AIR TOXICS IN ALLEGHENY COUNTY: SOURCES, AIRBORNE CONCENTRATIONS, AND HUMAN EXPOSURE

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Description of the Problem

- **Purpose:** Characterize air toxics concentrations, sources, and risks in Allegheny County
- **Rationale:** Large uncertainties still exist regarding sources, exposure, and health risks mostly due to a lack of data
- **Context:** Time resolution and consistency of these measurements allow for more in-depth analysis than has previously been possible

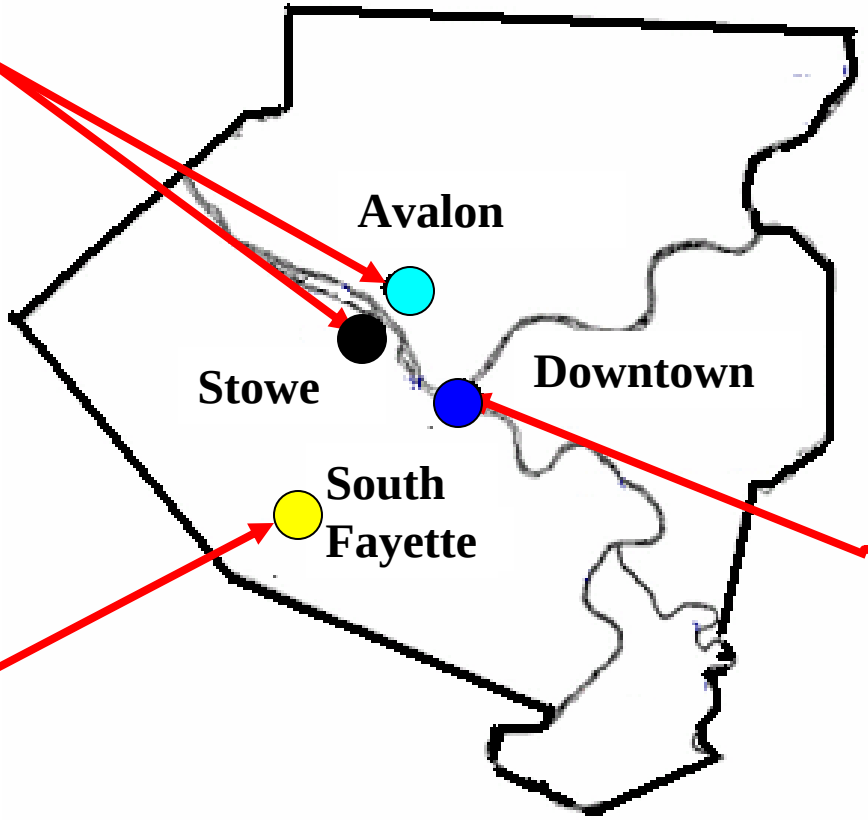
Project Objectives

- Ambient measurements
  - Baseline (ACHD)
  - Intensives (CMU)
- Estimate health risks (CMU, Pitt)
- Determine source contributions (CMU)
- Evaluate relative risks (CMU)
  - Local vs. regional sources
  - Pittsburgh vs. other cities

Monitoring Sites

Industrial Sites

Regional Background Site



Mobile Dominated Site

Design and Implementation of Project

- Two types of measurements
  - Baseline
    - 4-sites
    - 24hr average concentrations
    - Measured 1:6 for a year
    - Canisters (TO-15 standard)
    - Cartridges (TO-11a standard)
  - Intensives
    - 3-sites
    - Hourly measurements for 1 to 2 months
    - Gas and particle phase measurements

Automated Field Instrument

Gas Chromatograph Mass Spectrometer/ Flame Ionization Detector (GCMS/FID)

- 1 hour resolution
- 70+ compounds
- Low detection limit(<.2µg/m³)

(Millet JGR, 2005)

Compounds Measured

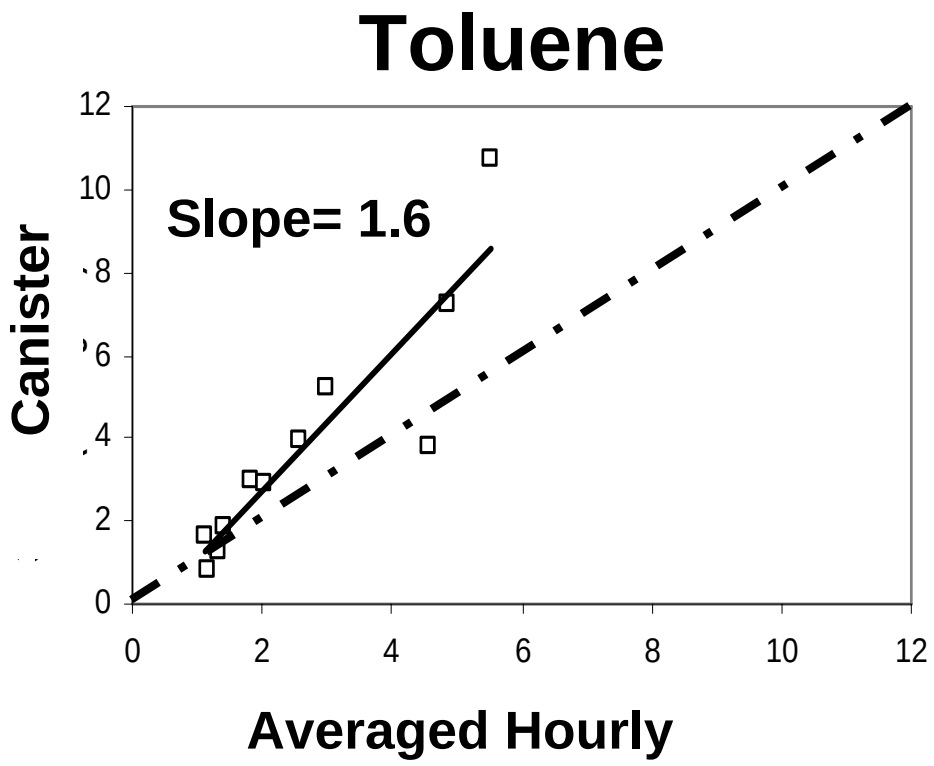
Toluene
2-Butanone (MEK)
Methyl alcohol
Styrene
Benzene
4-Methyl-2-pentanone (MIBK)
Naphthalene
Ethylbenzene
Carbon disulfide
Methyl-t-butyl either(mtbe)
1,2,4-Trimethylbenzene
Isopropylbenzene
Ethylene oxide
Phenanthrene
Methylene chloride
Methyl methacrylate
Bromomethane
Fluoranthene
Pyrene
m-Xylene

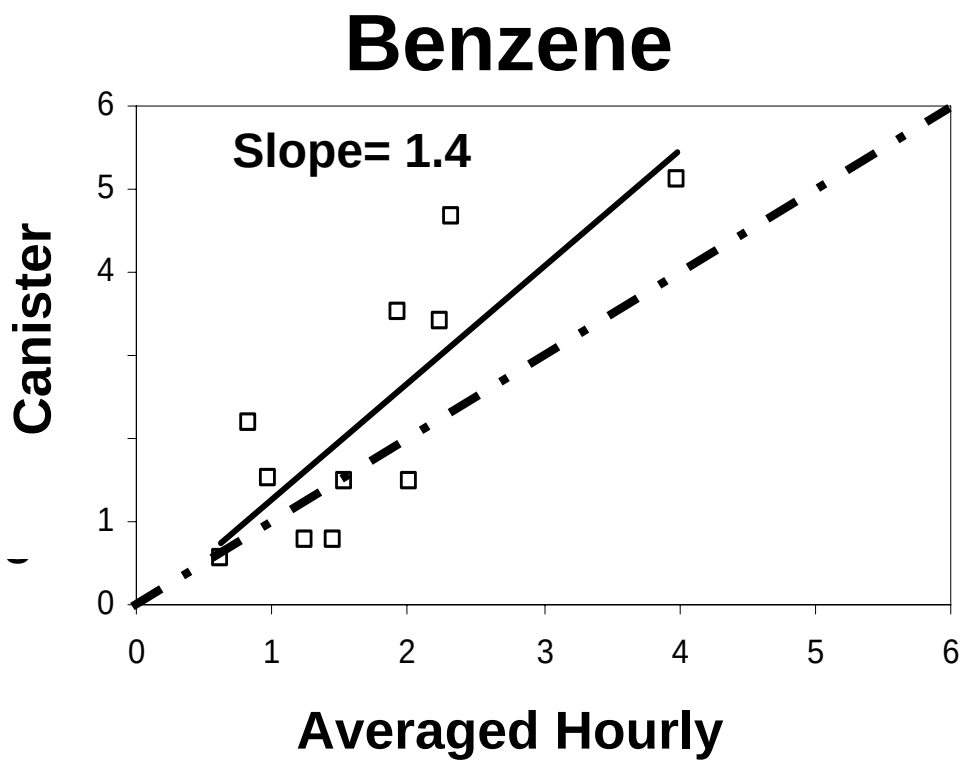
Chrysene
Benzo[a]anthracene
Fluorene
Tetrachloroethene
Acenaphthene
Anthracene
o-Xylene
Chloroform
p-Xylene
Vinyl chloride
Heptane
Ethyl acetate
Trichloroethene
1,1,2,2-Tetrachloroethane
Vinyl acetate
1,4-Dioxane
Acrolein (Propenal)
Acenaphthylene
Benzyl chloride
1,4-Dichlorobenzene

Chloromethane
Quinoline
Benzo[k]fluoranthene
1,1,2-Trichloroethane
Chlorobenzene
cyclohexane
1-Propanol
Chloroethane
Acrylonitrile
1,2-Dichloroethane
1,1-Dichloroethane
1,1,1-Trichloroethane
Benzo[b]fluoranthene
Bromochloromethane
Pyridine
n-Propylbenzene
1,2-Dichlorobenzene
Bromoform

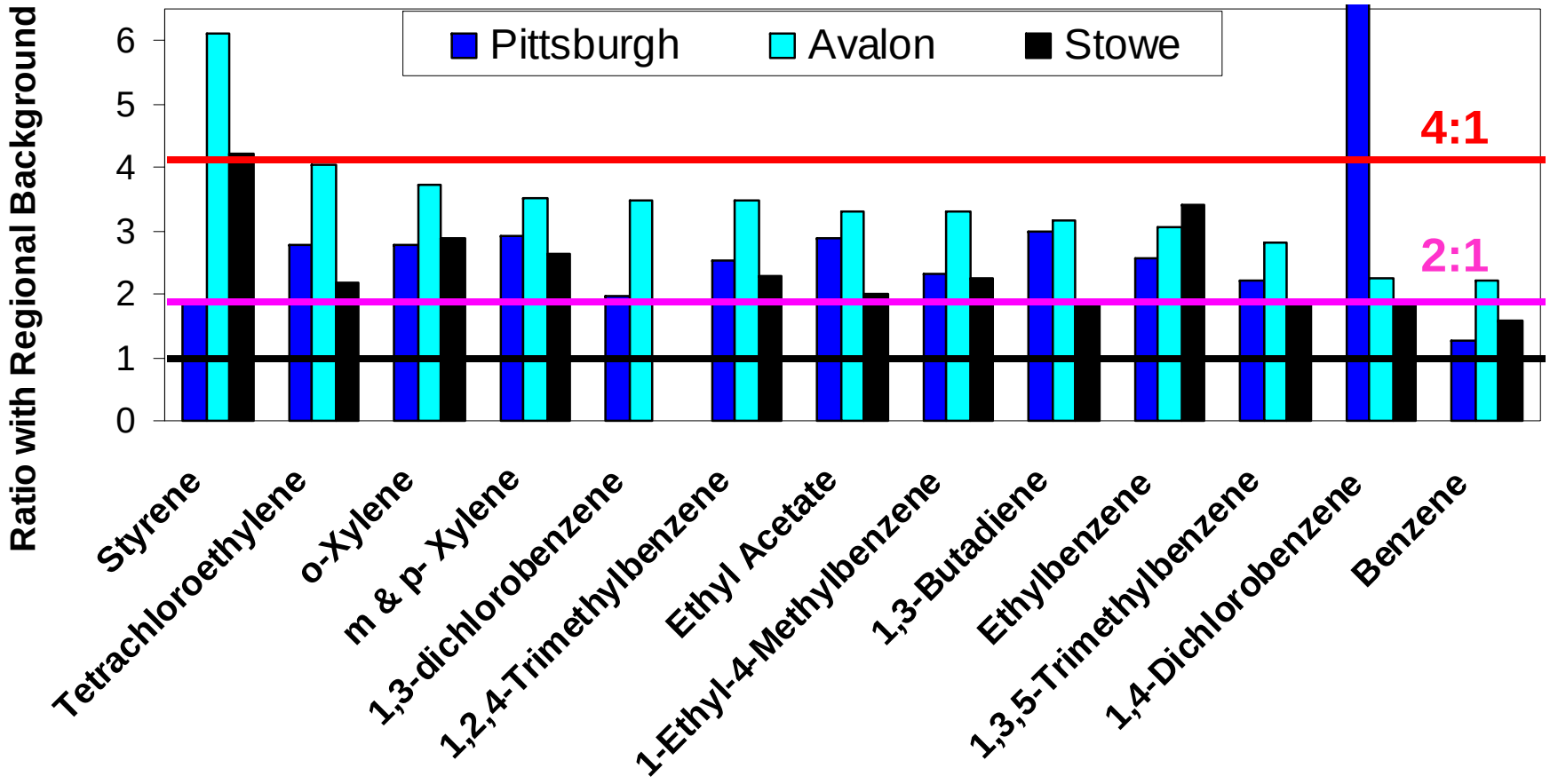
*Simultaneous measurements of local meteorology and criteria pollutants

Measurement Inter-comparison

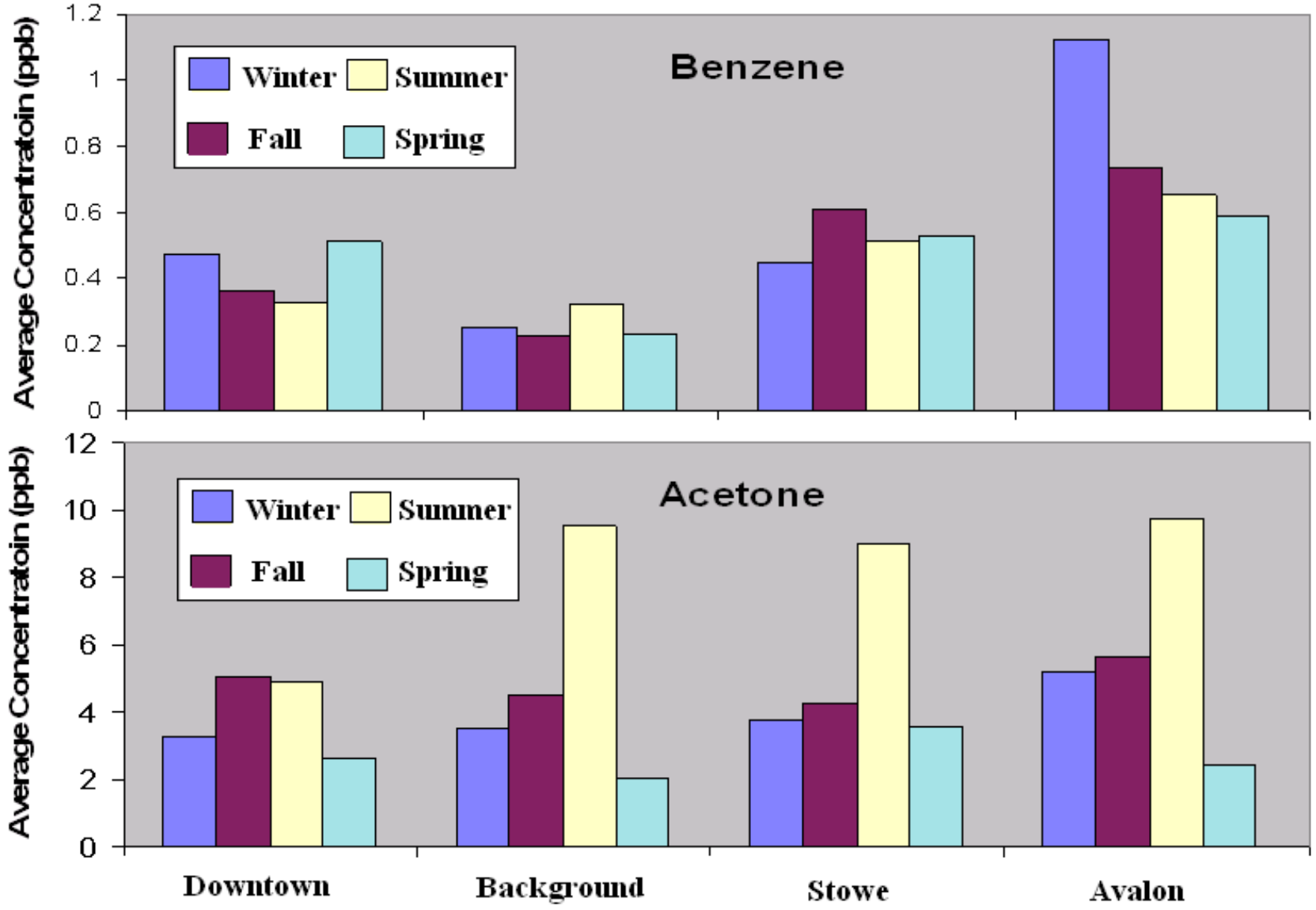




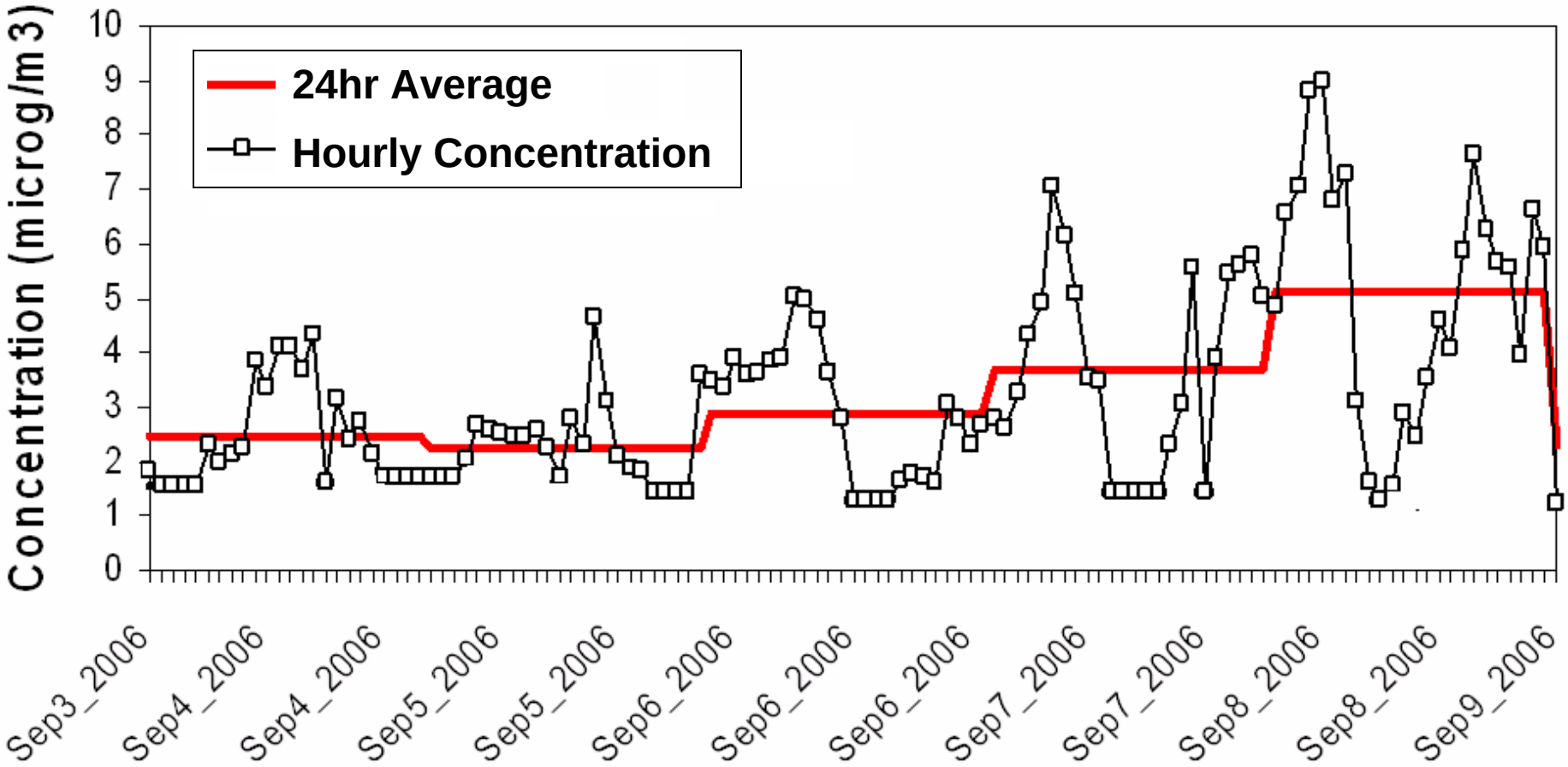
Air toxic concentrations relative to South Fayette



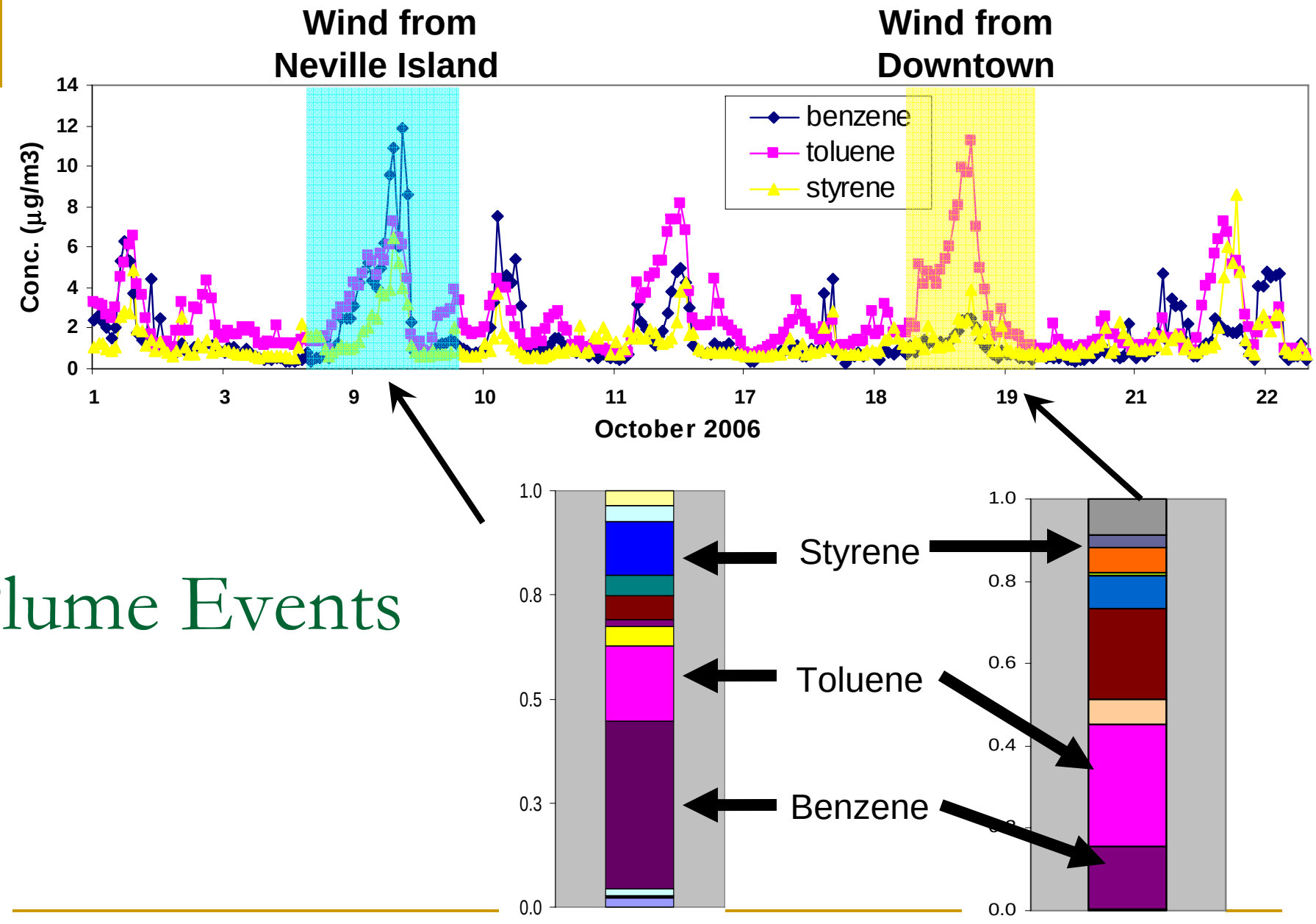
Seasonal Variations



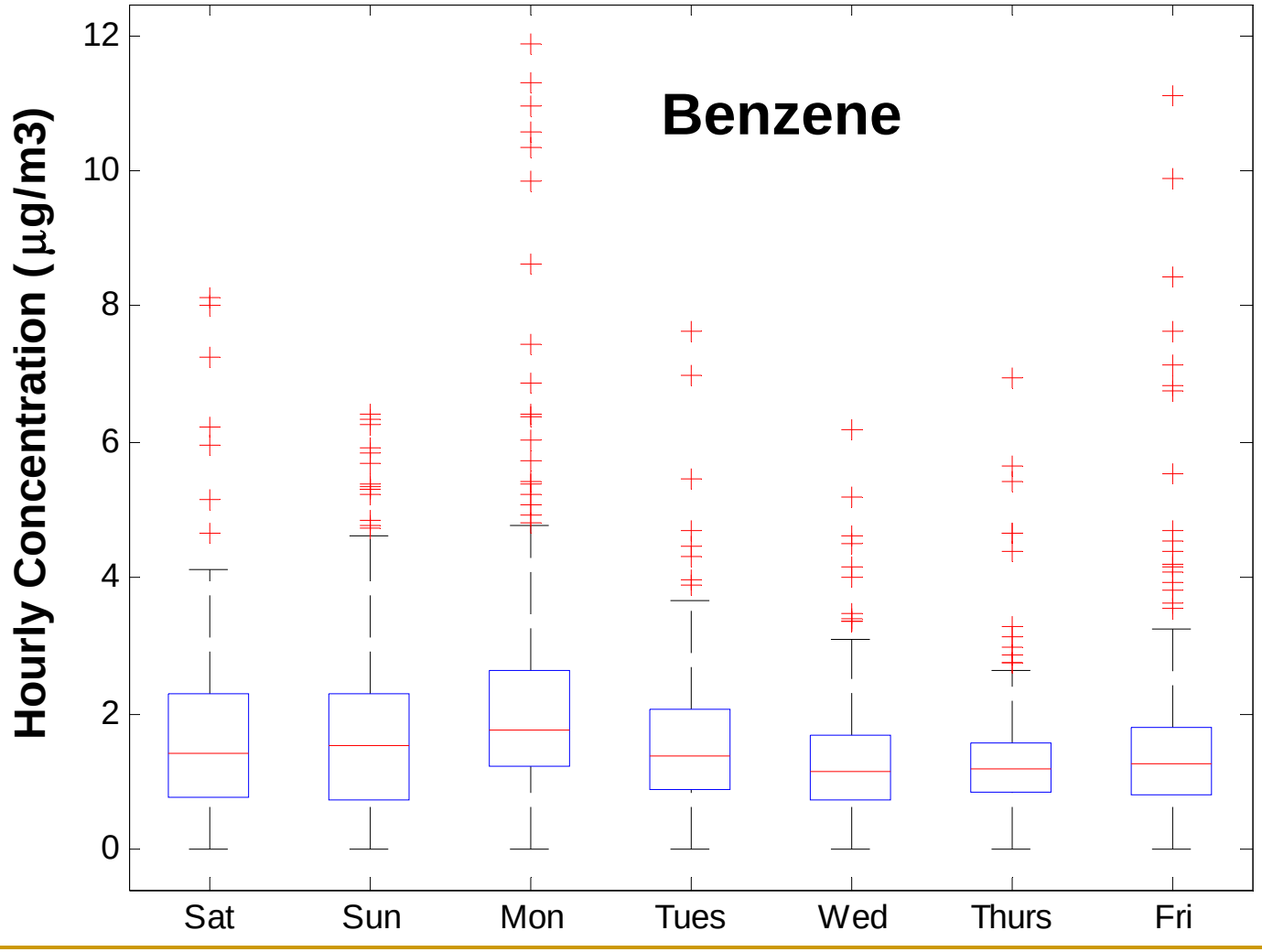
High Temporal Resolution



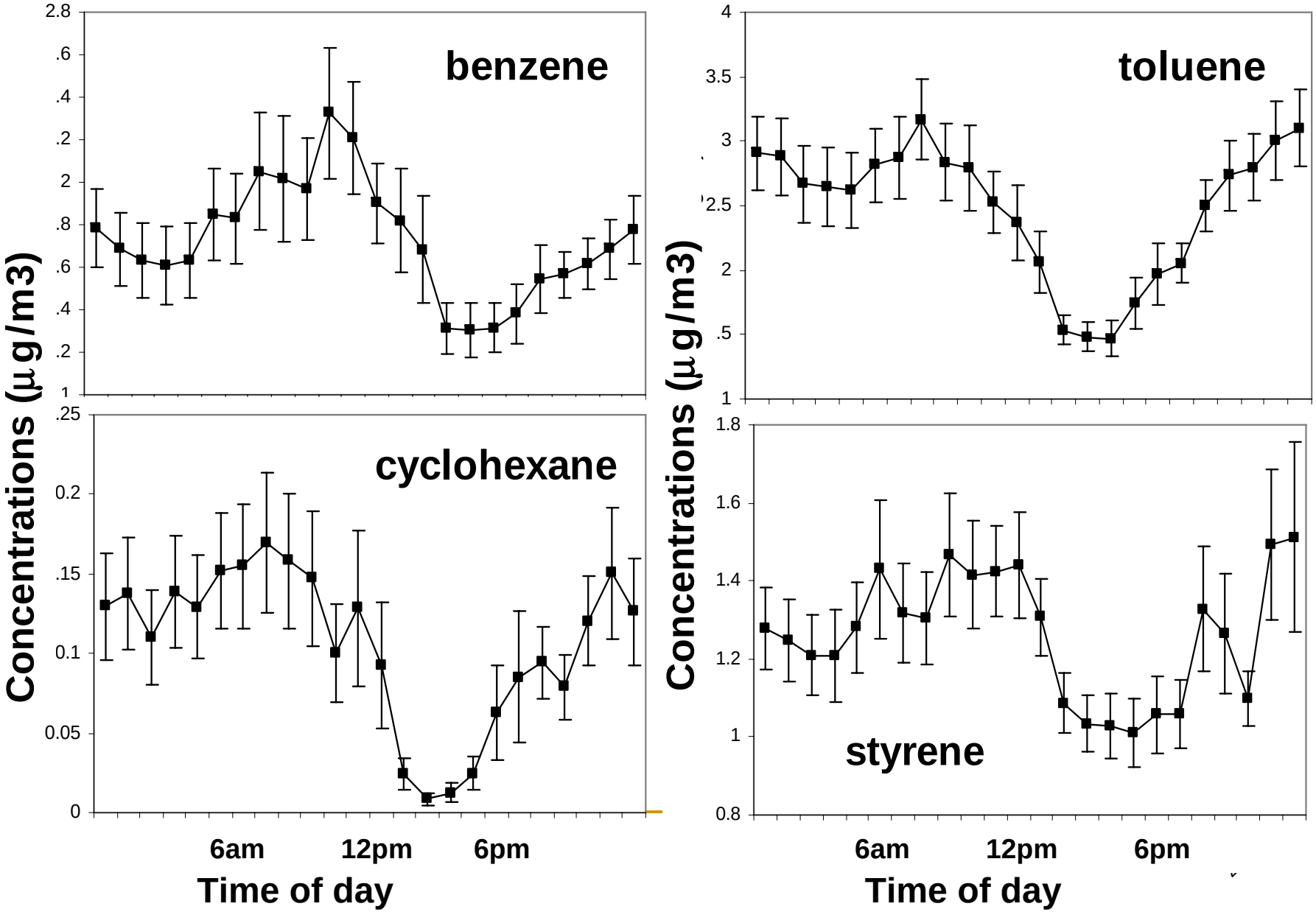
Plume Events



Benzene by Day of the Week in Avalon



Average Diurnal Patterns at Avalon



Estimating Lifetime Cancer Risk

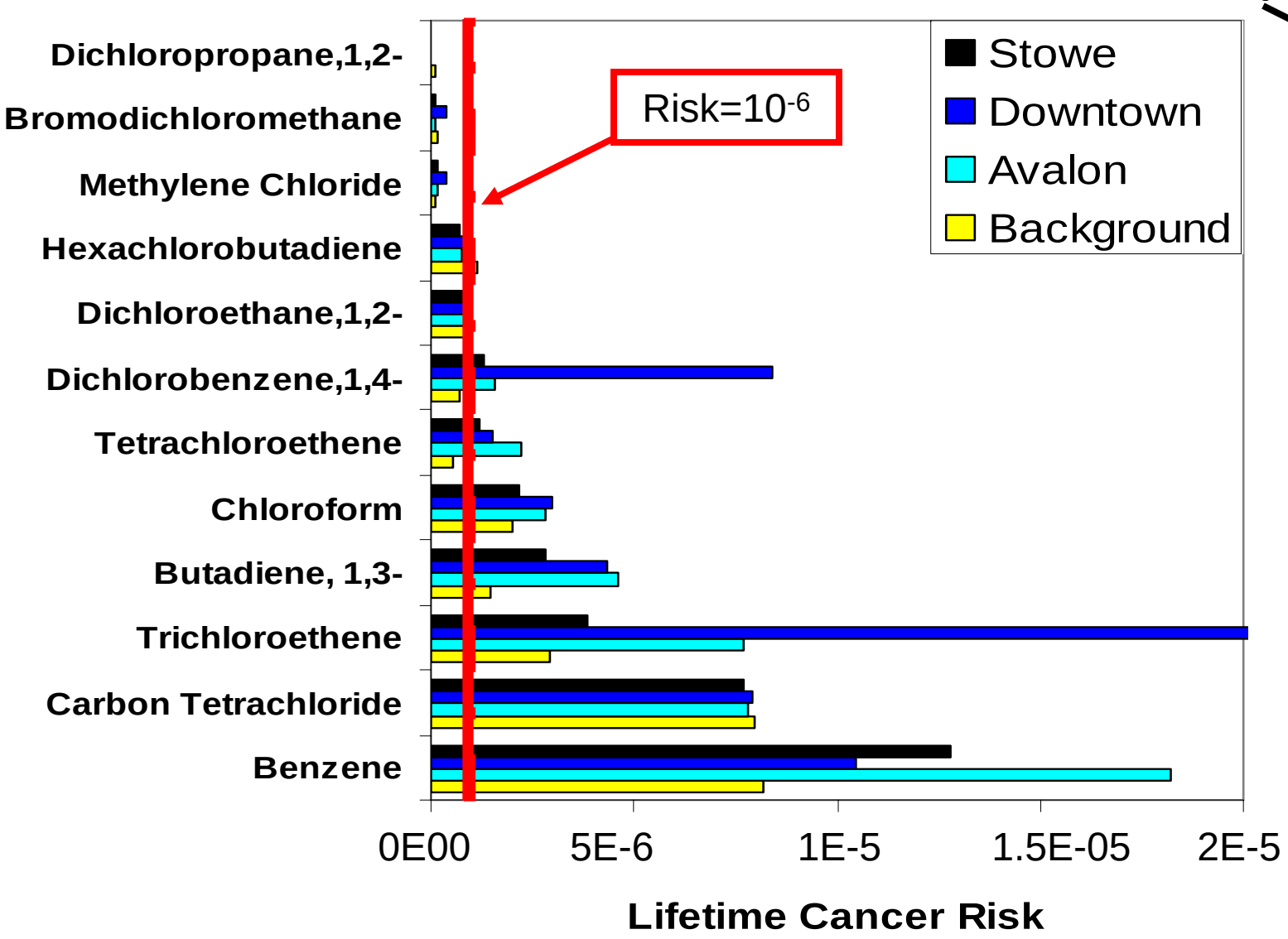
Linear No-Threshold Model:

Lifetime Individual Cancer Risk: $$LIR = LADD * SF$$

SF=Slope Factor

Lifetime Averaged Daily Dose: $$LADD = \frac{C_{95th,\,percentile} * f_a * IR}{BW}$$

Air Toxics Cancer Risks



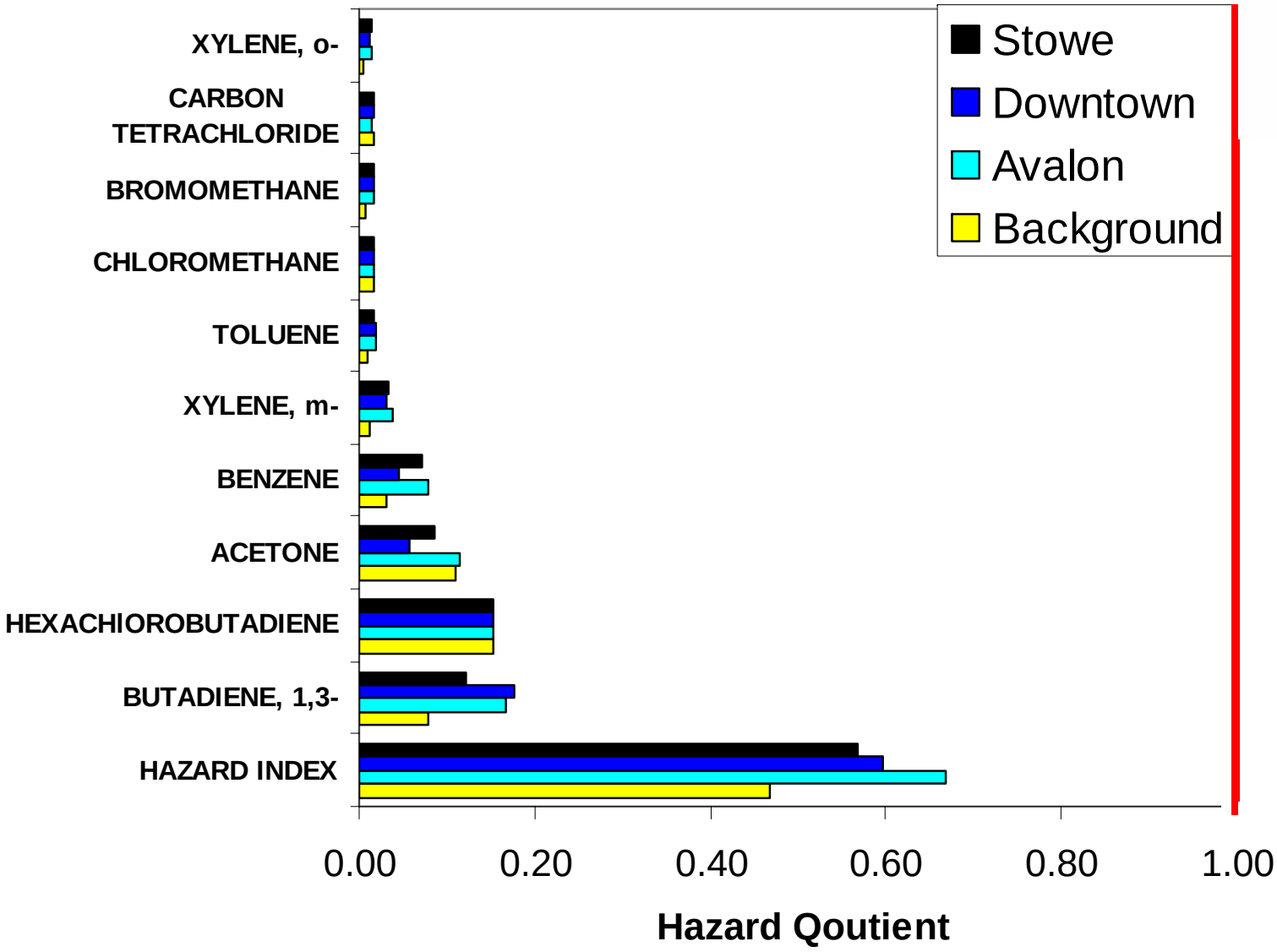
Non-Cancer Health Risks

$$HQ = \frac{Concentration}{RfC}$$

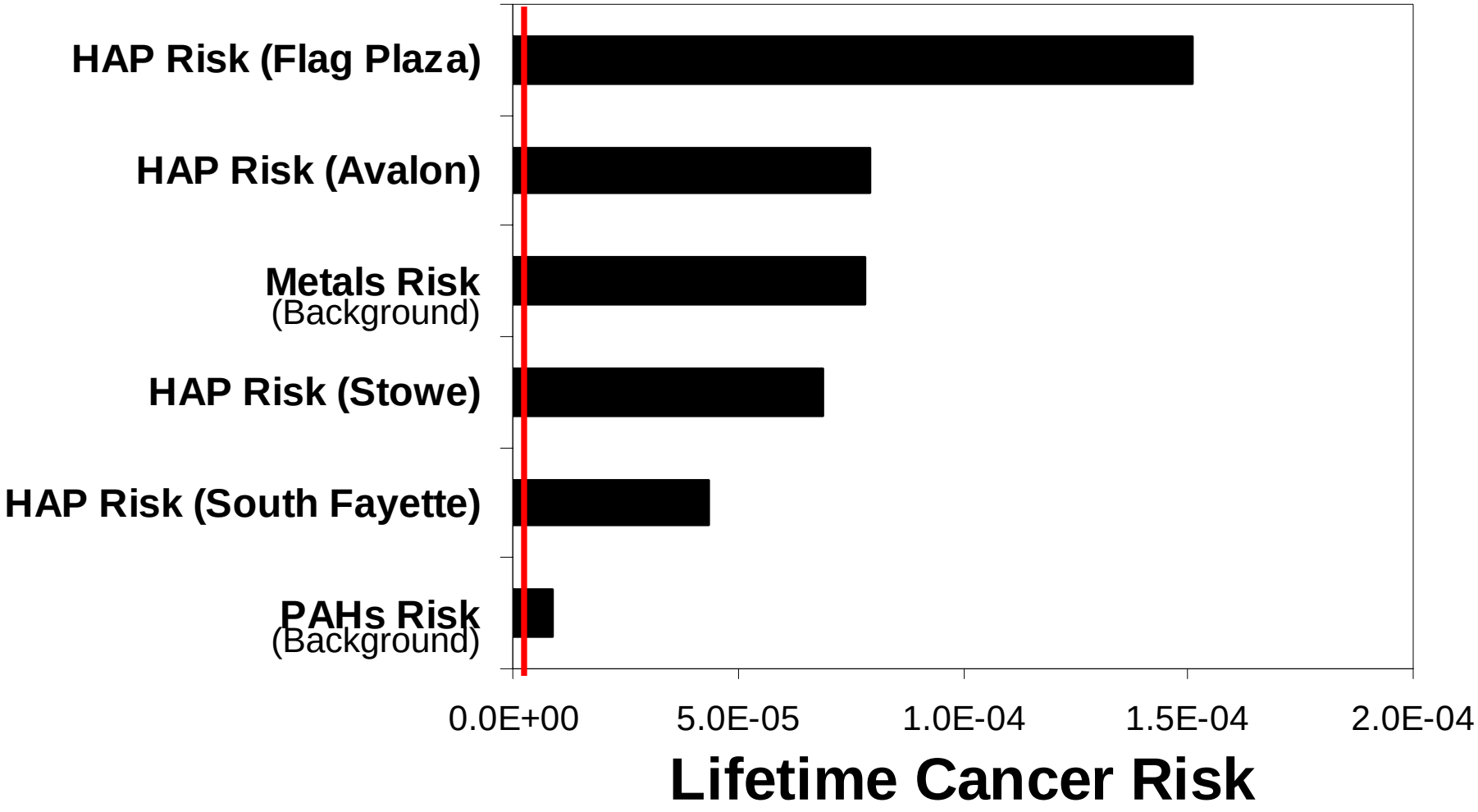
HQ*=**Hazard Quotient ***RfC = Reference Concentration

- Chronic
  - Annual 95th percentile canister data
- Intermediate and Acute
  - Maximum hourly concentration at Avalon: 14 days to 1 year

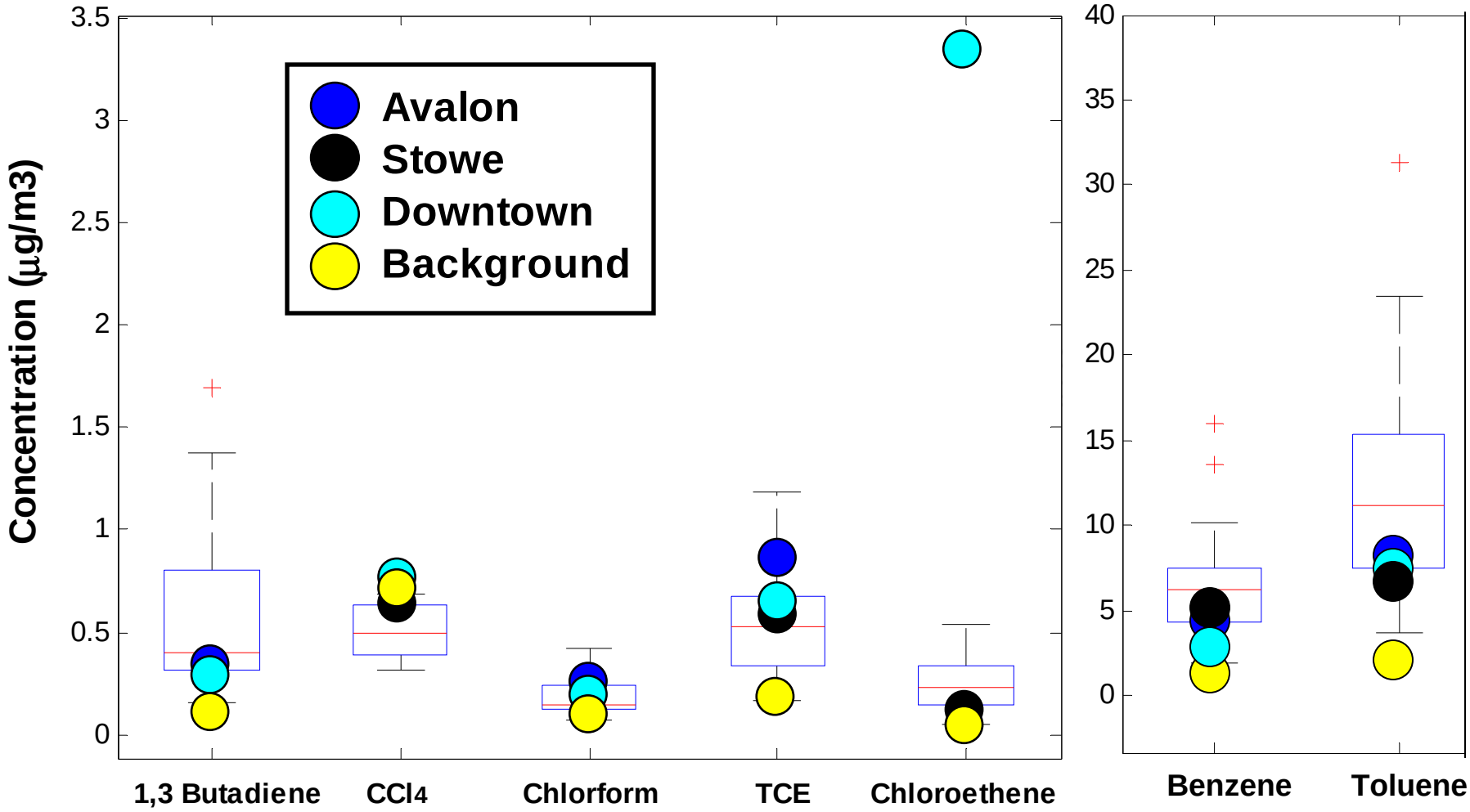
Non-Cancer Risks



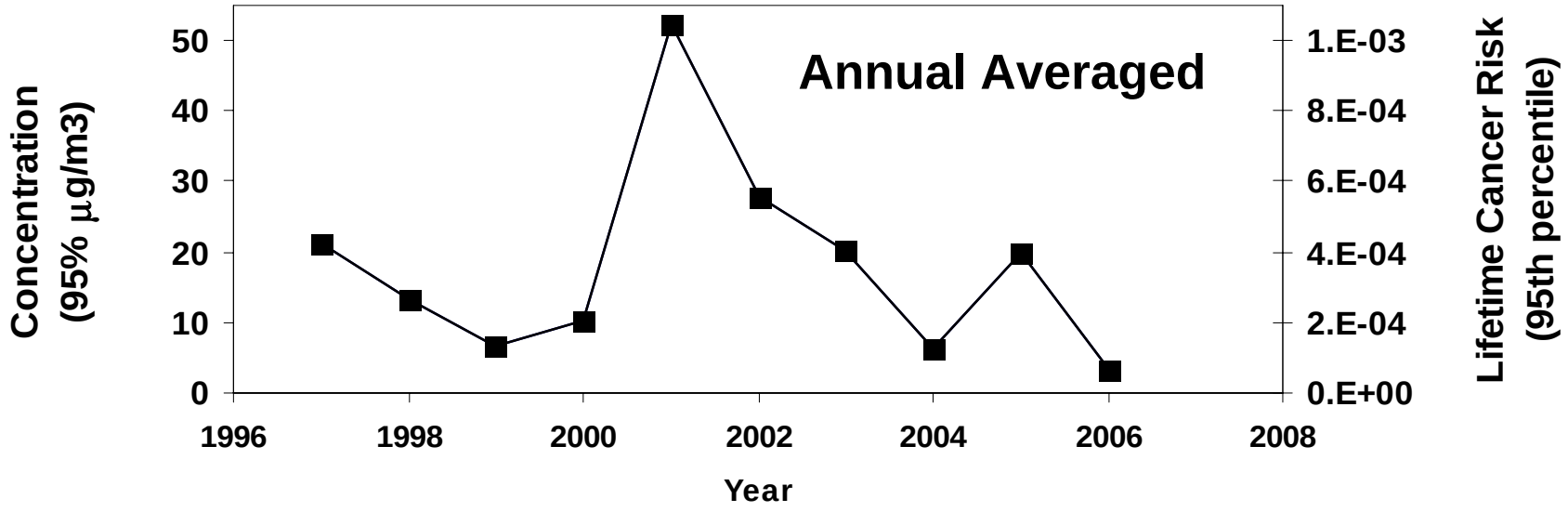
Comparison of Aggregate Air Toxics Risks

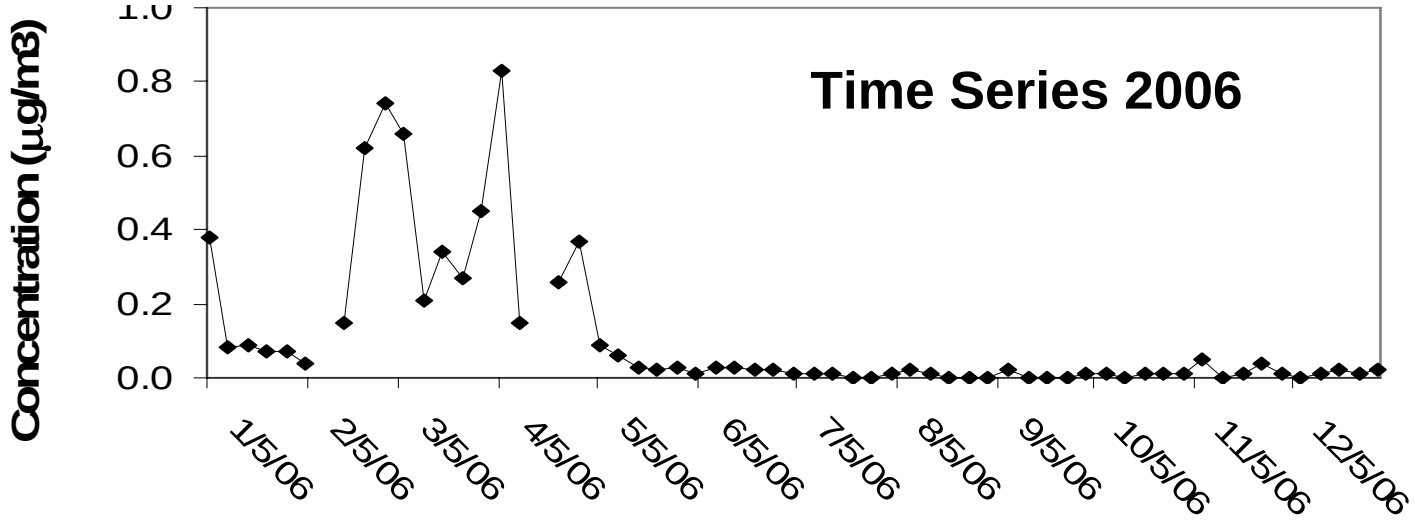


How does Allegheny County compare to other cities?



Downtown Exposure: Trichloroethene





Source Apportionment

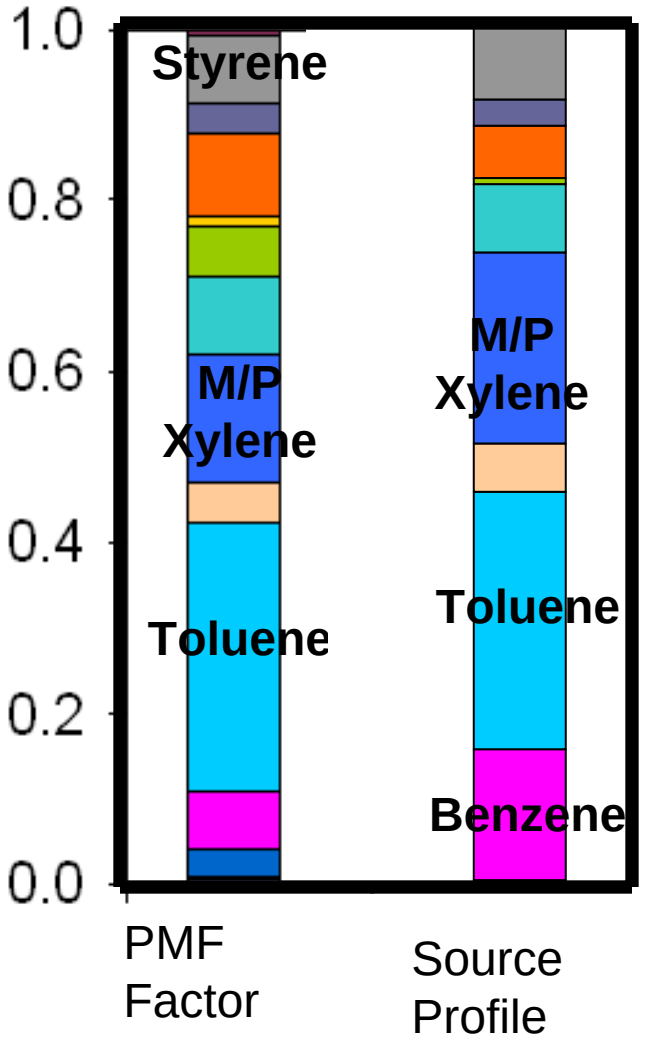
PMF solves:

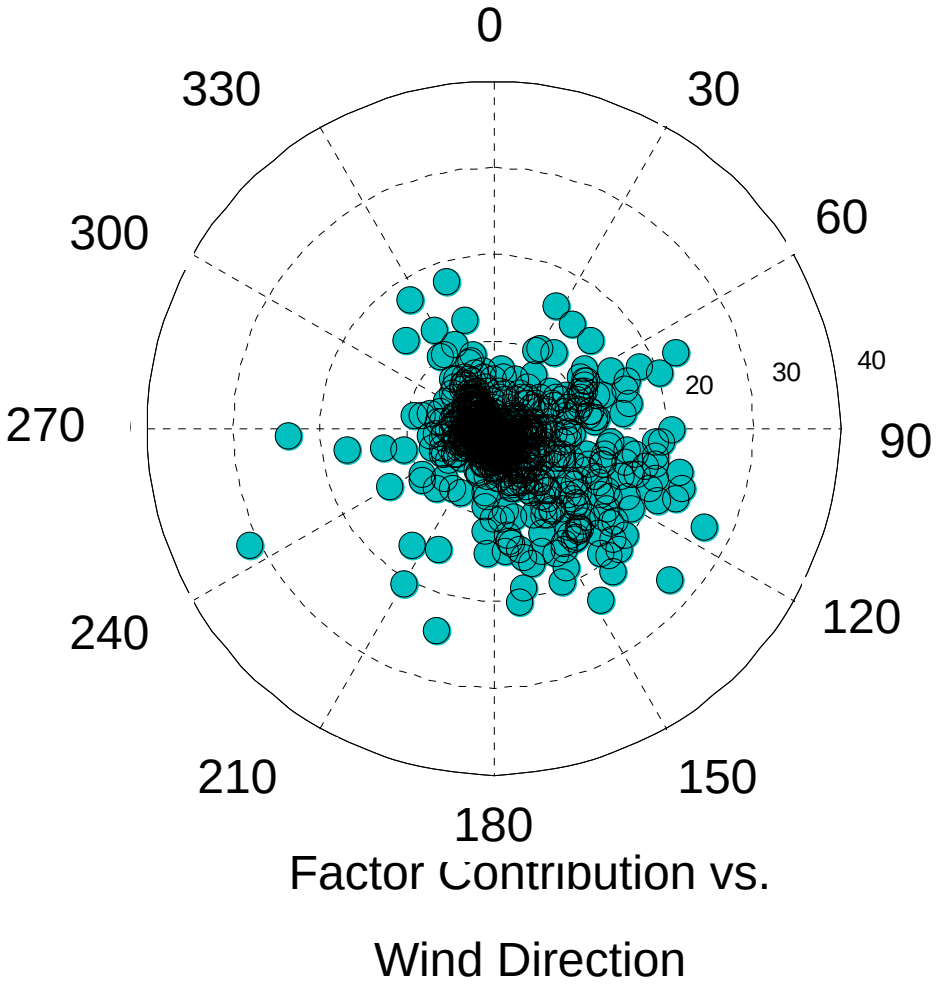
$$X = GF$$

scores loadings

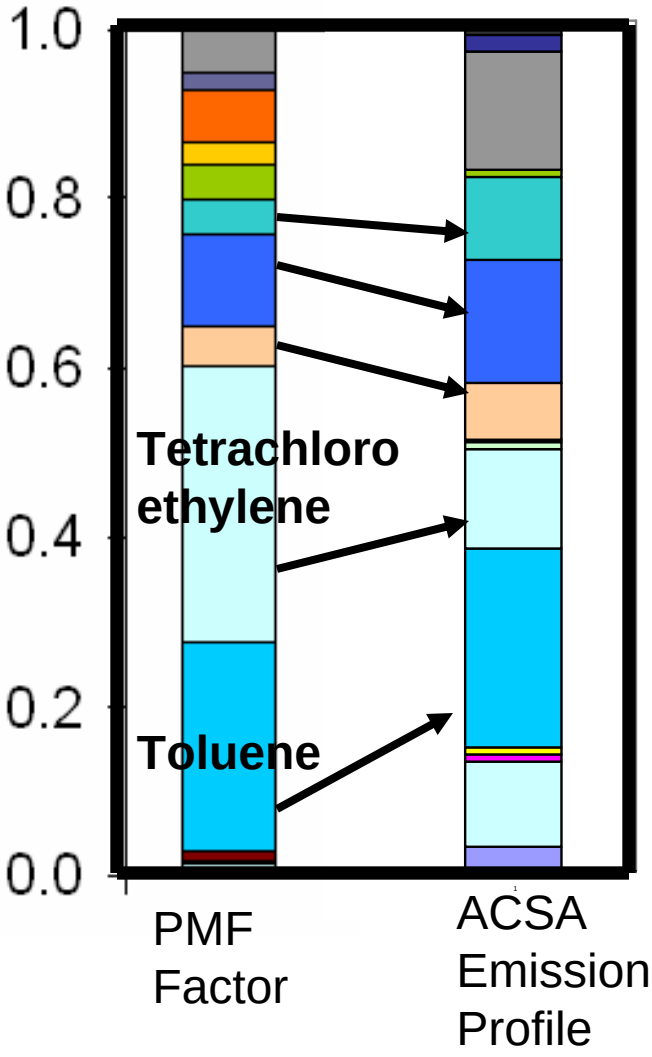
- Main issue: Associating sources and factors
  - Event profiles
  - Source profiles

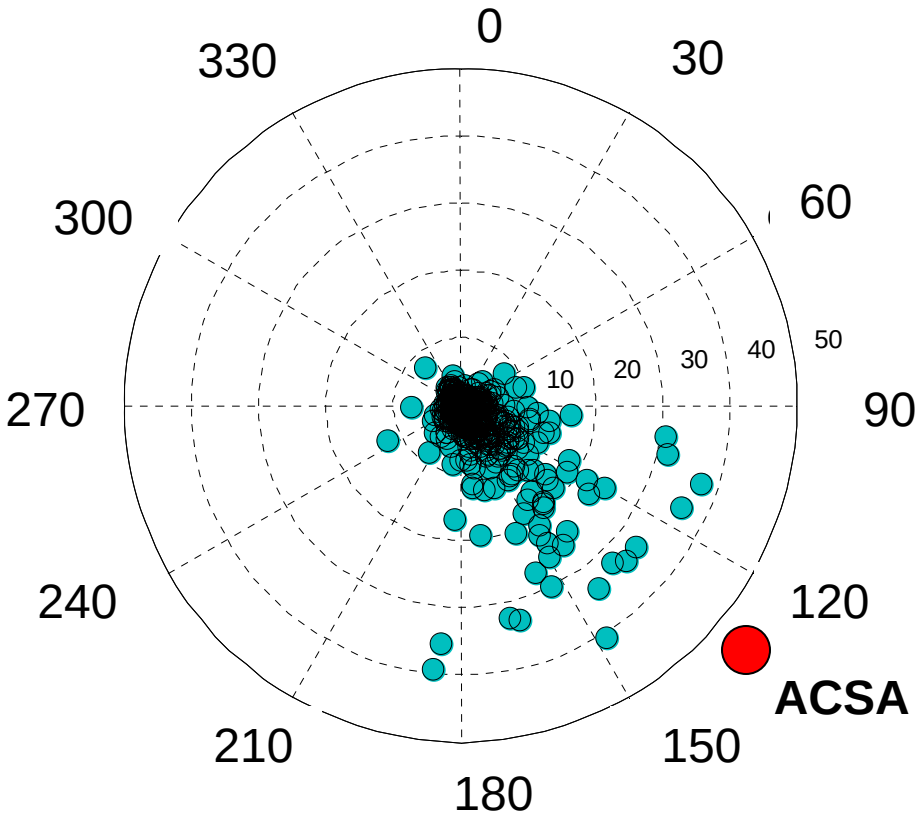
Mobile Gasoline Factor





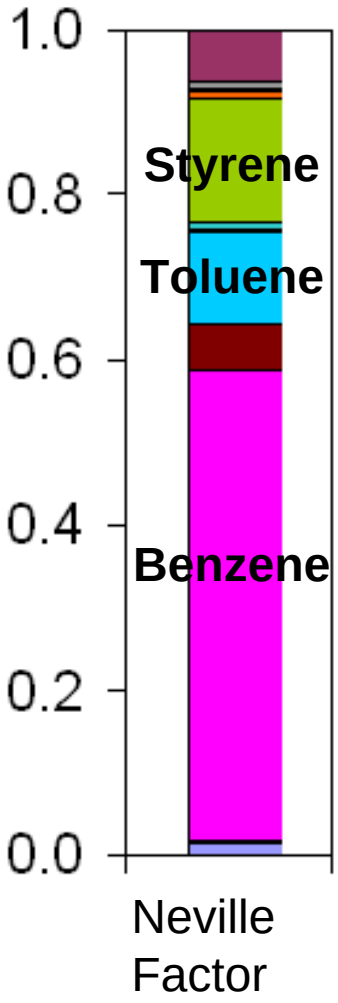
Water Treatment Factor

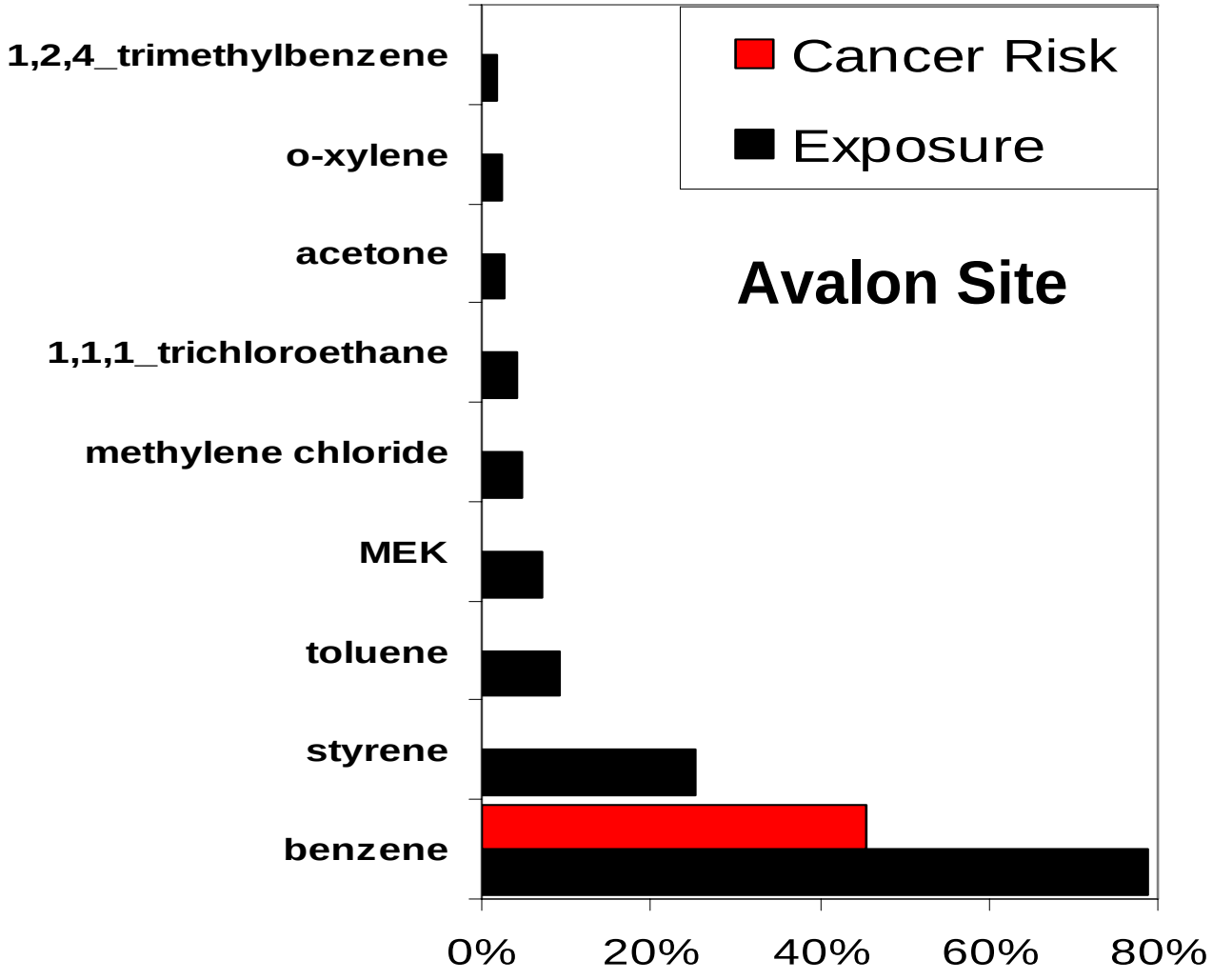




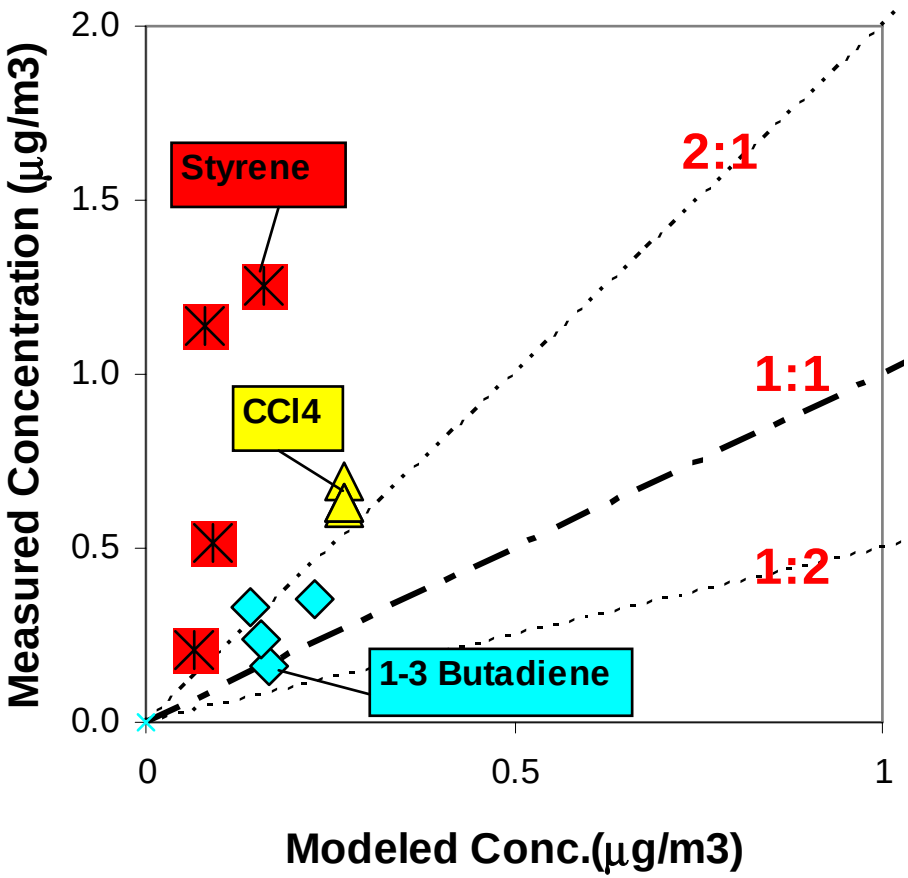
Factor Contribution vs. Wind Direction

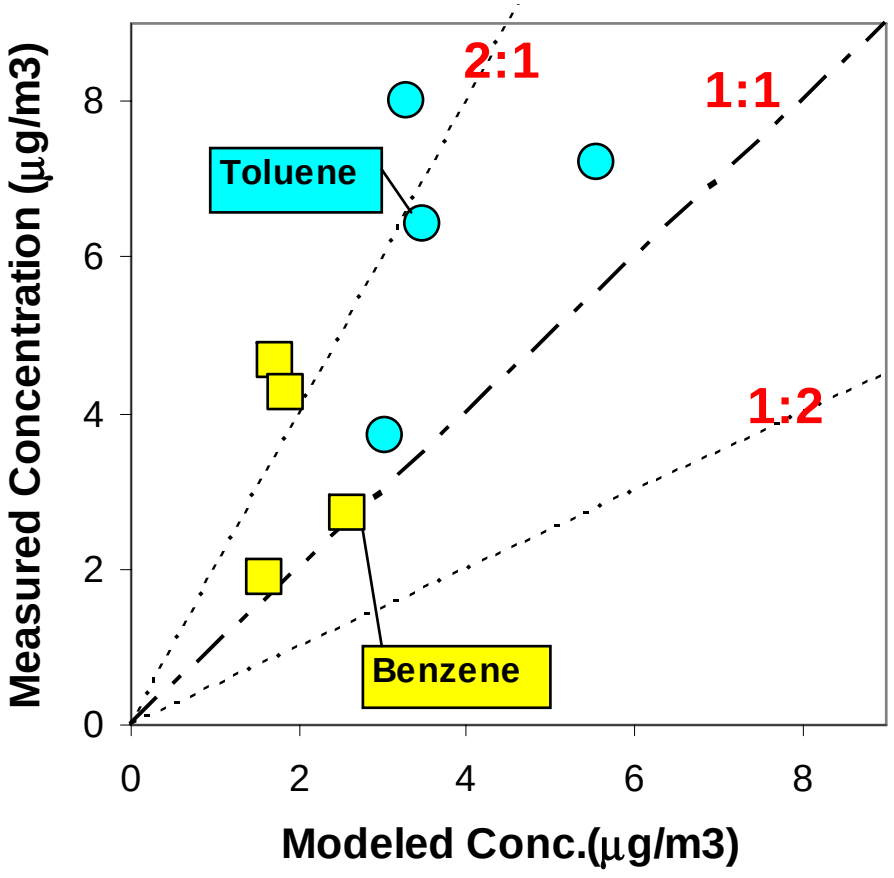
Linking Risk to Sources



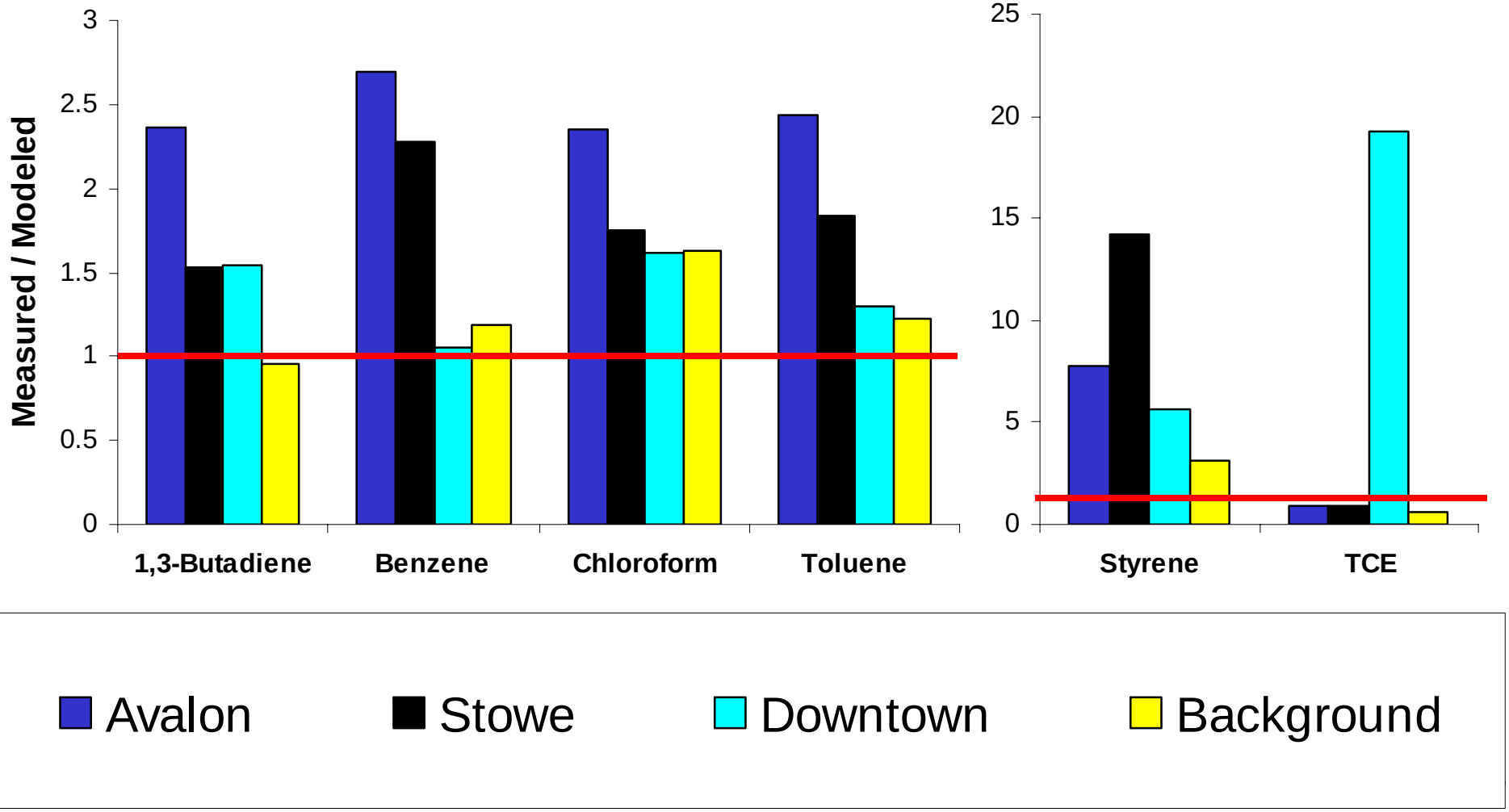


NATA Evaluation by Pollutant

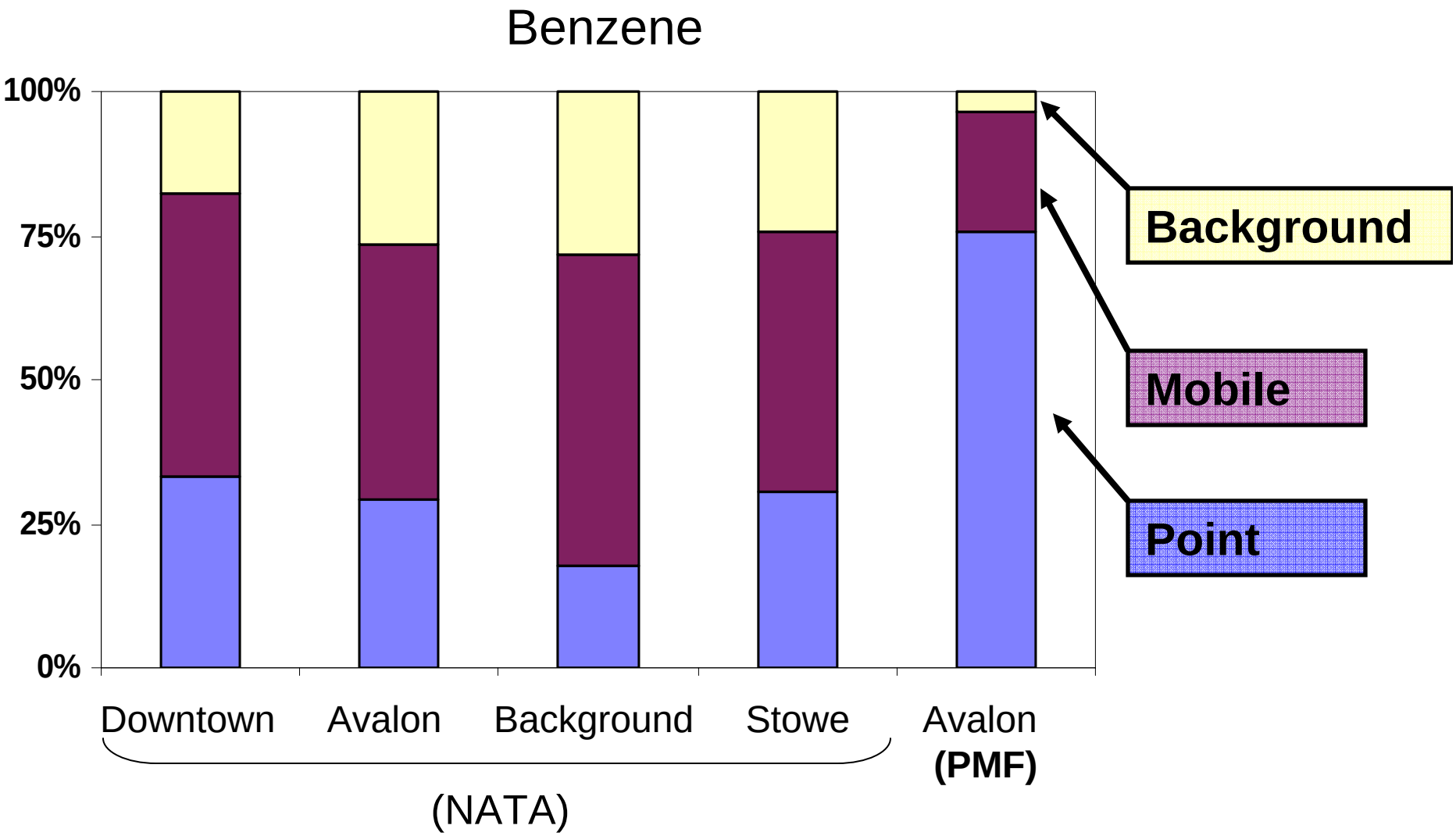




NATA Evaluation by Site



NATA Evaluation: Source Apportionment



Application of Results

- Quantifying risk
- Source Apportionment
- Policy and funding decisions
- NATA evaluation

Lessons Learned

- Meeting all of our goals.
- Design of the project was sufficient to meet goals and additional scientifically interesting work is being done using the results.
- In retrospect

Future Work

- Intensives
  - Downtown
  - South Fayette
- Expand and improve PMF analysis
- Synergistic risk models
- NATA evaluation

Acknowledgments

- Funding
  - Clean Air Fund
  - EPA

Questions