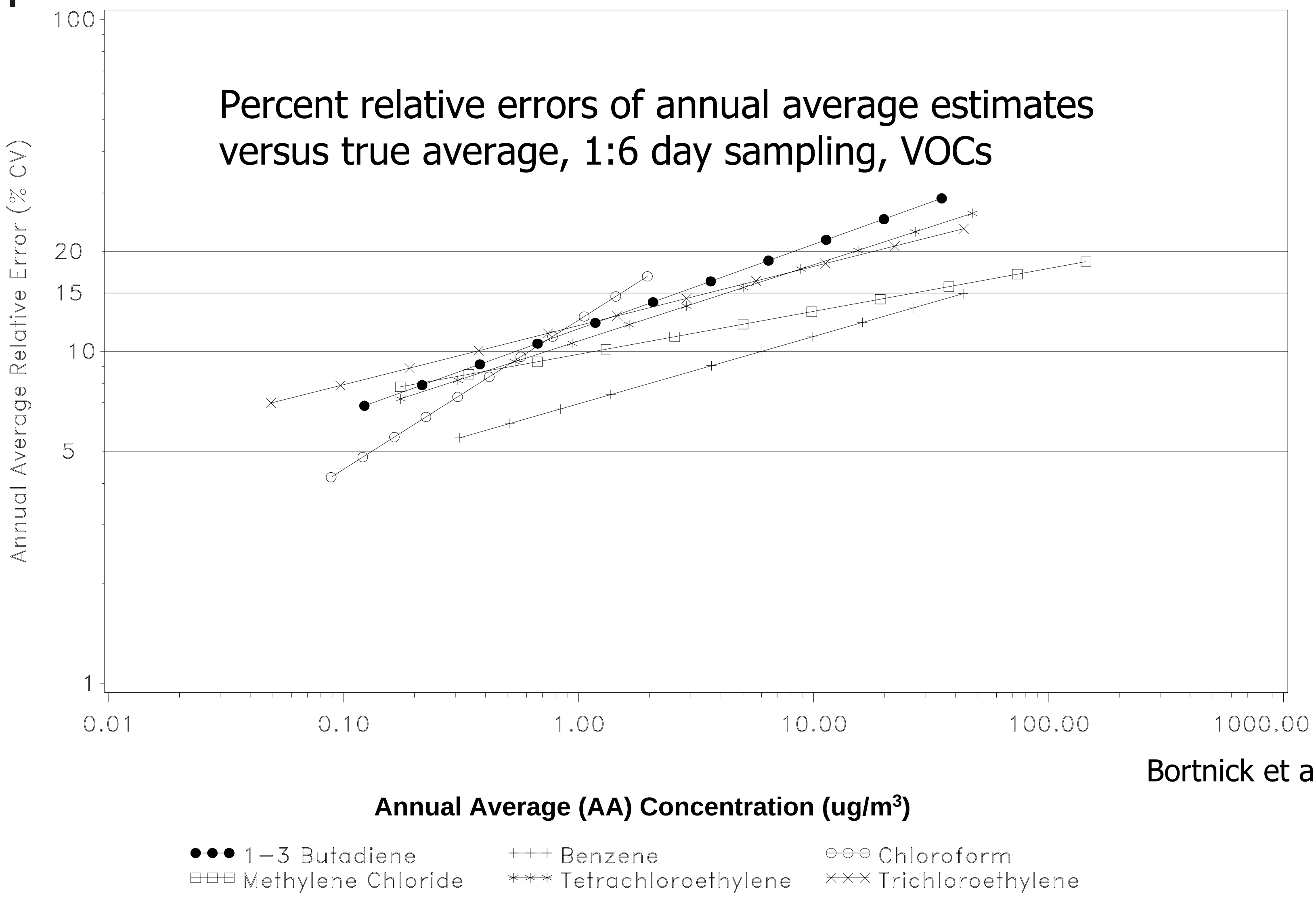
- Monitoring network design questions were addressed to guide decisions on
  - How many monitors are needed (i.e., nationally, regionally, in a city)?
  - How often do we need to sample to accurately describe annual averages, and do we need sub-daily, 24-hr, or longer sampling?
  - Which HAPs do we measure well?
  - How should we treat data below detection?

How Many Monitors Are Needed?



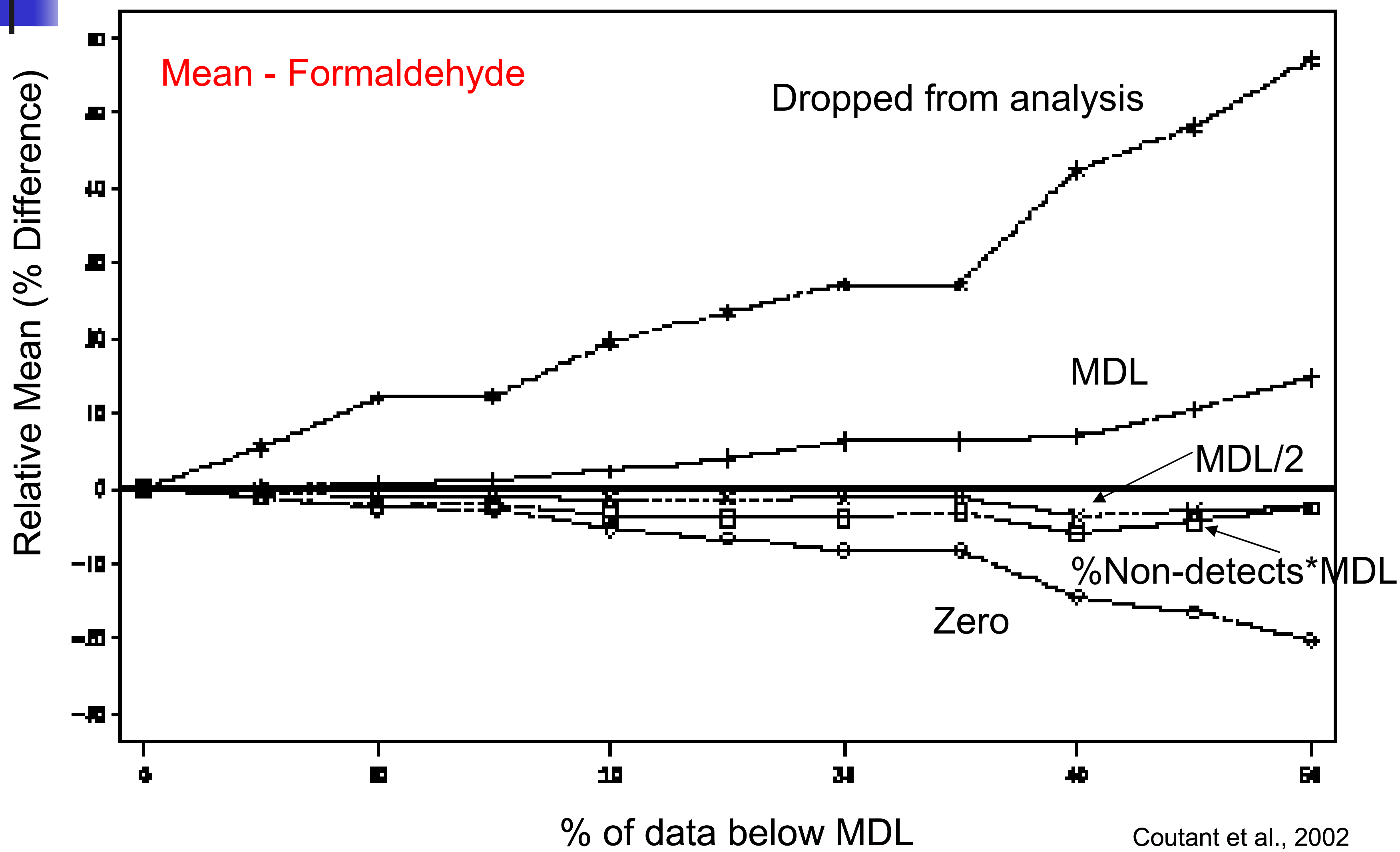
Bortnick et al., 2001

What Sampling Frequency is Needed to Estimate Site-Specific AAs with ≤ 10-15% Relative Error?



Bortnick et al., 2001

How Should Missing Data and Data Below MDL Be Treated?



Coutant et al., 2002

Key Lessons Learned – Phases I/II (1 of 2)

- Number of Monitors
  - Spatial variability exists for most HAPs
  - Few sites are required when emissions are absent
  - A large number of sites are required when emissions are present, depending on monitoring objectives
- Sampling Frequency
  - 1:6 day sampling is sufficient to provide a site-specific AA concentration with ≤ 10-15% relative error for most HAPs
  - More frequent sampling (i.e., 1:3 day) is recommended for higher concentration and source-oriented sites

Key Lessons Learned – Phases I/II (2 of 2)

- HAPs measurements
  - Some HAPs are better represented, spatially and temporally, than others.
  - Confidence in the historical record for acrolein is questionable.
- MDL reporting and substitution
  - Reported values below the MDL (when available) and MDL/2 for nondetect data are used to provide a defensible annual average for data sets with up to 50% of data below the MDL.
  - If more than 50% of the data are below the MDL, the annual average can be biased by the choice of MDL substitution.

Phase III – Policy-Relevant Questions

- Can a community's data be used to address policy-related questions?
- How do air toxics concentrations vary nationally and locally?
- How do air toxics concentrations vary temporally?
- What do air toxics data tell us about the effectiveness of emission controls?

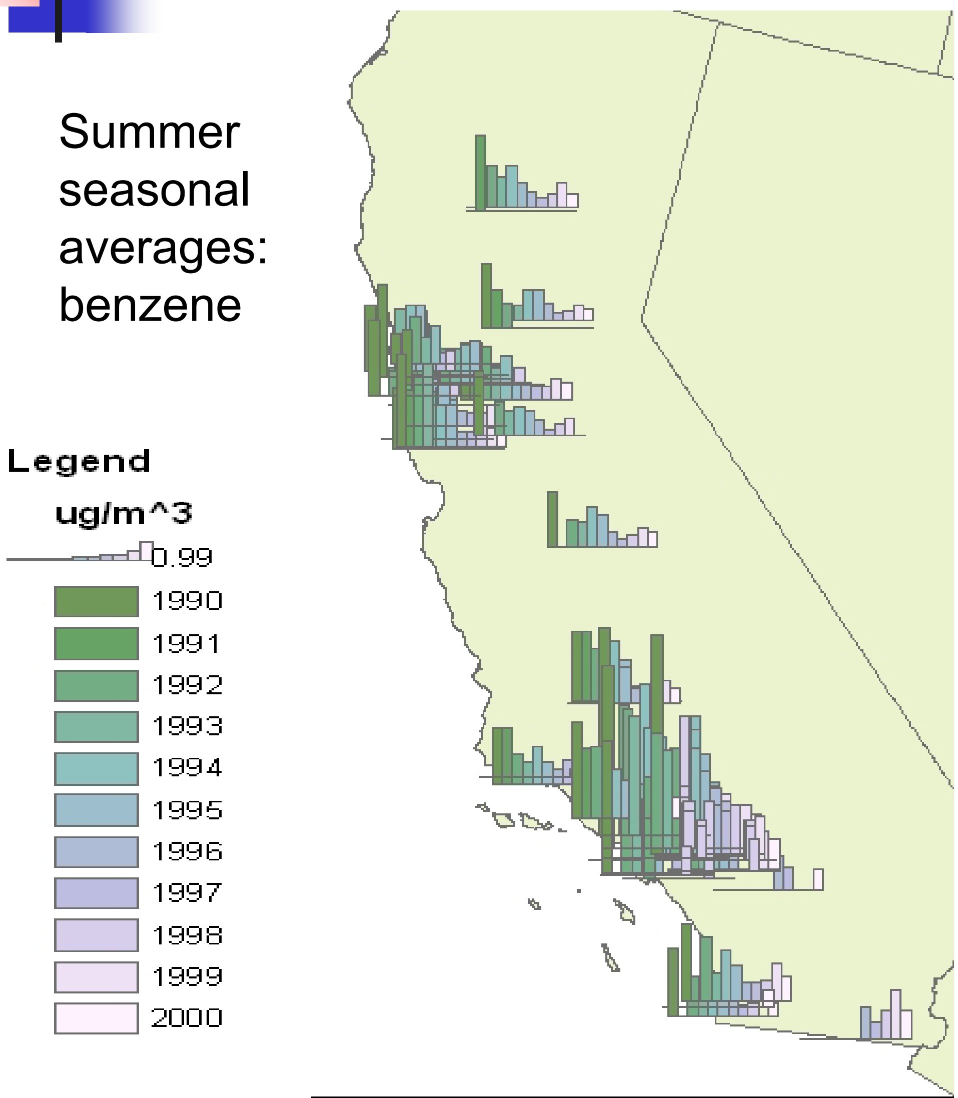
What Is Our Confidence In The Data?

- Confidence varies by pollutant.
- Guidelines were developed to assist stakeholders in determining how best to use their data to answer risk-related questions. Even data in red may be useful for trends (and potentially other) analysis.

Pilot City	Cancer Benchmark/MDL <1 **(Risk levels at or below MDL cannot be quantified)**	Cancer Benchmark/MDL = 1 to 10 **(Risk levels can be estimated or quantified)**	Cancer Benchmark/MDL >10 **(Risk levels can be quantified)**
Median/MDL <1 **(Cannot quantify AA, can set upper limit of AA)**	Cadmium $PM_{2.5}$ Cadmium TSP Chromium (VI) Tetrachloroethylene Chloroform 1,3-Butadiene Arsenic $PM_{2.5}$	Vinyl chloride Trichloroethylene	Beryllium PM_{10}
Median/MDL = 1 to 10 **(Can identify AA with some uncertainty)**	Arsenic TSP Carbon tetrachloride Chromium PM2.5 Chromium TSP	Beryllium TSP Methylene Chloride Chromium PM_{10} Benzene	Cadmium PM_{10} Lead $PM_{2.5}$ Lead TSP
Median/MDL >10 **(Can quantify AA)**		Acetaldehyde Formaldehyde	Lead PM_{10} Nickel PM_{10}

How Do Air Toxics Concentrations Vary Nationally and Locally?

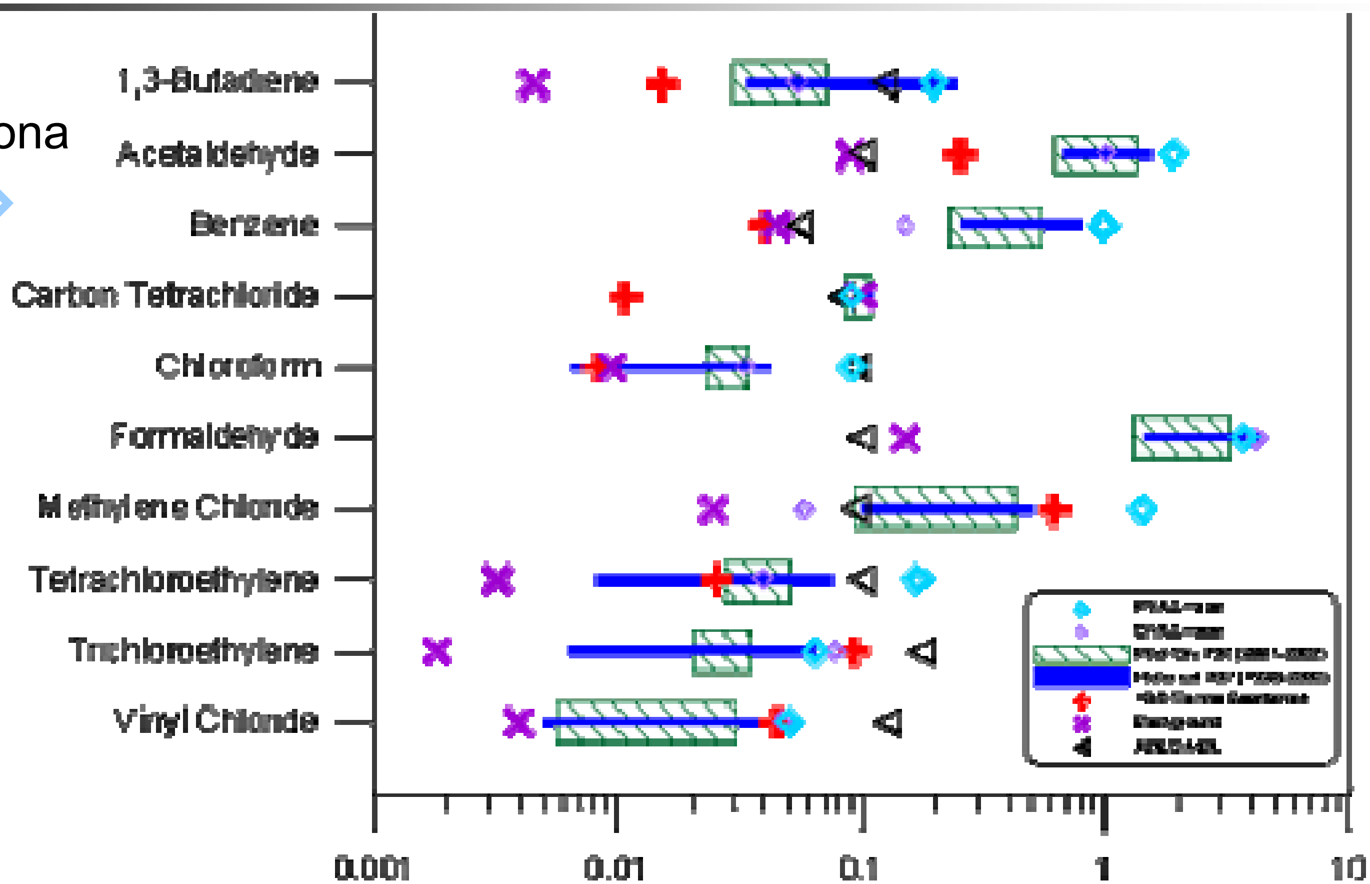
Summer seasonal averages: benzene



- Species with lifetimes more than a few hours or dominated by area and mobile source emissions varied by about a factor of 3 (nationwide, site-to-site).
- Short-lived species, or those dominated by local point sources, varied by more than a factor of 10.

How Do Concentrations In My City Compare to Other Cities?

Phoenix, Arizona
urban ◇
rural ◇

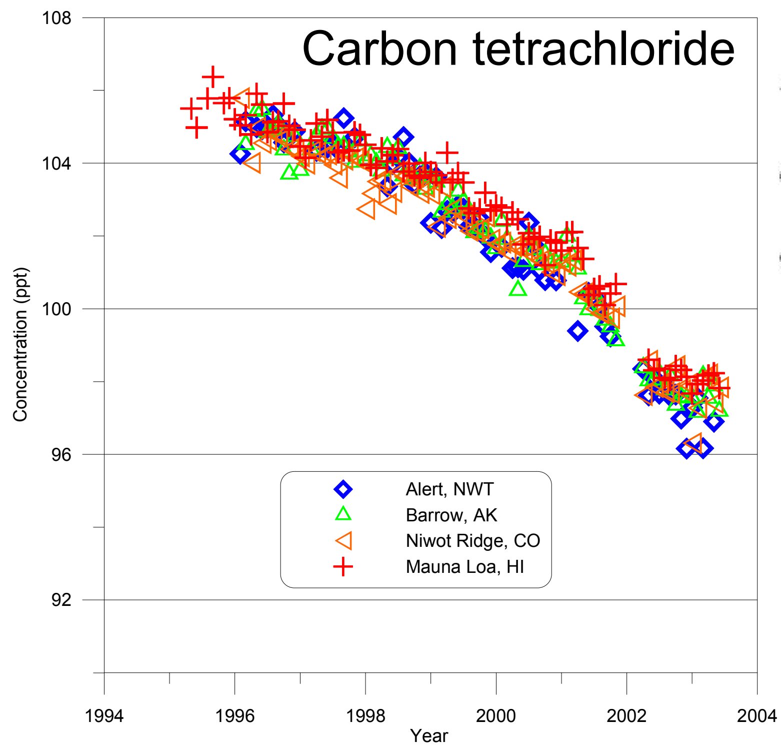


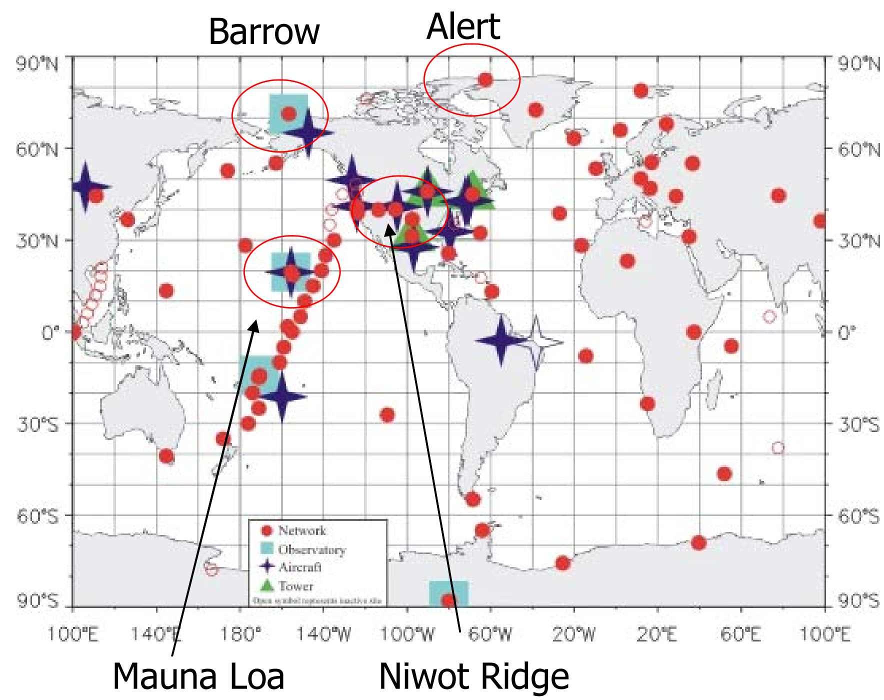
Using historical and Pilot City concentration ranges, a small network's concentrations can be put in perspective with background, cancer benchmark, and typical urban concentrations.

From recent work for Arizona Dept. of Environmental Quality

What are Background Concentrations of HAPs?

Background levels of CCl_4 concentrations are declining by about 1 ppt/year.

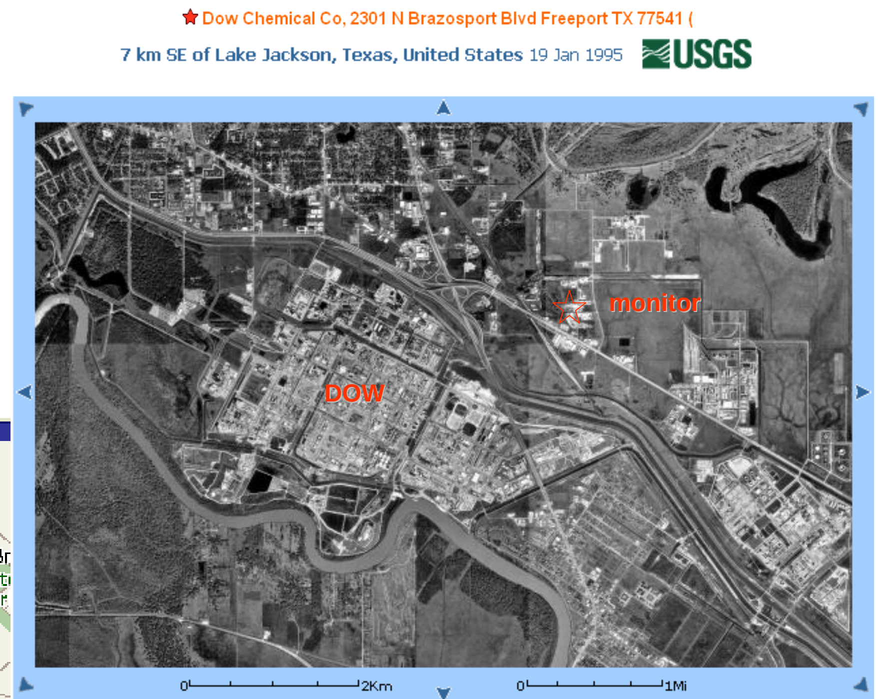


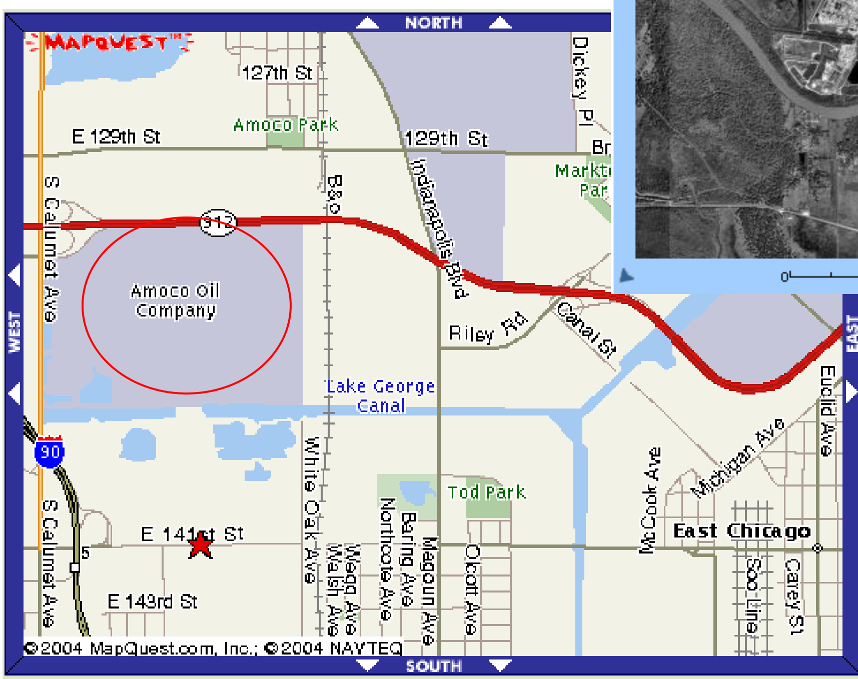


Remote (and rural) background measurements are available for some species through other measurement programs.

Is Detailed “Standard Metadata” Needed to Better Define the Specific, Micro-scale Characteristics of Air Toxics Monitoring Sites?

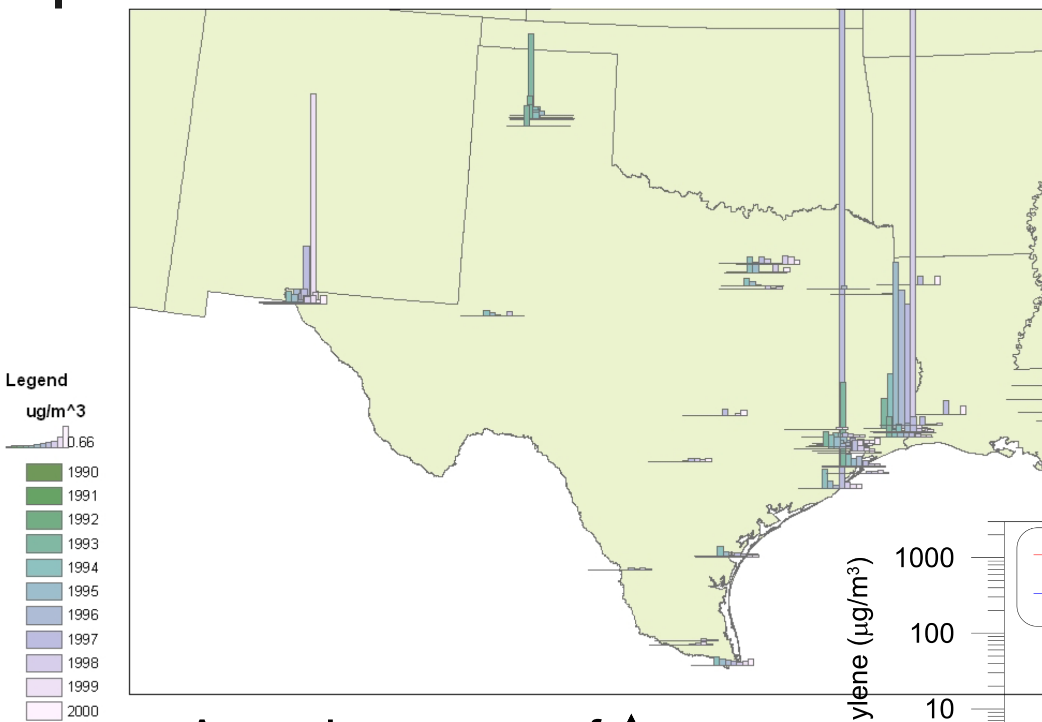
Detailed “standard metadata” is helpful to better define the specific, micro-scale characteristics of air toxics monitoring sites.





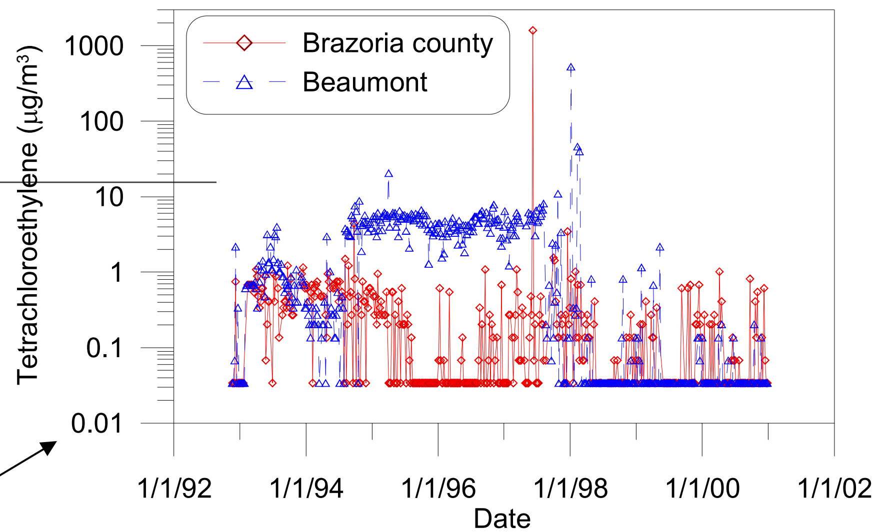
Local knowledge seems to be necessary as well.

How Do We Characterize “Spikes” In Ambient Concentrations?



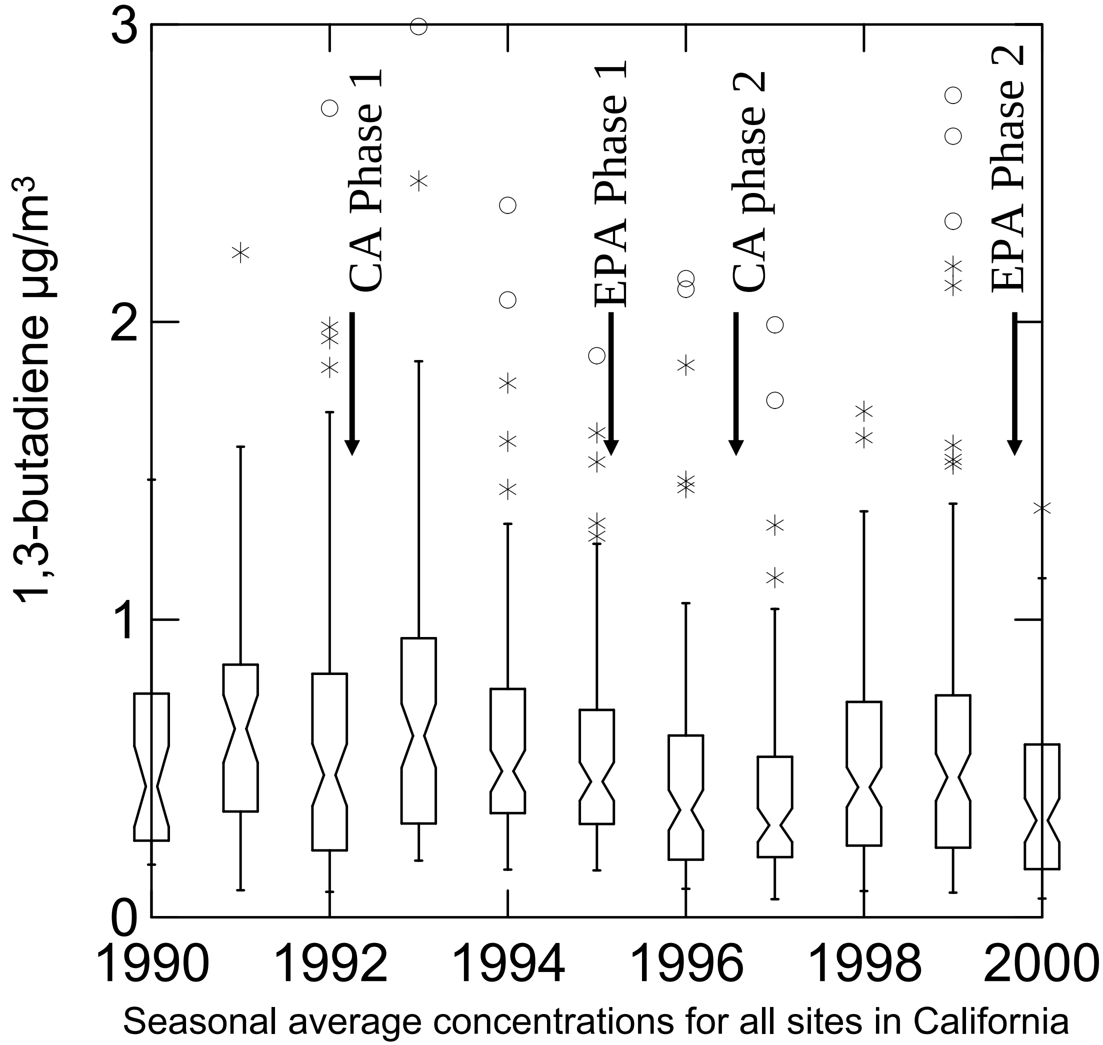
Annual averages of tetrachloroethylene

Concentration spikes are observable with maps; case studies are needed to understand (and validate) the spikes.



Daily averages of tetrachloroethylene

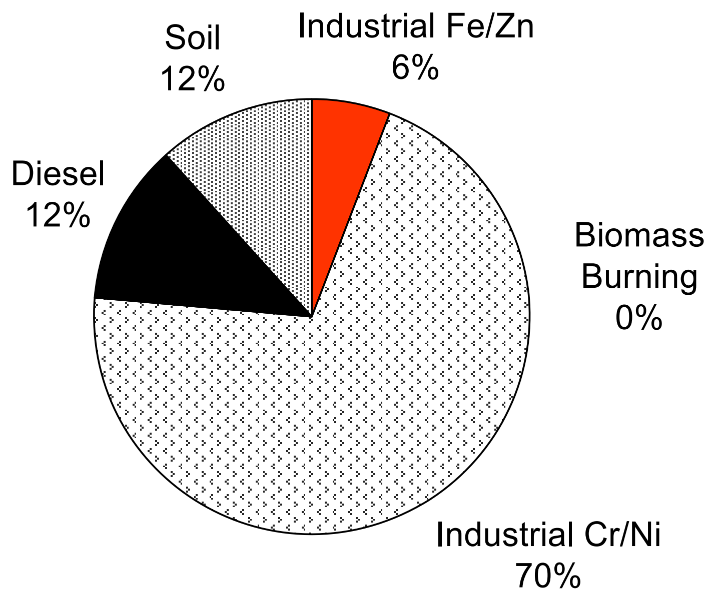
How Effective Have Mobile Source Controls Been In Reducing Exposure To Toxics?



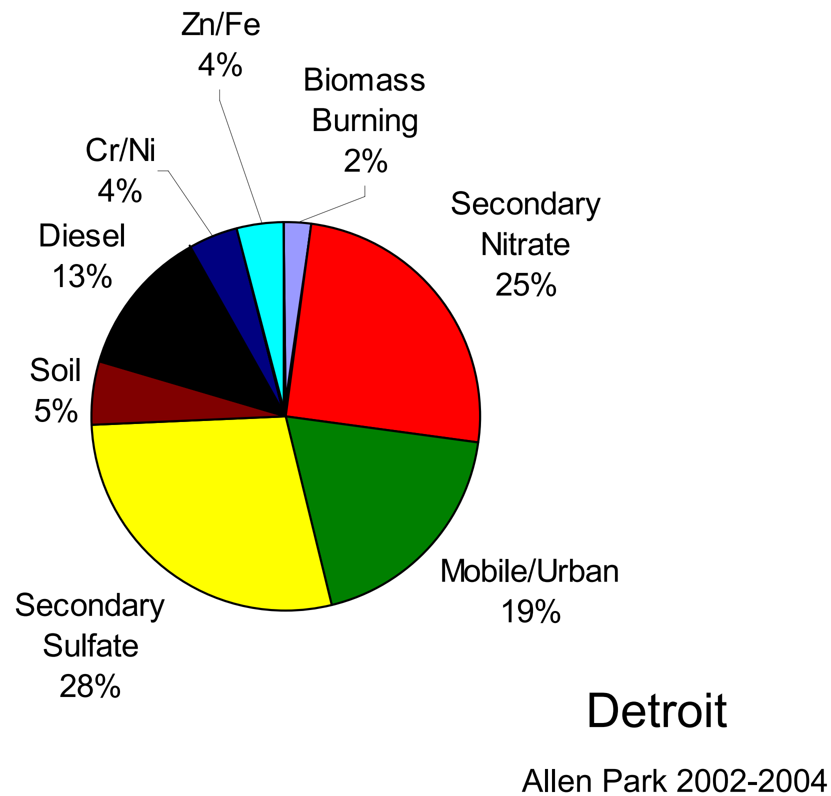
- Median 1,3-butadiene concentrations declined from 1993 through 1997 consistent with predicted changes due to reformulated gasoline (RFG).
- The reason for the increases in the late 1990s is unclear.

Are Other (Non-Toxic) Species Needed for Source Apportionment of Air Toxics? (1 of 2)

YES. Analyses such as source apportionment need non-toxic species to better identify source types (e.g., OC, EC, PAHs, and Fe for diesel).



Average contribution to Nickel mass



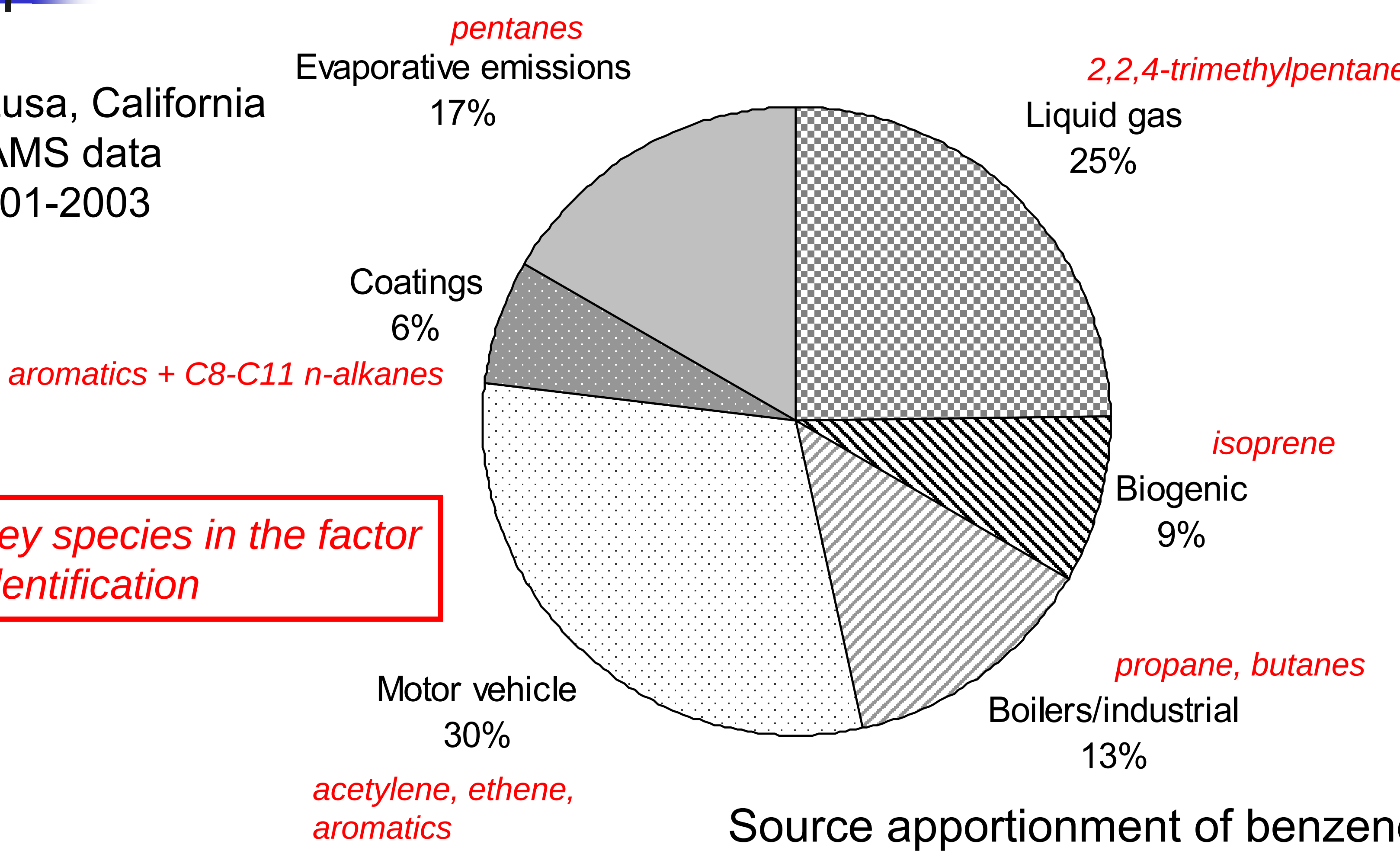
Average contribution to $PM_{2.5}$ mass

From recent work for Lake Michigan Air Directors Consortium

Are Other (Non-toxic) Species Needed for Source Apportionment of Air Toxics? (2 of 2)

Azusa, California
PAMS data
2001-2003

Key species in the factor identification



Source apportionment of benzene

From recent work for South Coast Air Quality Management District

Key Lessons Learned – Phase III (1 of 2)

- Cancer benchmarks are often below HAPs MDLs.
- Background concentrations of HAPs are typically small compared to urban concentrations (except for carbon tetrachloride and chloroform).
  - McCarthy et al., 2005 "Background concentrations of 18 core air toxics in the northern hemisphere. " (*in press*)
- Concentrations of some HAPs (e.g., benzene, 1,3-butadiene, tetrachloroethylene, and lead [tsp]) appear to be decreasing over time.

Key Lessons Learned – Phase III (2 of 2)

- HAPs concentrations vary spatially by a factor of three for some air toxics (e.g., benzene, formaldehyde) and a factor of 10 for others (tsp metals, 1,3-butadiene) across the nation
- It is difficult to tie ambient changes in HAPs concentrations to specific control measures
  - Kenski et al., 2005 “Lessons Learned from Air Toxics Data Analysis: A National Perspective” (*published in EM, June 2005*)

Conclusions

- Although many lessons were learned in previous analyses, many important questions remain about air toxics
  - Not all findings were quantified
  - Not regional or local scale analysis
- Data analysis is a continuing process
  - More available data
  - New methods (e.g., Aethalometers)
  - Emissions changes

Next Steps – Phase IV

- With a national perspective
  - Quantify temporal trends (diurnal, seasonal, and annual)
  - Quantify spatial variability (nationally, regionally, between-cities, and within-cities)
  - Explore whether additional analyses are warranted for the links among pollutants (i.e., ozone, PM, and HAPs), met-adjusted trends, and tying MACT to concentration changes

References

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McCarthy M.C., Hafner H.R., and Montzka S.A. (2005) Background concentrations of 18 core air toxics in the northern hemisphere. *J. Air & Waste Manage. Assoc.* (in press) (STI-903550-2589).

Acronyms

- AA = Annual average
- EC = Elemental carbon
- HAP = Hazardous air pollutant (i.e., air toxics)
- MACT = Maximum achievable control technology
- MDL = Method Detection Limit (sometimes minimum detection limit)
- NATTS = National Air Toxics Trend Sites
- OC = Organic carbon
- PAH = Polycyclic Aromatic Hydrocarbon
- $PM_{2.5}$ = Particulate matter less than 2.5 microns
- tsp = total suspended particulate