Using PAMS Data to Assess Potential Control Strategies to Reduce Ozone

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Presented at the
National Ambient Air Monitoring Conference
Denver, Colorado
May 14-17, 2012

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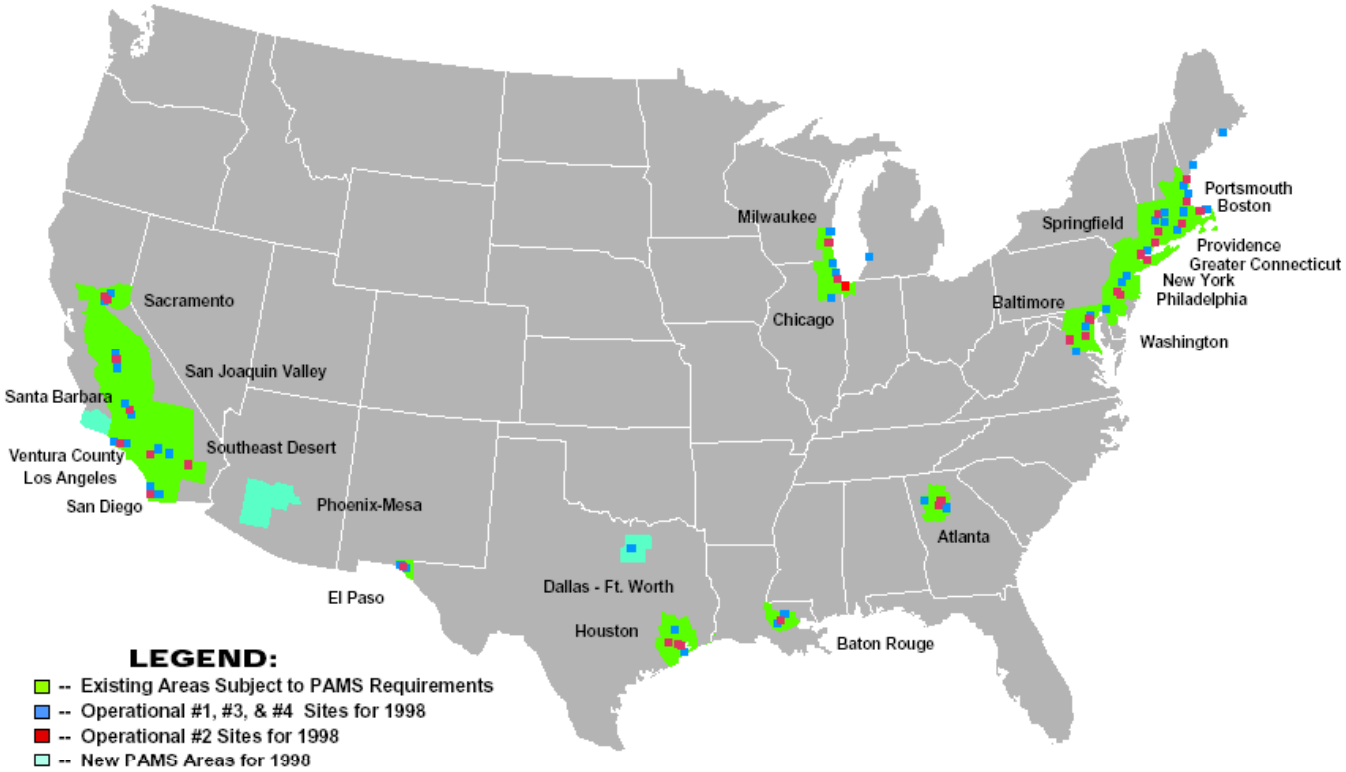
Air Quality Research and Innovative Solutions

Outline

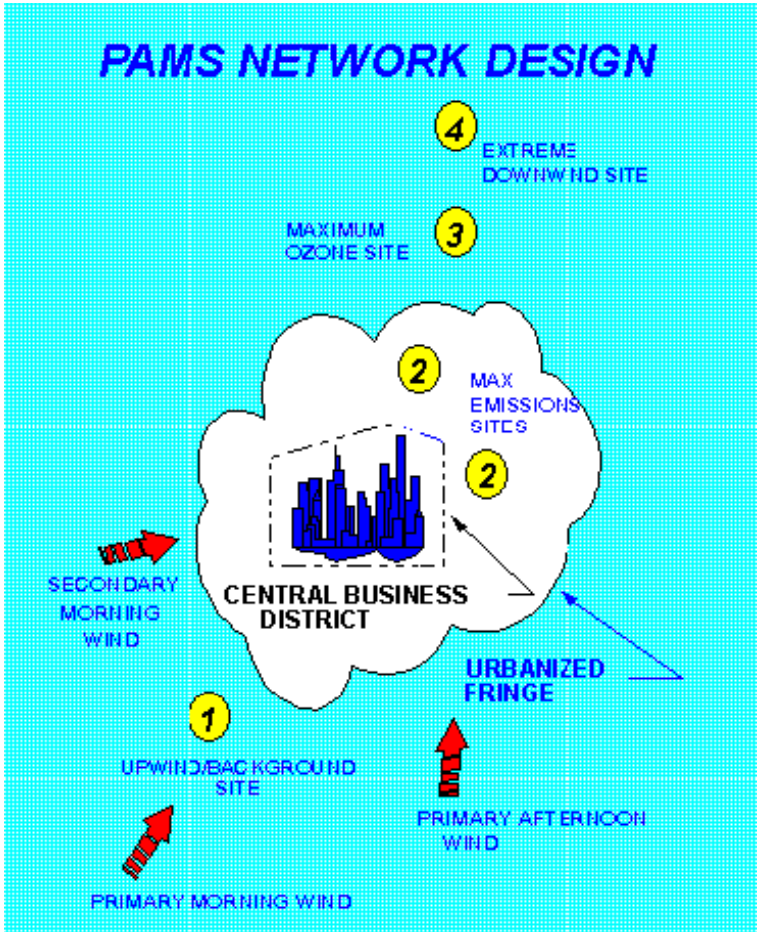
- Background
- What ozone precursors need to be reduced?
  - NO_x vs. volatile organic compound (VOC) limitations
  - Weekday/weekend concentration differences
- What VOC sources are most important?
  - Source apportionment
  - Emissions inventory (EI) evaluation
- What have been the effects of control programs on ambient concentrations?
  - Reformulated gasoline (RFG) implementation and fuel volatilization reduction effects
  - Fleet turnover effects

What Is PAMS?



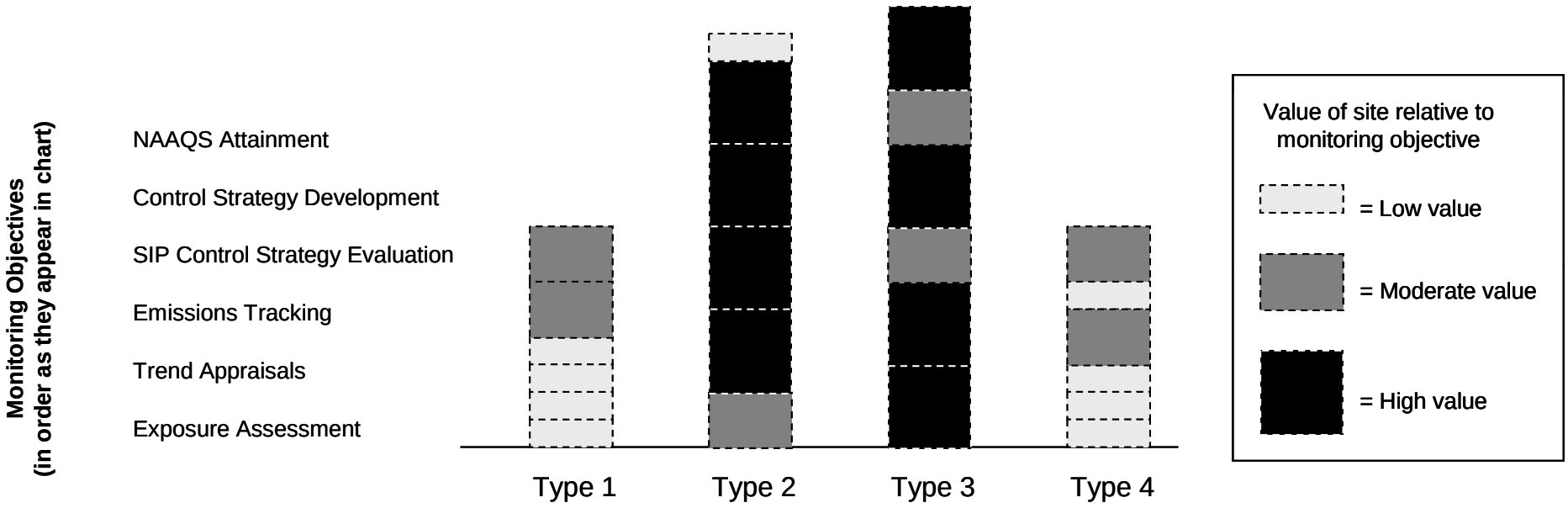
- EPA required more extensive monitoring of ozone and its precursors in areas with persistently high ozone levels.
- States established ambient air monitoring sites called Photochemical Assessment Monitoring Stations (PAMS) to collect and report VOCs, NO_x, ozone, and meteorological parameters.
- These data help analysts to better understand the underlying causes of ozone, to devise effective remedies, and to measure improvement.

PAMS Site Types and Objectives



- Build VOC database for evaluation of control strategies and modeling efforts
- Provide data for model and EI evaluation
- Track trends

PAMS Site Types and Analyses

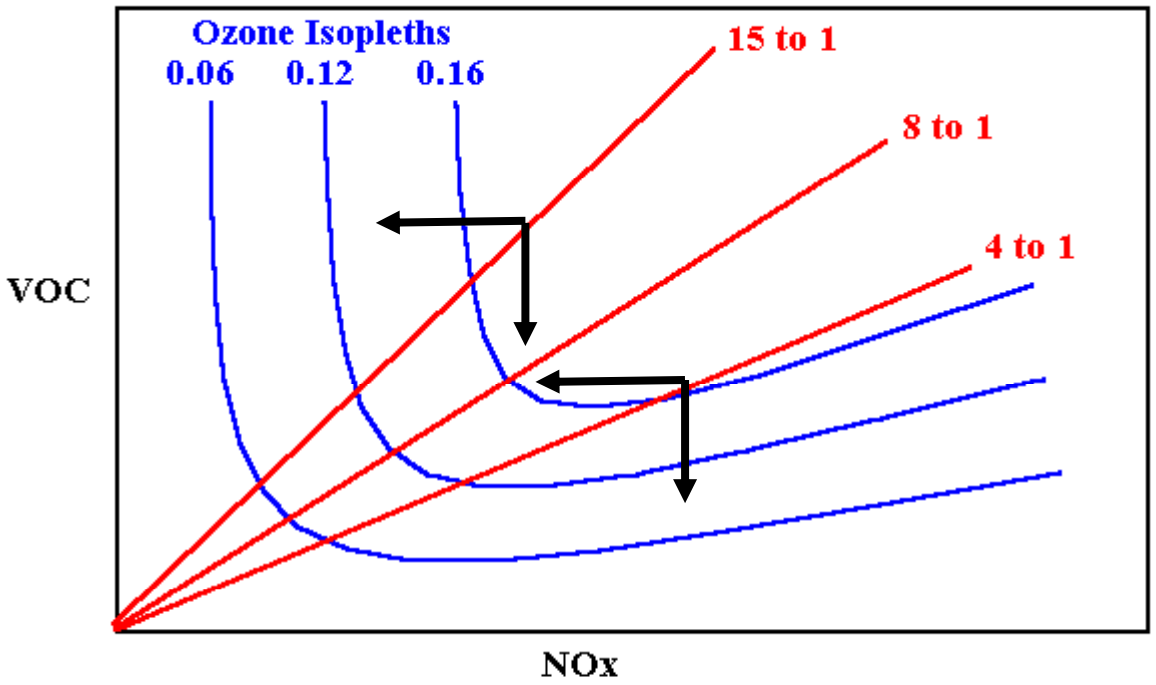


Site Types 2 (Maximum emissions) and 3 (Maximum ozone) provide the most value in terms of the number and value of monitoring objectives they cover.

NAAQS = National Ambient Air Quality Standards
SIP = State Implementation Plan

What Ozone Precursors Should Be Reduced?

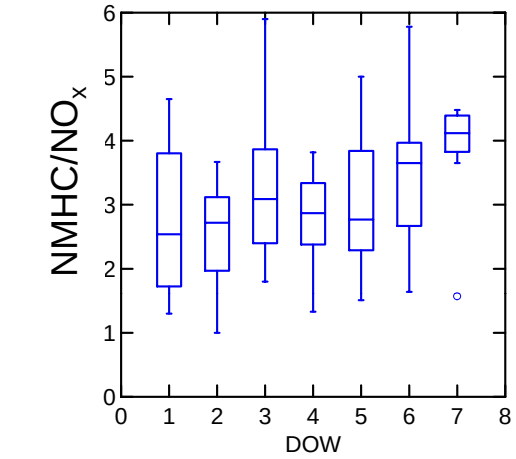
Emission control strategies are based on assessments of whether an area is "VOC-limited" or "NO_x-limited."

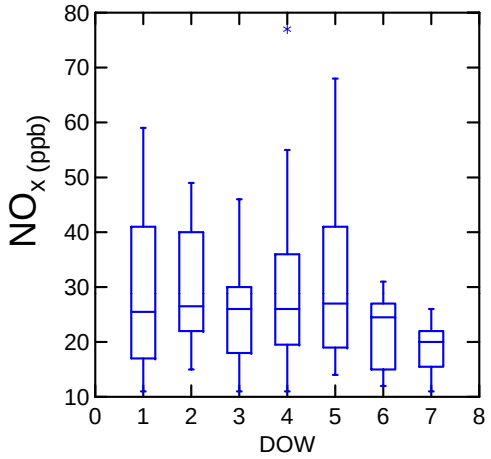


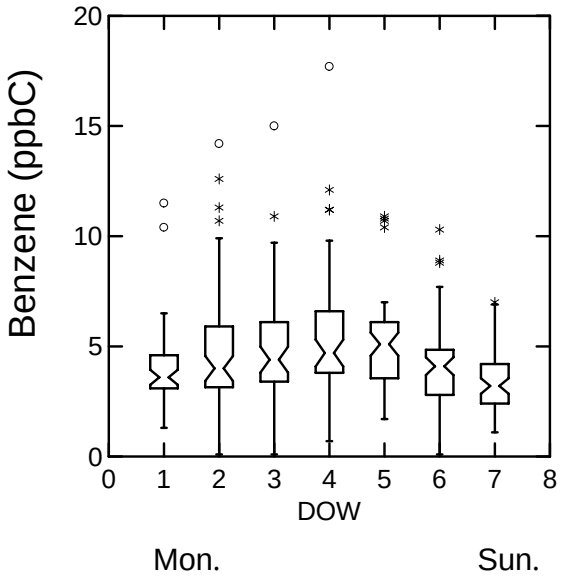
At high VOC/NO_x ratios, ozone formation is limited by the availability of NO_x – reducing NO_x reduces ozone.

At low ratios, ozone formation is limited by the availability of VOCs.

Daily Data Are Best for Investigating Day-of-Week Variations



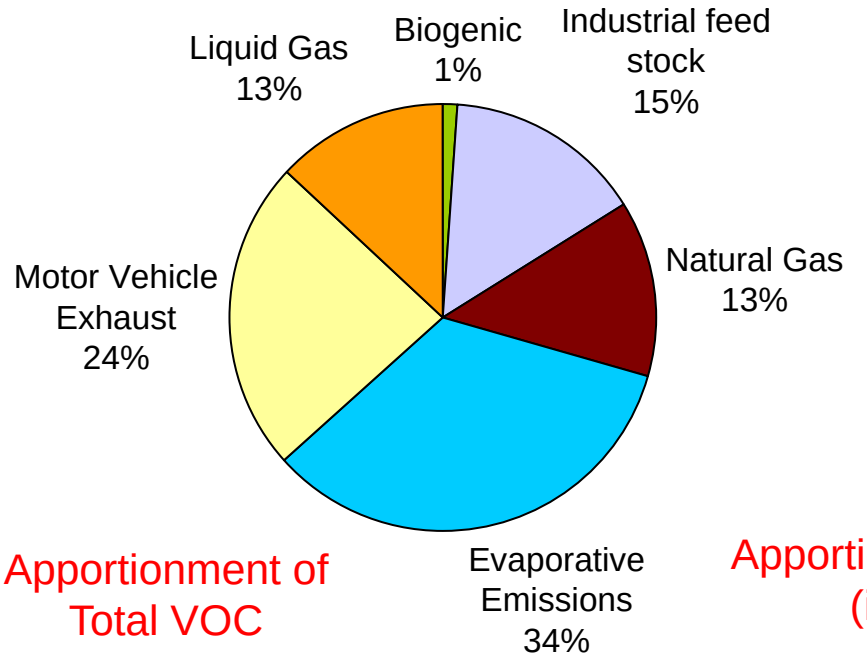




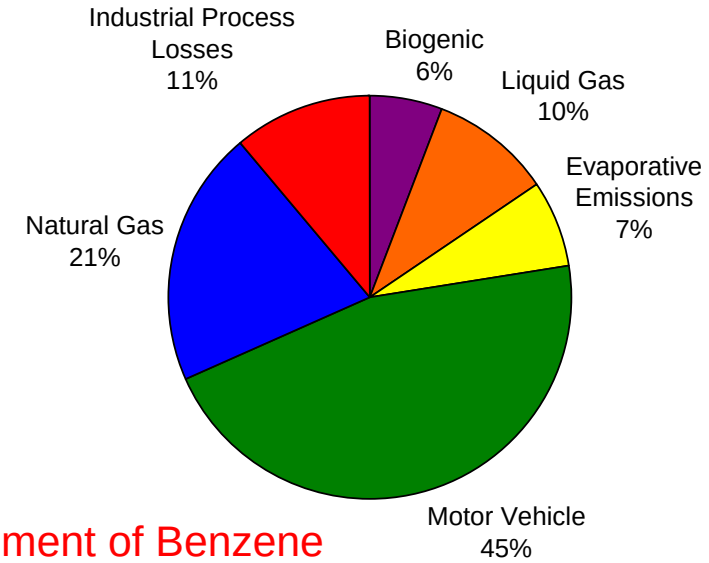
Morning nonmethane hydrocarbon (NMHC)/NO_x ratios, NO_x concentrations (ppb), and benzene concentrations (ppbC) at an urban site by day of week. Monday = 1, Sunday = 7.

Source Apportionment

What source types may be contributing to ambient VOC concentrations?

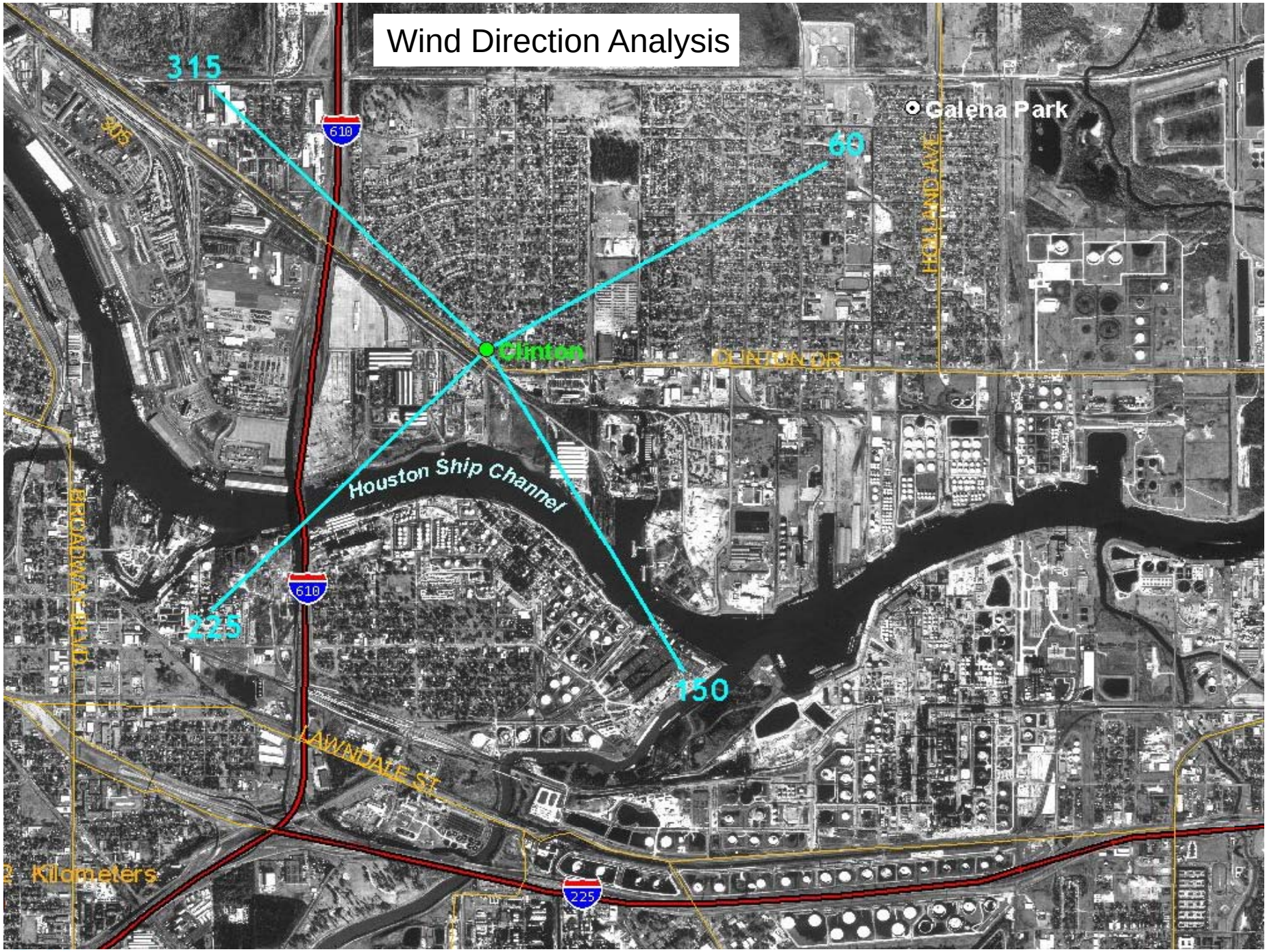


Apportionment of Total VOC

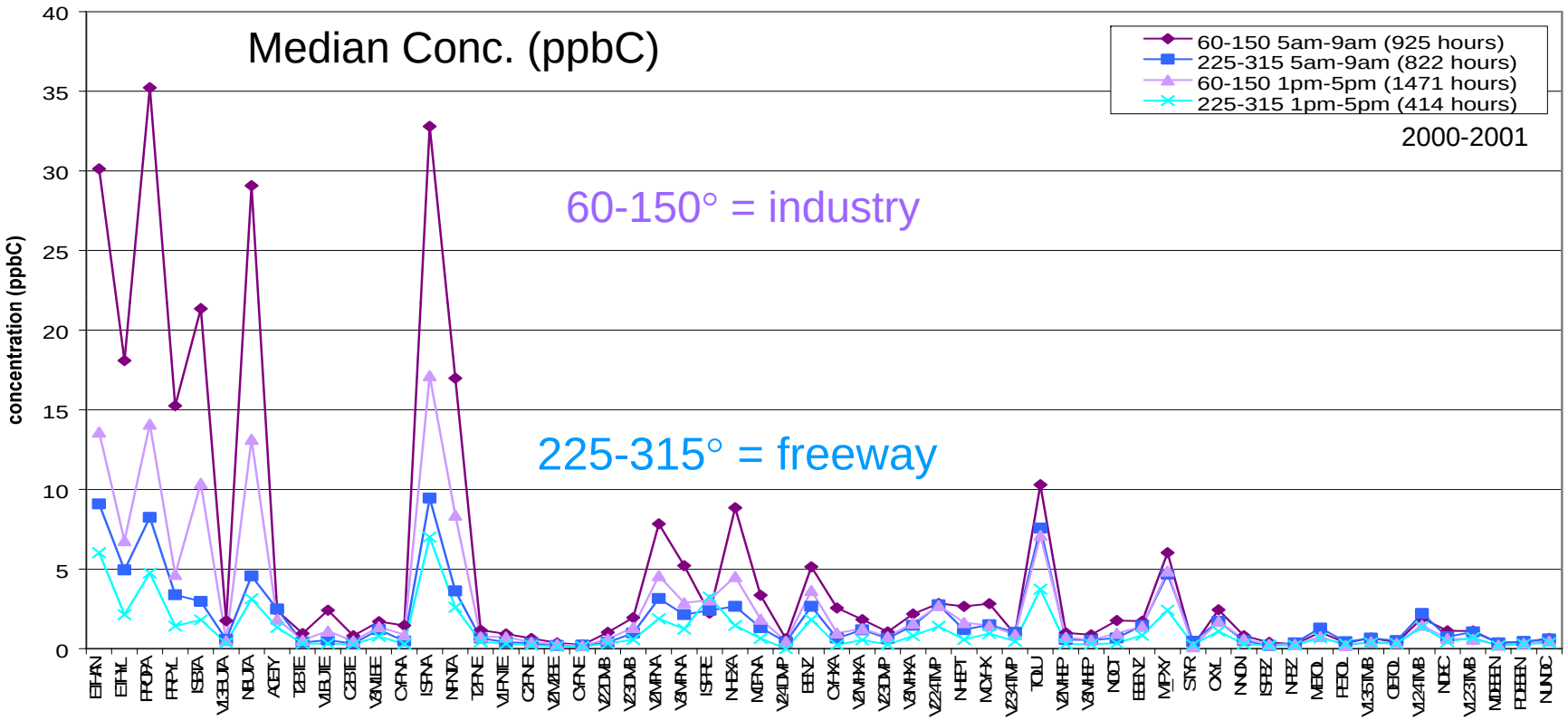


Apportionment of Benzene (in Total VOC)

Azusa (Los Angeles Basin), 2001-2003


Wind Direction Analysis
315
69
225
150
Clinton
Galena Park
Houston Ship Channel
610
610
225
HOLLAND AVE
CENTRAL DR
BROADWAY BLVD
LAWNDALE ST
Kilometers

Composition by Wind Sector

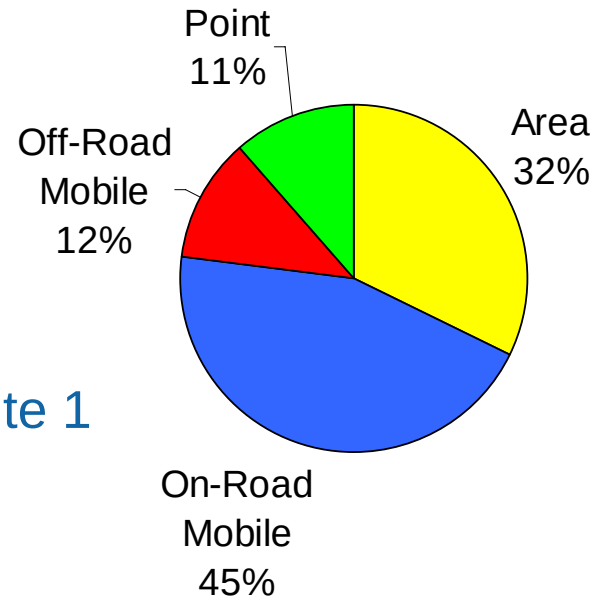


With winds from the Houston Ship Channel, concentrations are much higher and reactive species are a higher wt.% than with winds from the freeway.

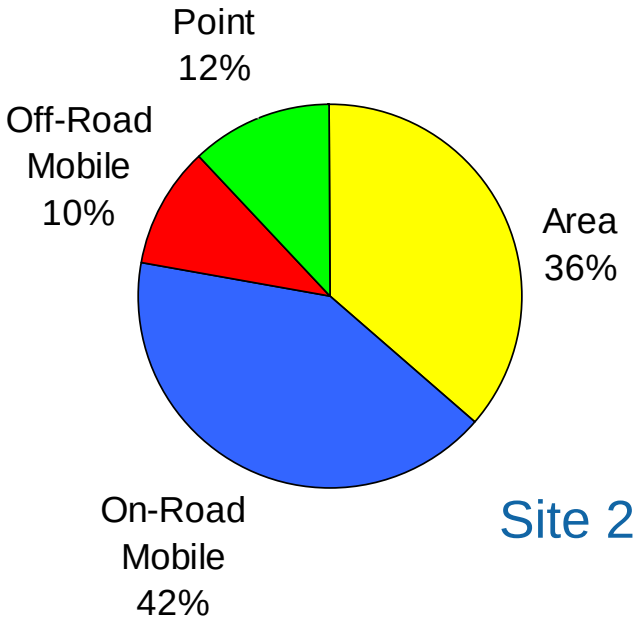
Comparison to Emissions Inventory

Mobile sources at two Los Angeles area sites may be underestimated in the emissions inventory:

- Site 1 = 57% EI, 74% PMF
- Site 2 = 52% EI, 77% PMF



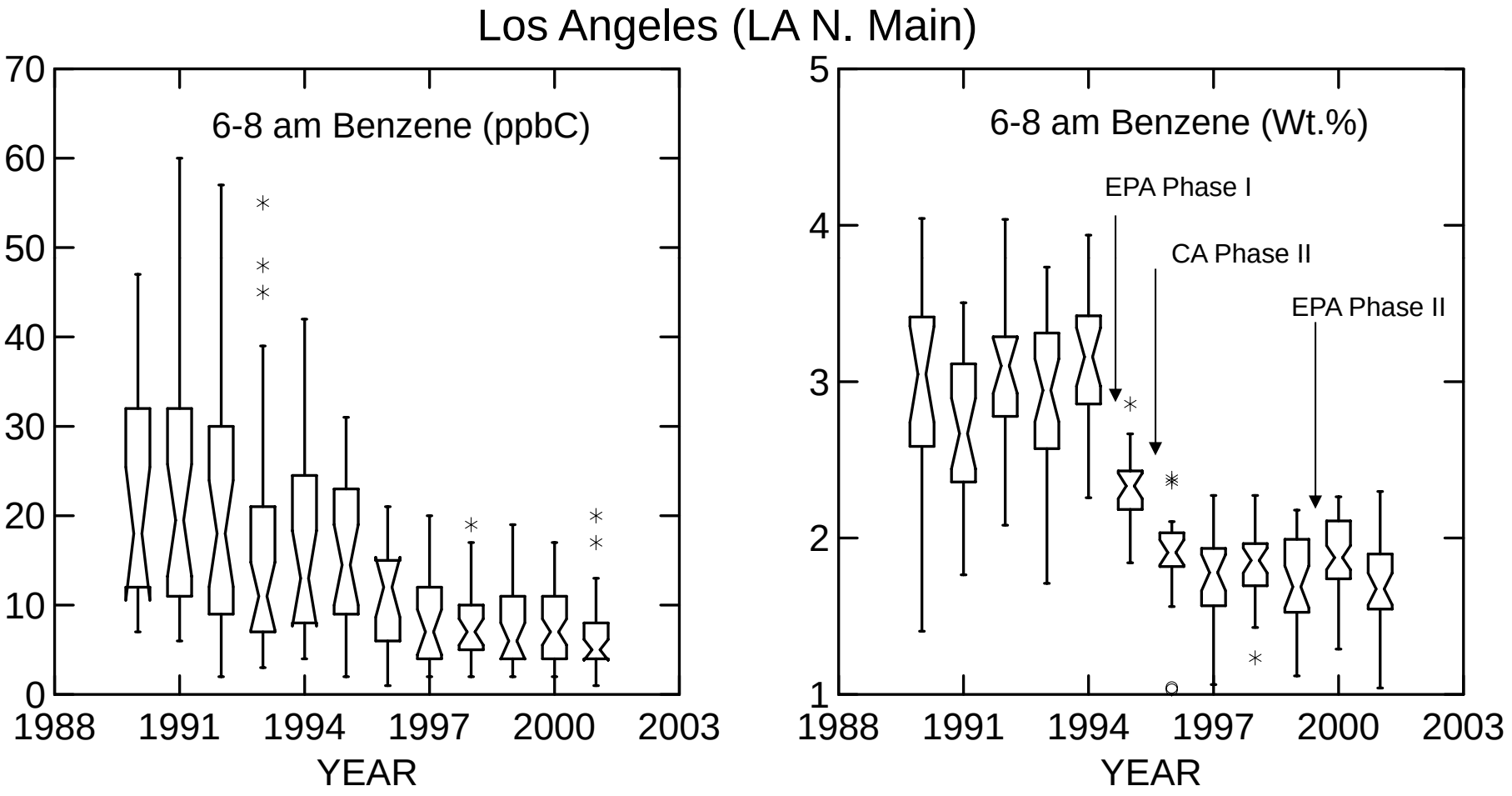
Site 1



Site 2

Results (2000–2001) are consistent with a ratio analysis suggesting that emissions inventory acetylene, toluene, and xylenes are underestimated.

Assessing Changes in Fuel Composition

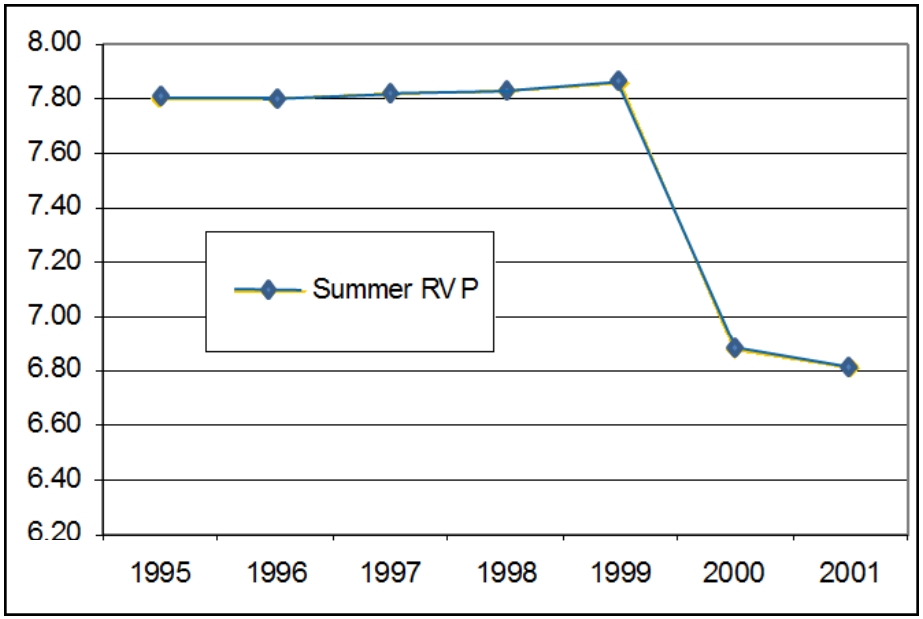


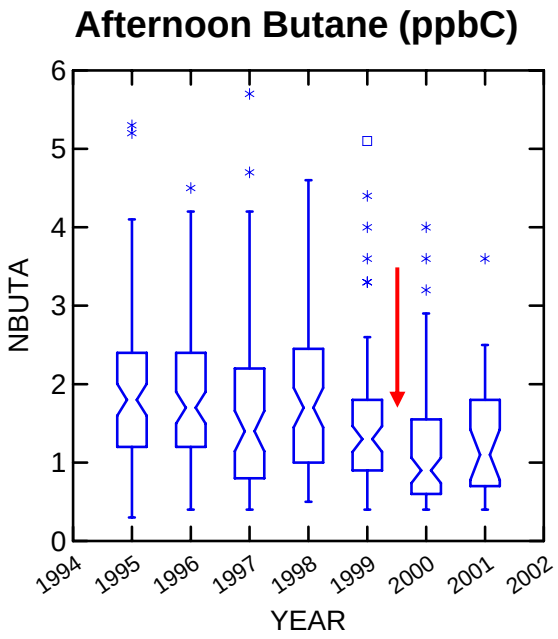
RFG resulted in ambient benzene reductions.

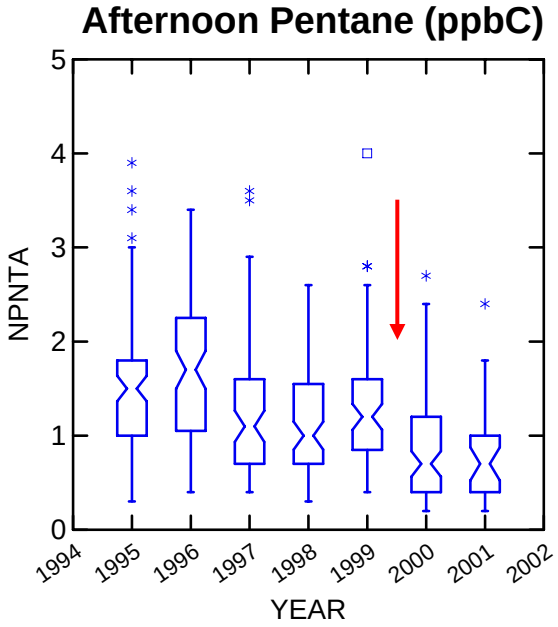
Fuel Volatilization Changes

Reid Vapor Pressure changes:

Afternoon butane and pentane concentrations (ppbC) show a decline.



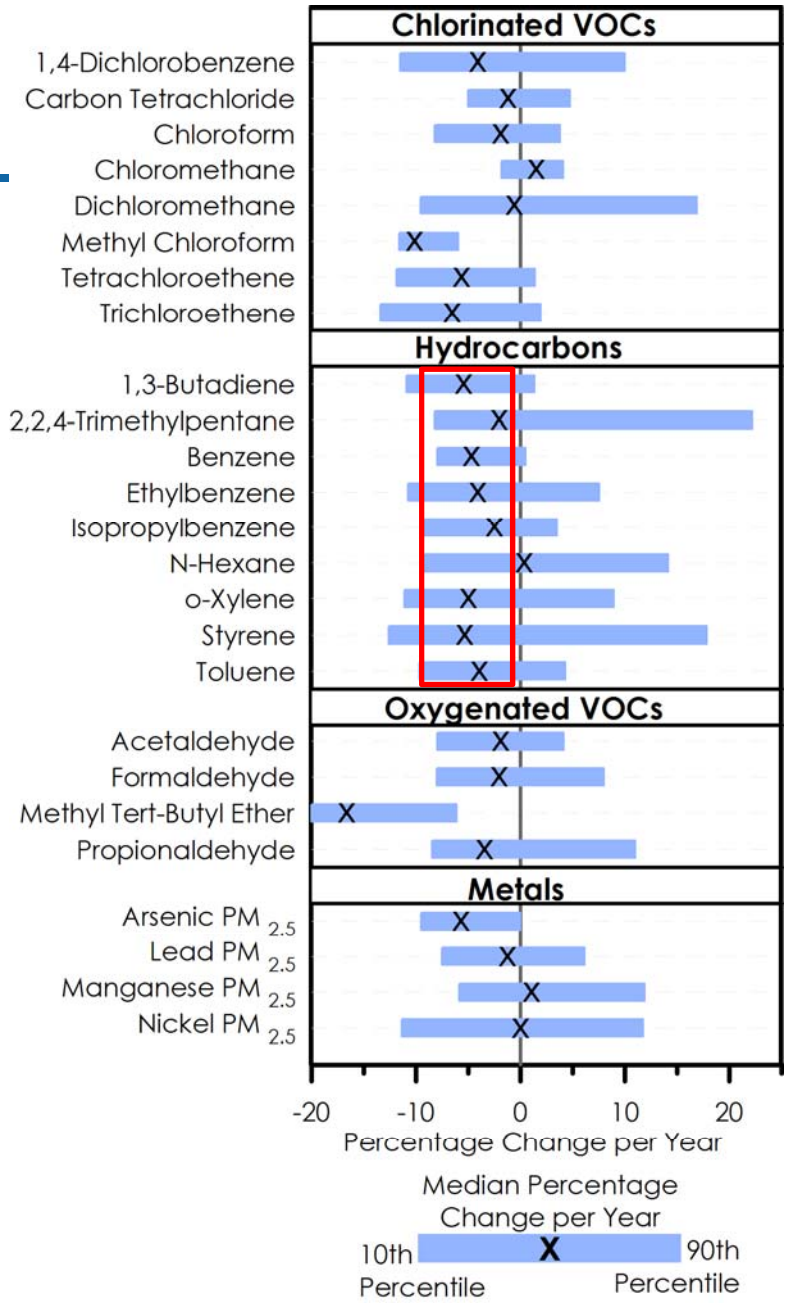




Fleet Turnover Effects

Ambient VOC trends match VOC reductions from fleet turnover effects:

- Harley et al. (2006) showed that a 4% per year decline in benzene, for example, was attributable to fleet turnover.
- Ambient VOC data from PAMS and air toxics sites across the US show about a 5% per year decline (2003–2008).



Summary

PAMS data are useful to support SIP development

- Identify whether NO_x or VOC (or both) should be controlled
- Identify sources to control (source apportionment)
- Evaluate/improve emissions inventory and models
- Investigate effectiveness of control programs
- Track trends in ozone, and in ozone precursors

Resources

- PAMS data analysis workbook:
  - http://www.epa.gov/airquality/pams/analysis/index.html
  - PDFs to be posted on AMTIC
- Past work: http://www.epa.gov/oar/oaqps/pams/
- More recent work on air toxics: http://www.epa.gov/ttn/amtic/airtoxpg.html