# Source Apportionment of Fine Particulate Matter


**Eric M. Fujita and Barbara Zielinska**

Division of Atmospheric Sciences
Desert Research Institute
Nevada System of Higher Education
Reno, Nevada



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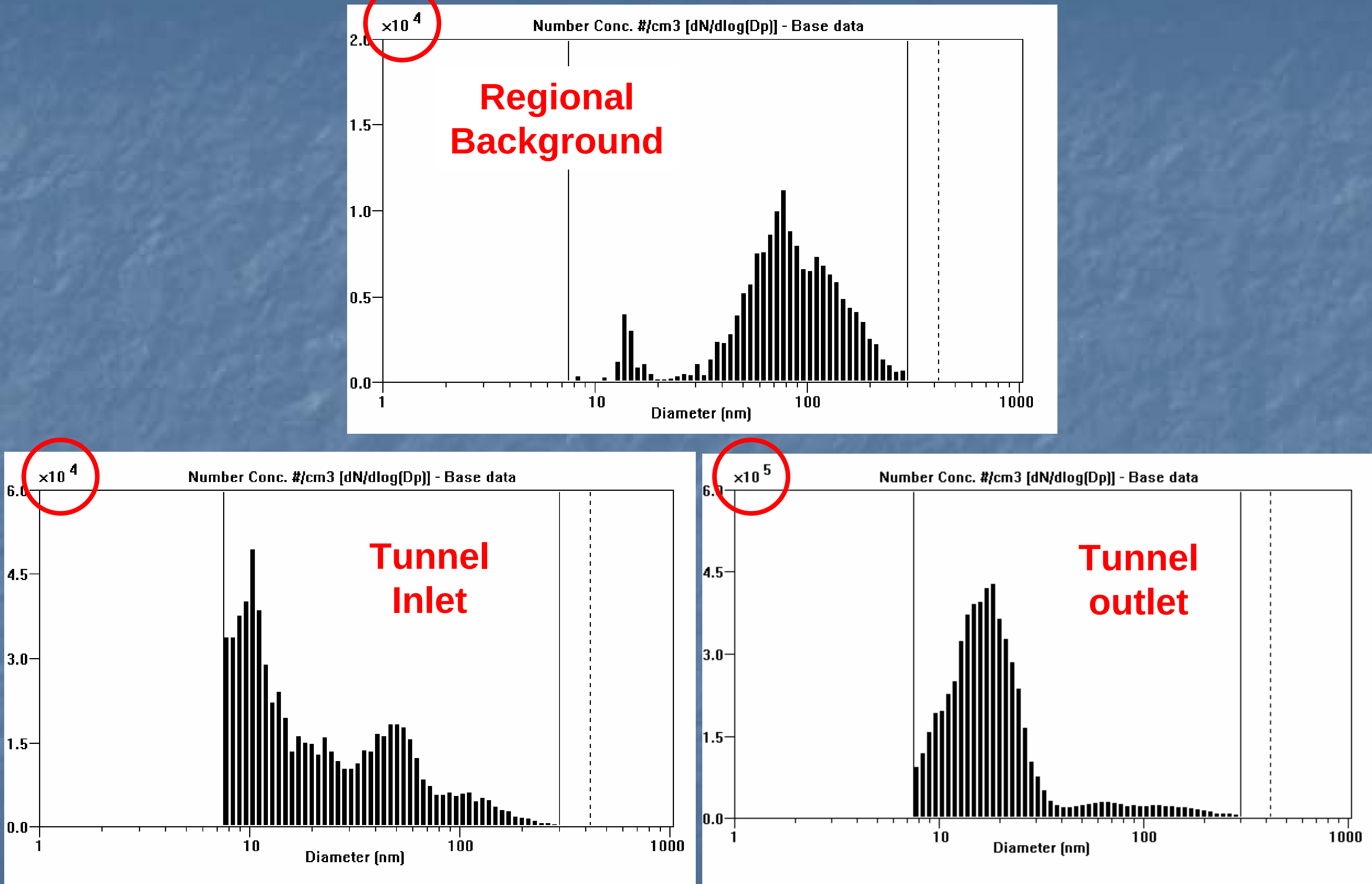
# Overview

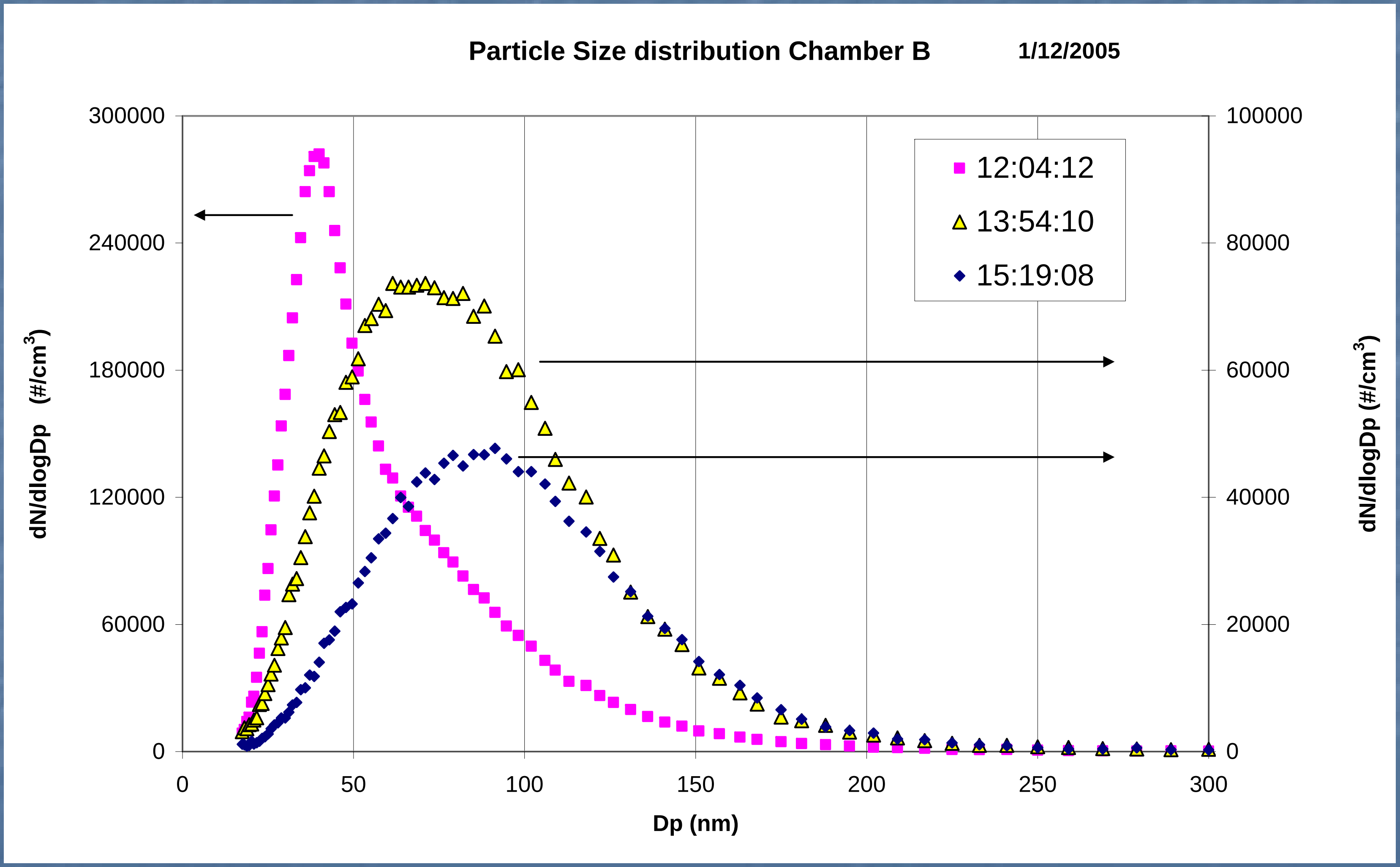
- Ambient PM source apportionment studies have focused on $PM_{2.5}$ in the context of NAAQS attainment.
  - Ultrafine particles are associated with combustion sources.
  - Chemical composition of varies with particle size and operating conditions.
  - Size distribution changes rapidly.
- Variations in on-road and near-road black carbon and $PM_{2.5}$ concentrations.
- Contributions of diesel and gasoline exhaust to ambient carbonaceous particles in high traffic areas.

# Particle Number Concentration Distribution at the Tuscarora Tunnel, 5/21/99



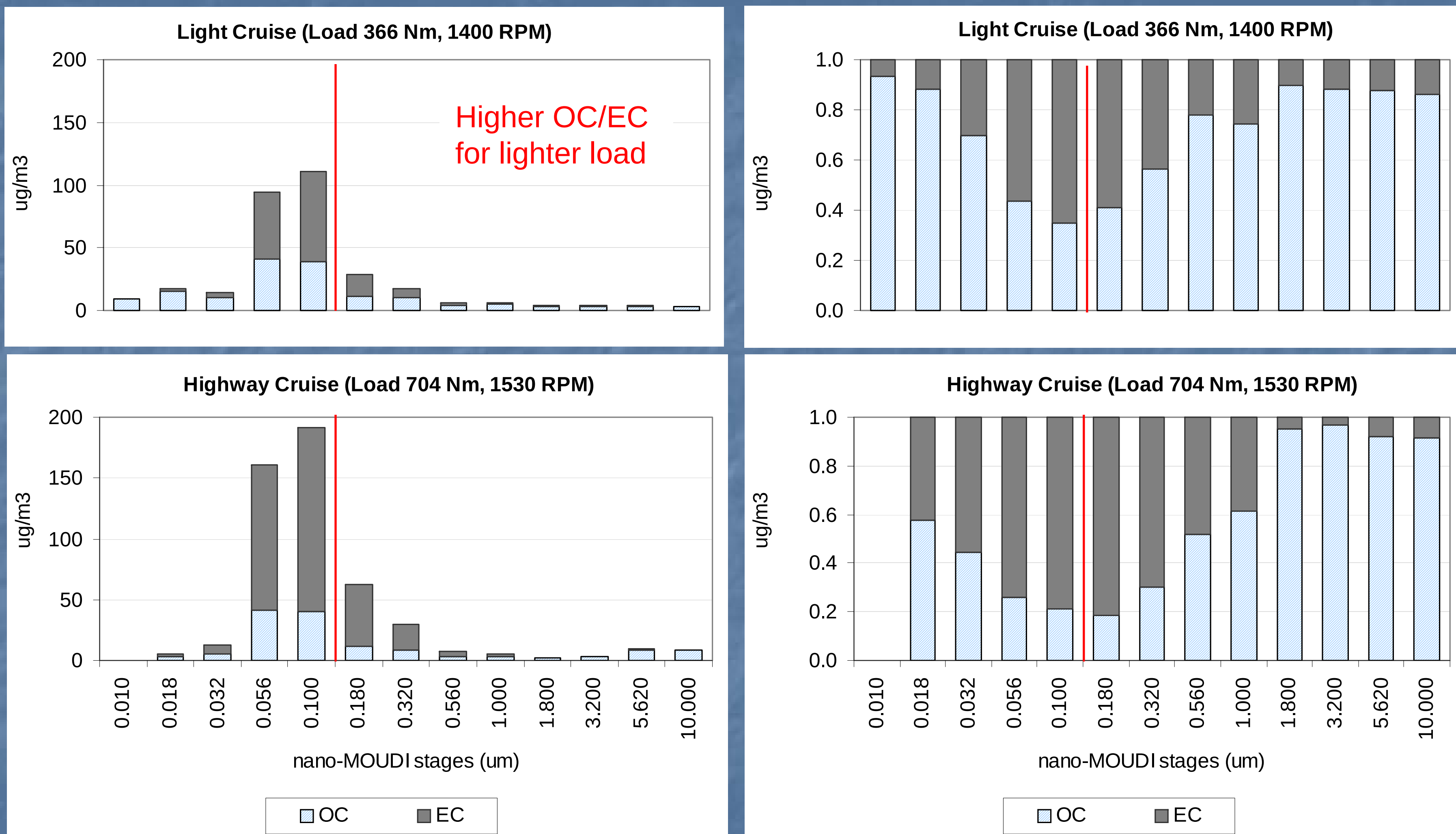

* Source: HEI Project 98-3 courtesy of Dr. Fred Rogers, Desert Research Institute.

# Time Evolution of Diesel Exhaust Particle Size Distributions by Number in the EUPHOR Chamber in the Dark



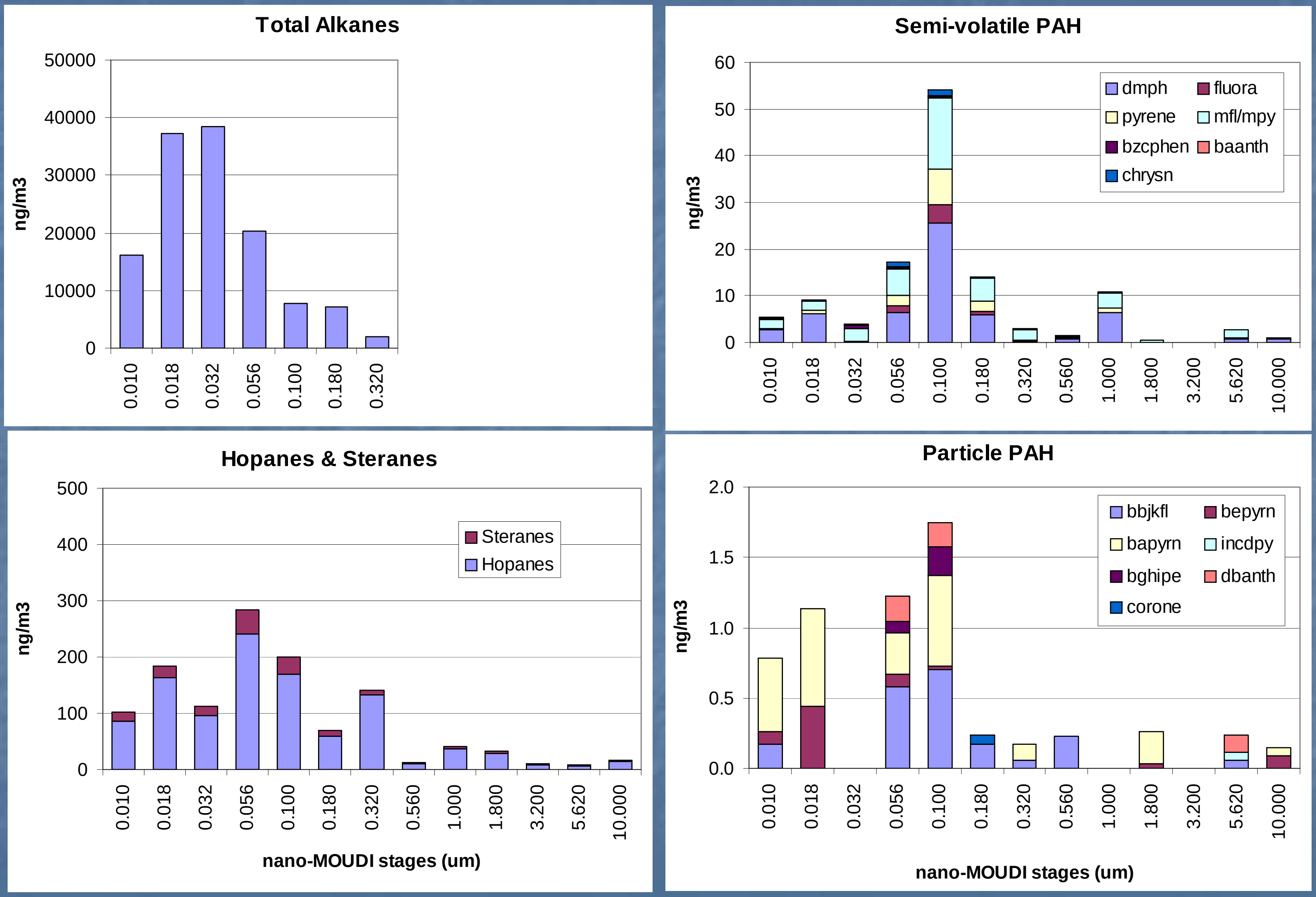

Source: Zielinska et al. 2006, HEI

# Concentration Distributions on nano-MOUDI Stages of OC and EC in Diesel Exhaust



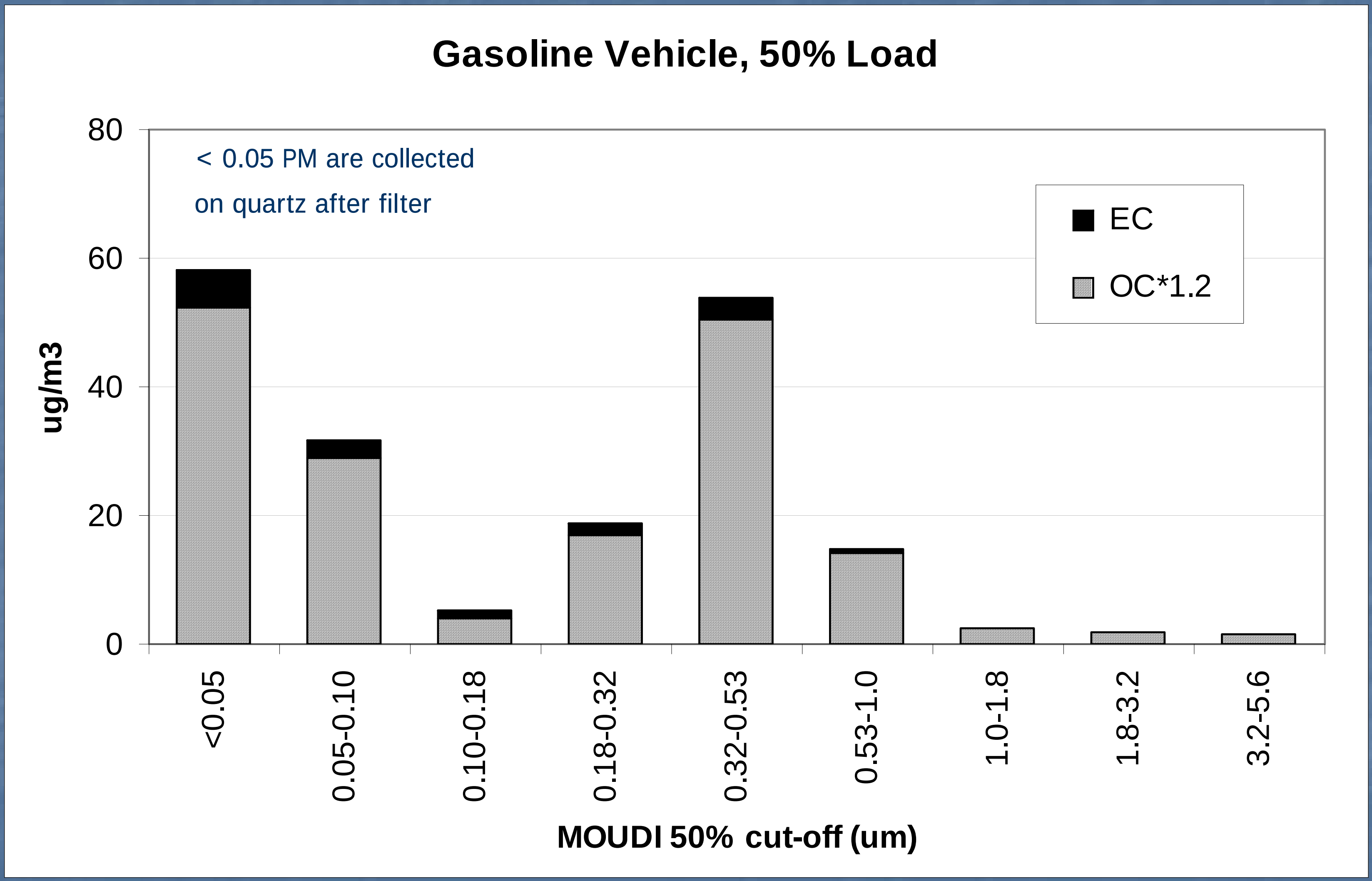

Source: Zielinska et al. 2003,
Project Report for CRC-E43.

# Concentration Distributions on nano-MOUDI Stages of Organic Compounds in Diesel Exhaust (Light Cruise)




Source: Zielinska et al. 2003, Project Report for CRC-E43.

# Size Distribution of OC and EC in Exhaust of Ford F-350 Light-Duty Gasoline Truck

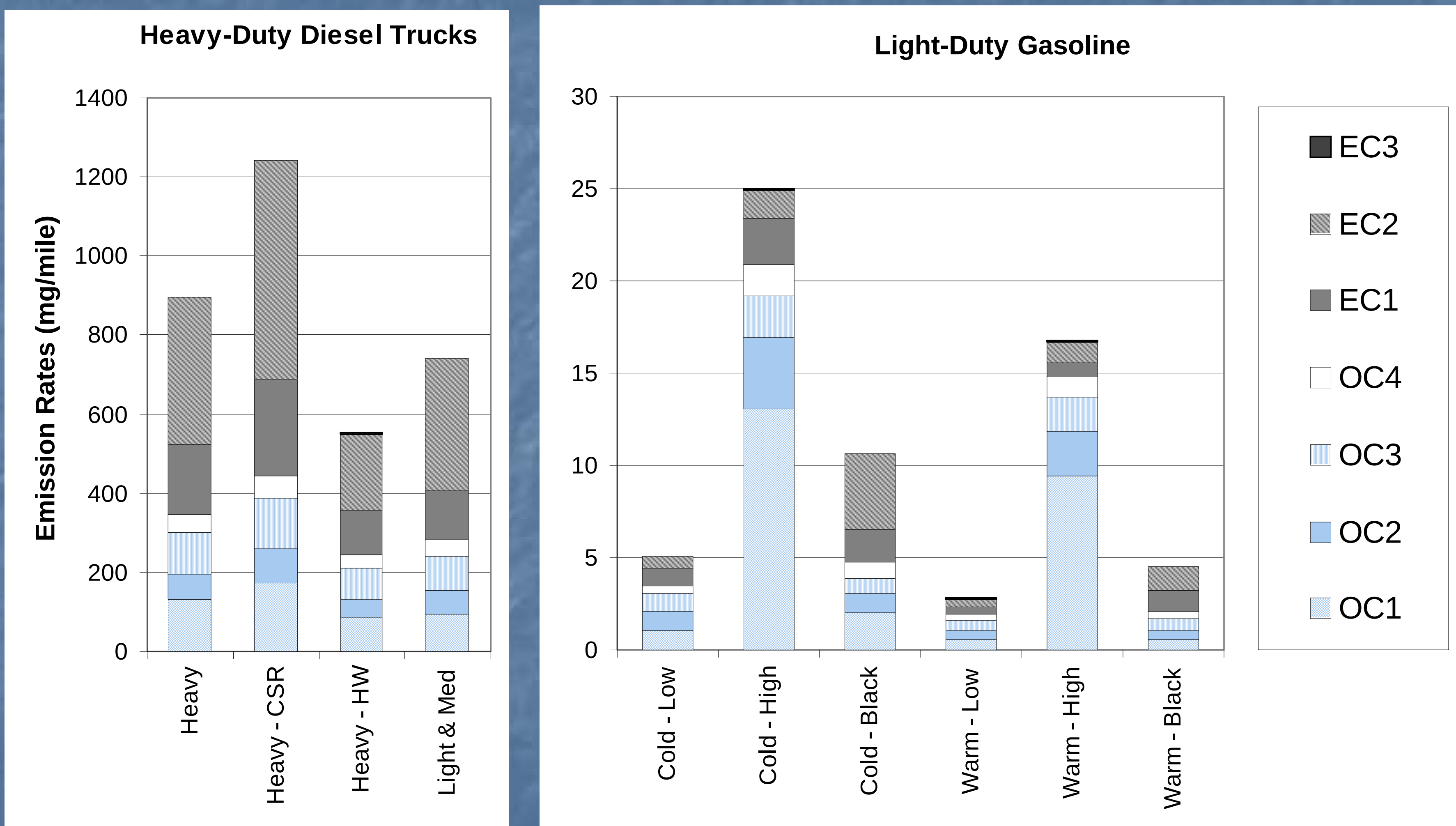



Source: SERDP Project (Zielinska et al., 2004)

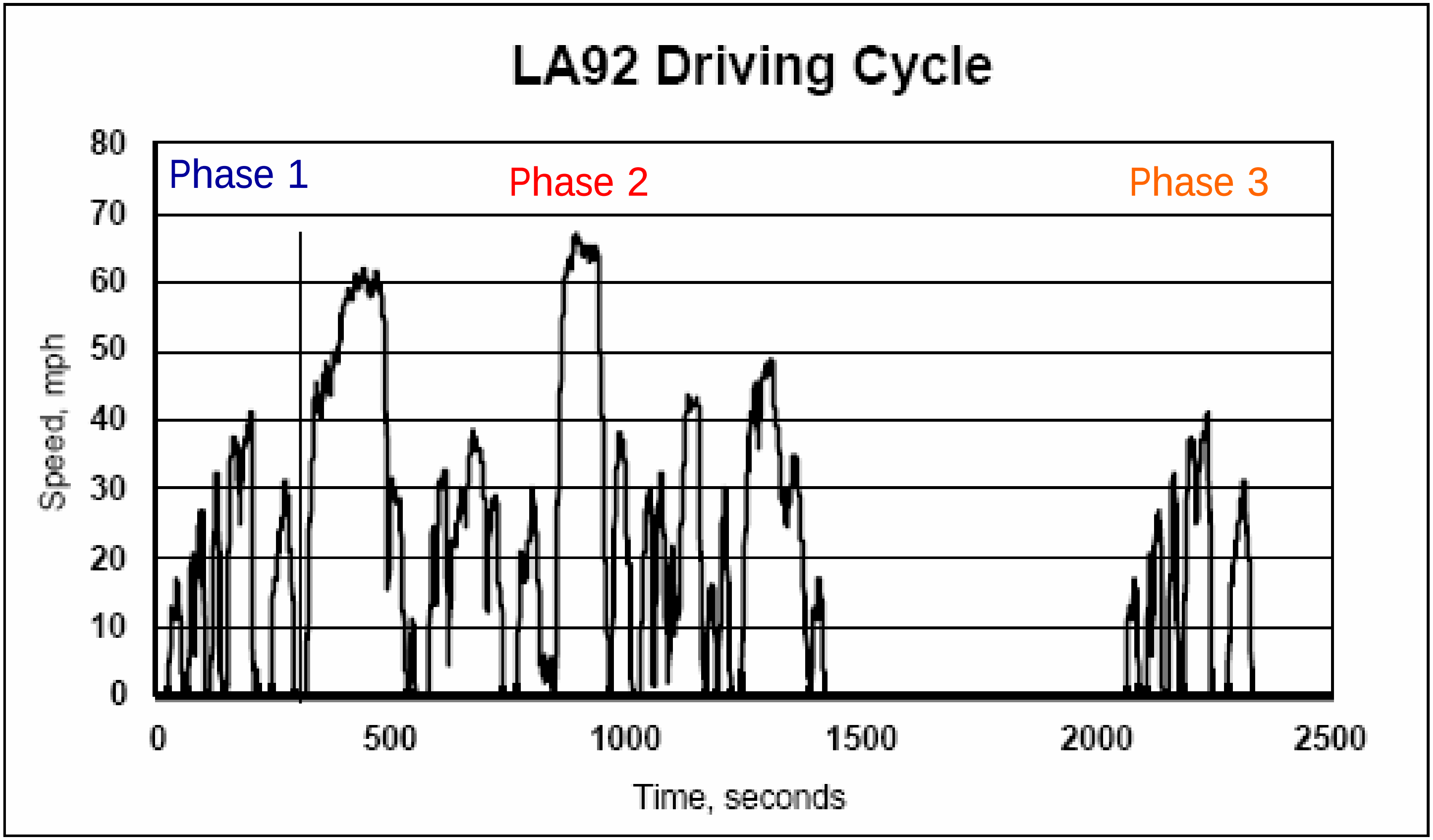
# Vehicle PM Emissions Characterization Apportionment and Exposure Studies

- Gasoline Diesel PM Split Study
  - Sponsor: U.S. Dept of Energy/National Renewable Energy Laboratory
  - Other collaborators: Clean Air Vehicle Technology Center, University of West Virginia, University of Wisconsin Madison
- Assessing Exposure to Air Toxics in Microenvironments Dominated by Mobile Sources
  - Sponsor – Health Effects Institute
- Characterization of Exhaust Emissions from LDGVs in the Kansas City Metropolitan Area
  - Sponsors: U.S. Environmental Protection Agency, Coordinating Research Council, DOE/NREL, Federal Highway Administration
  - Other collaborators: Eastern Research Group, Bevilacqua Knight Inc., NuStats

# PM2.5 Carbon Fraction Profiles by IMPROVE-TOR

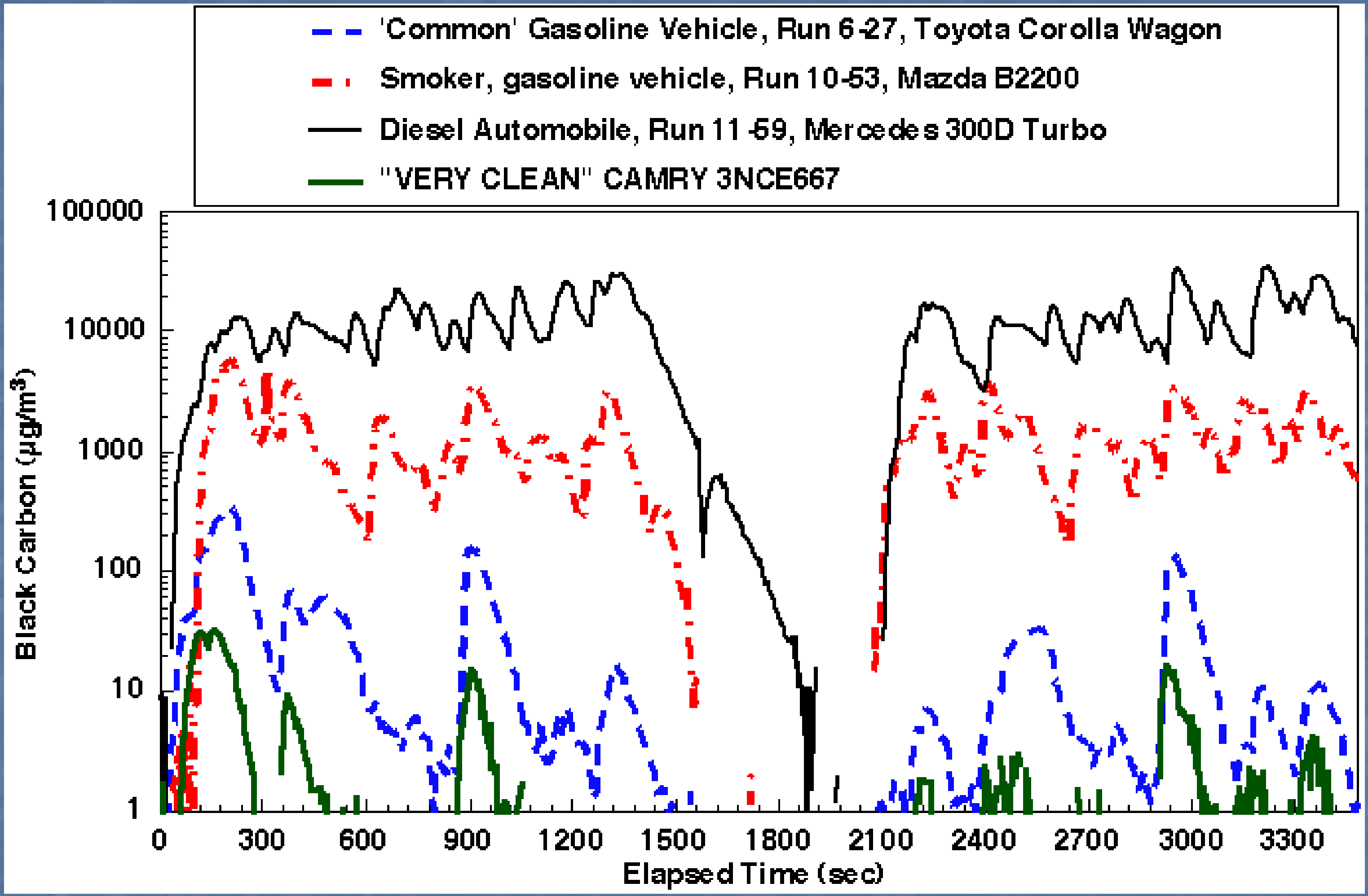



Gasoline/Diesel PM Split Study, Fujita et al., 2006



LA92 Driving Cycle
Phase 1
Phase 2
Phase 3
Speed, mph
80
70
60
50
40
30
20
10
0
0
500
1000
1500
2000
2500
Time, seconds

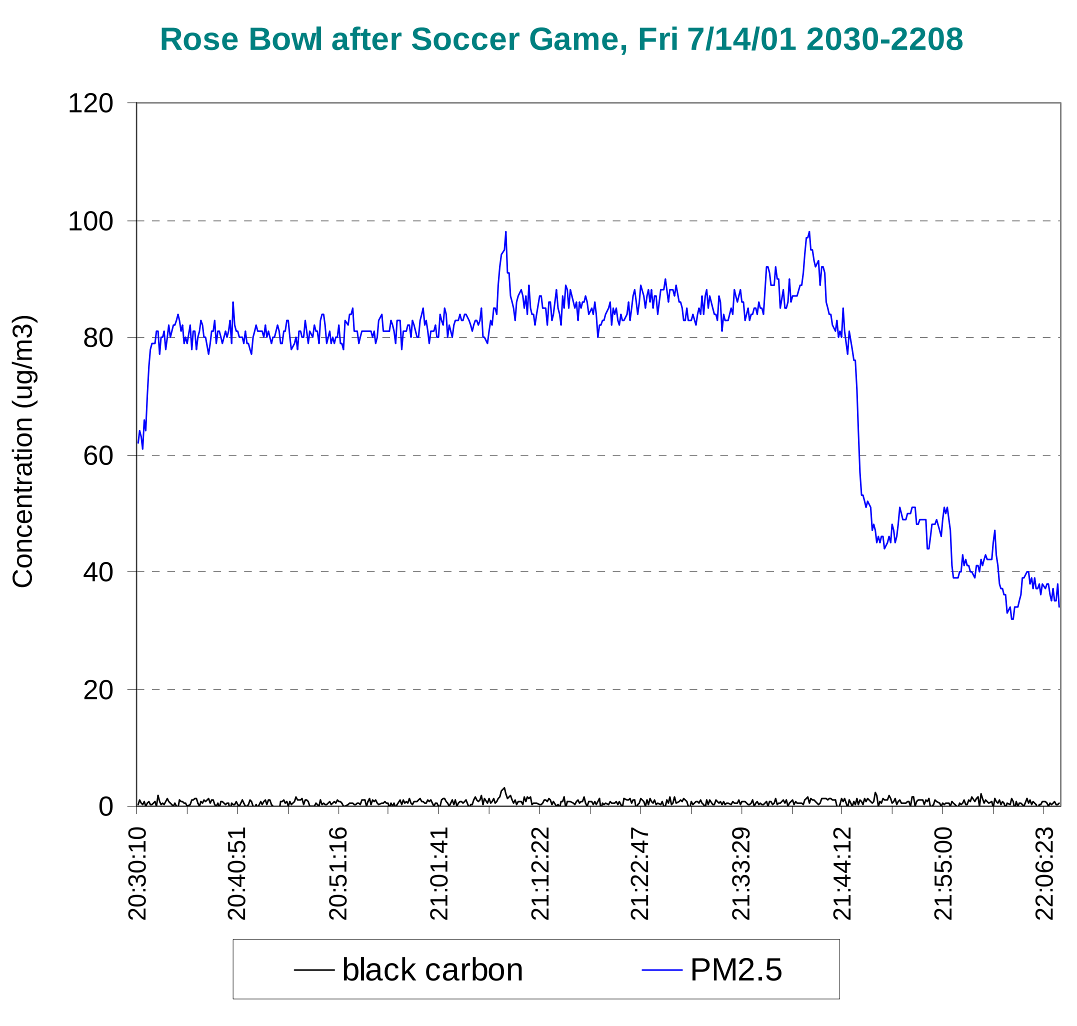
# Black Carbon Emissions Rates During UDC



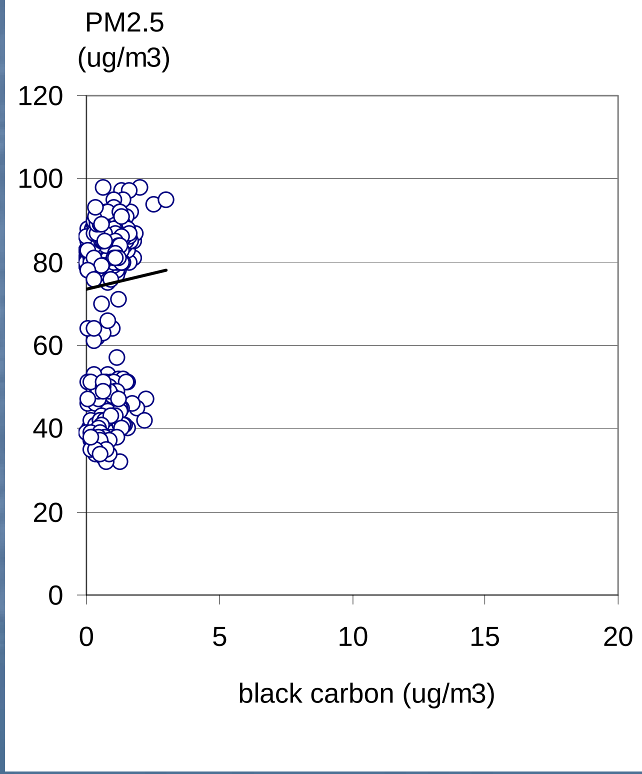

Source: Pat Arnott (2003)
NREL Gas/Diesel Split Study

Most PM emissions during UDC from cold start and hard accels with higher fraction of black carbon.

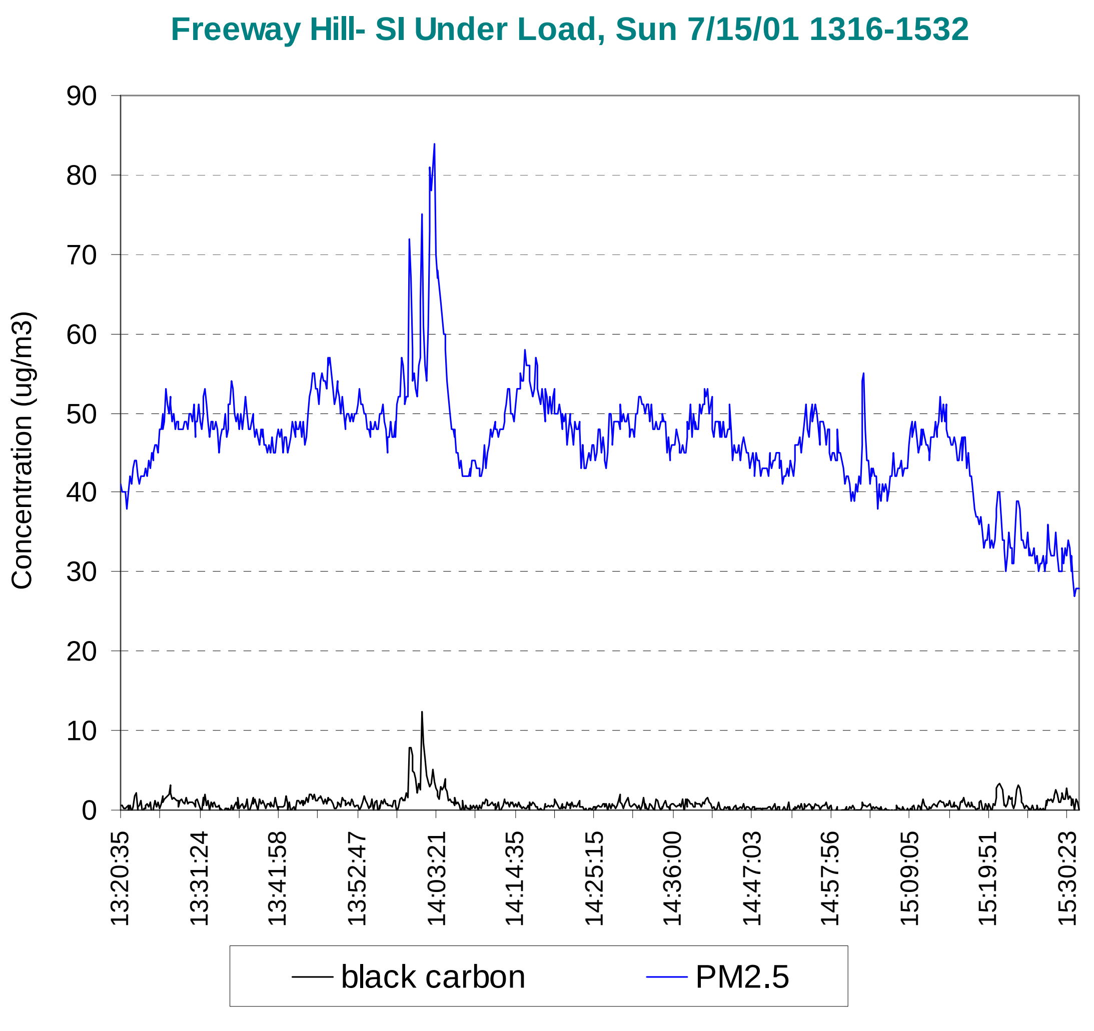
# Photoacoustic BC and DustTrak $PM_{2.5}$
# Gasoline Dominated, Low Load



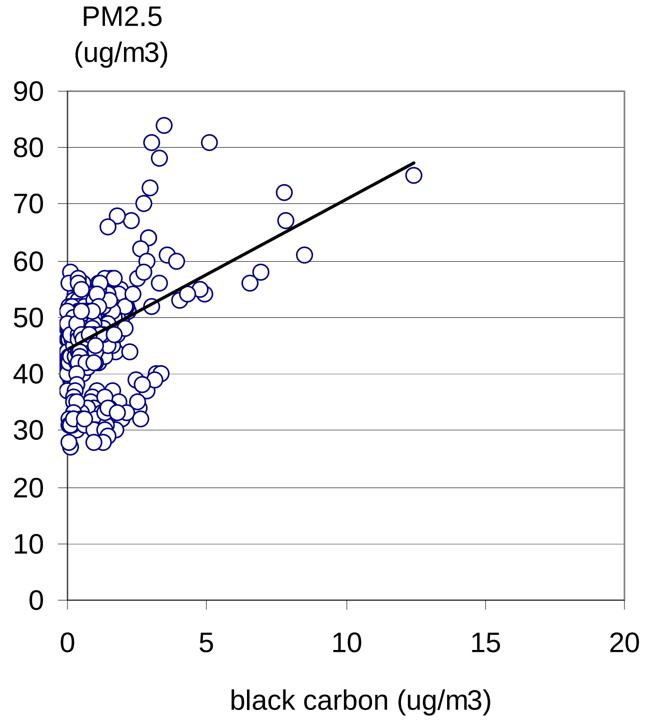

DustTrak > gravimetric mass by factor of 2 to 2.5



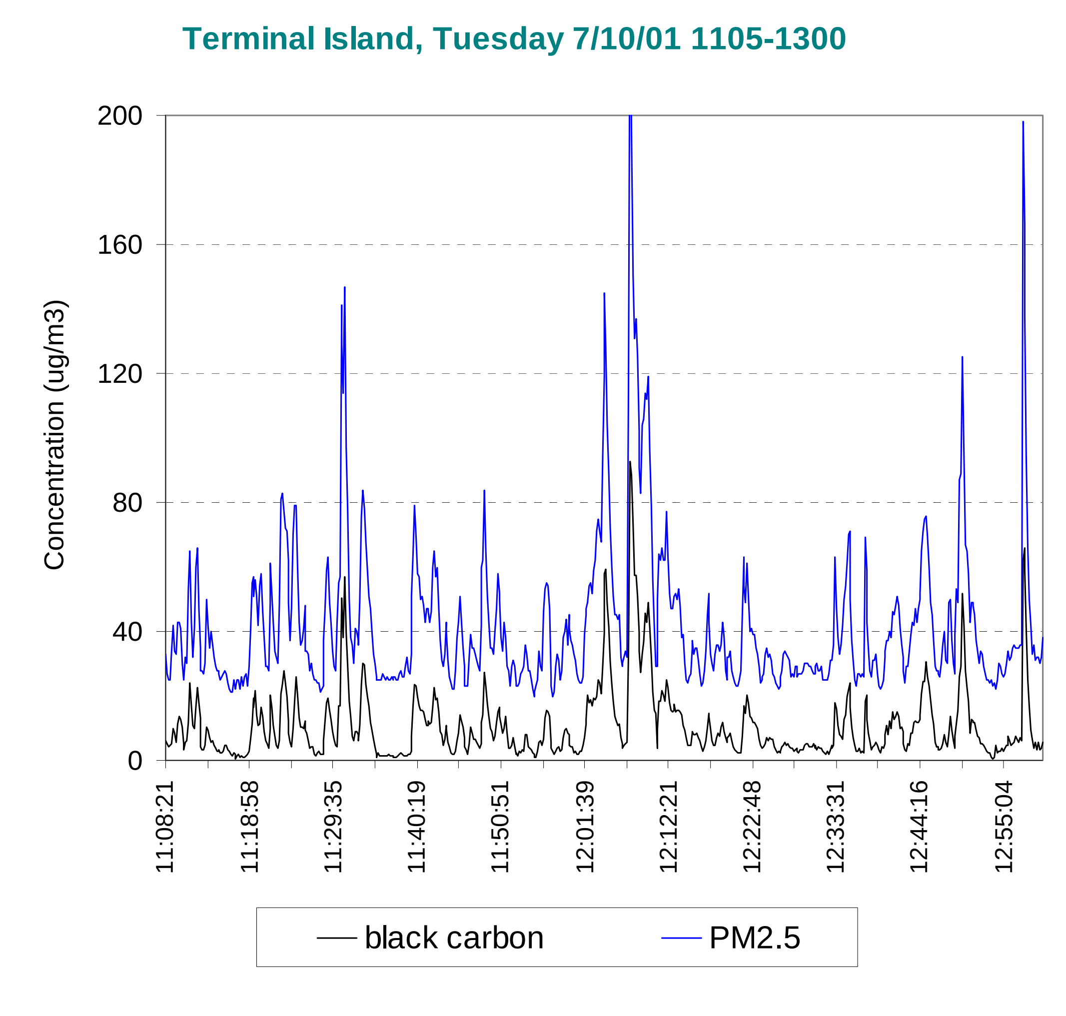
# Mobile Sampling – Photoacoustic BC and DustTrak $PM_{2.5}$ Predominantly Gasoline, Variable Load



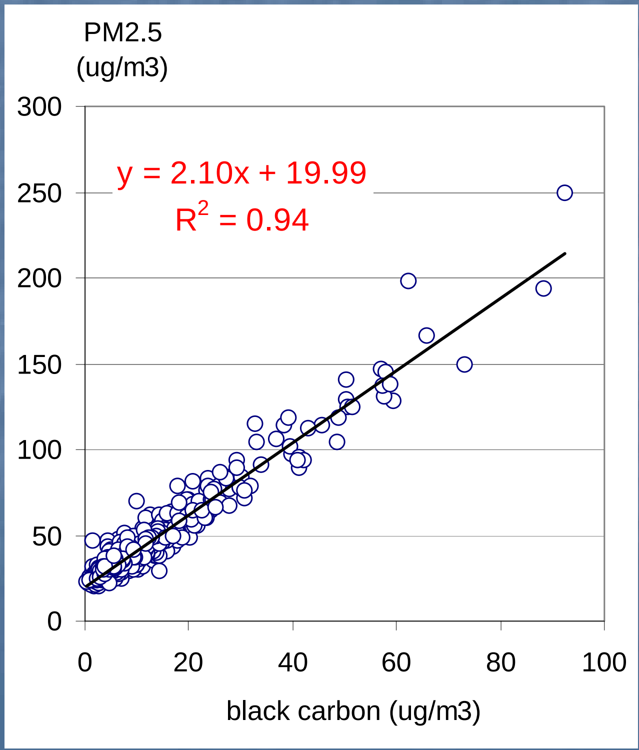

DustTrak > gravimetric mass by factor of 2 to 2.5



# Mobile Sampling – Photoacoustic BC and DustTrak $PM_{2.5}$
# Terminal Island – Port Area Diesel Dominated

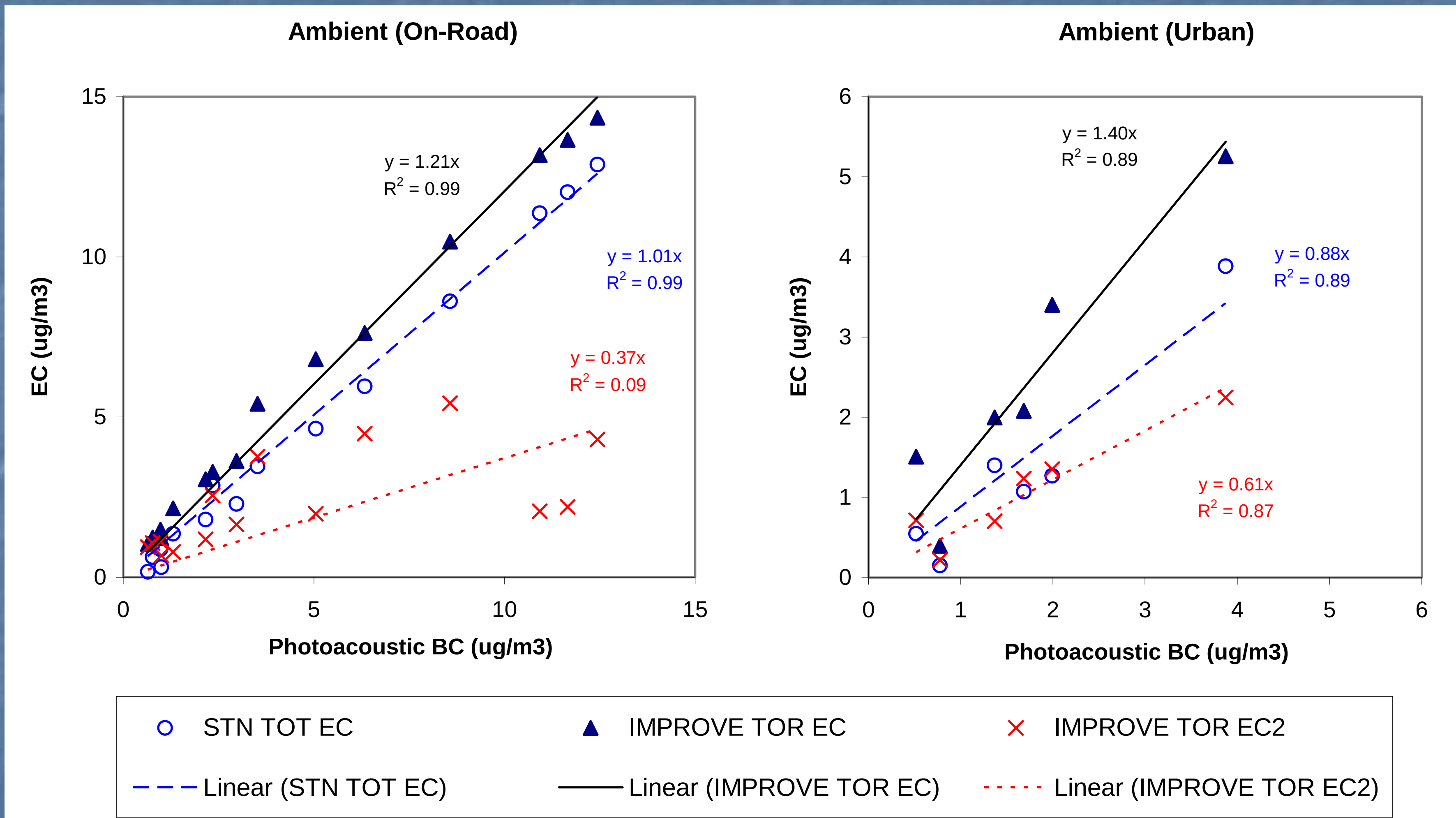


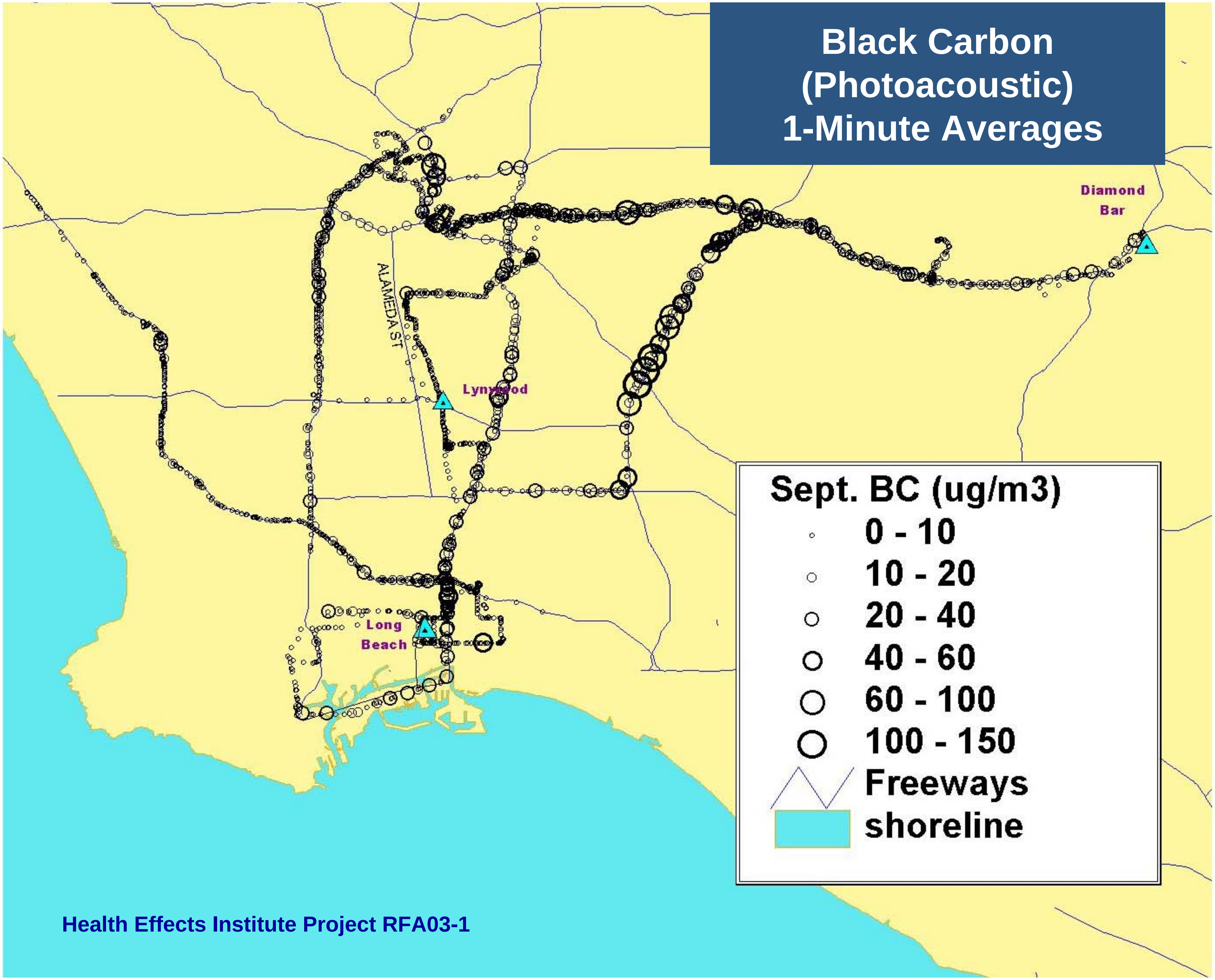




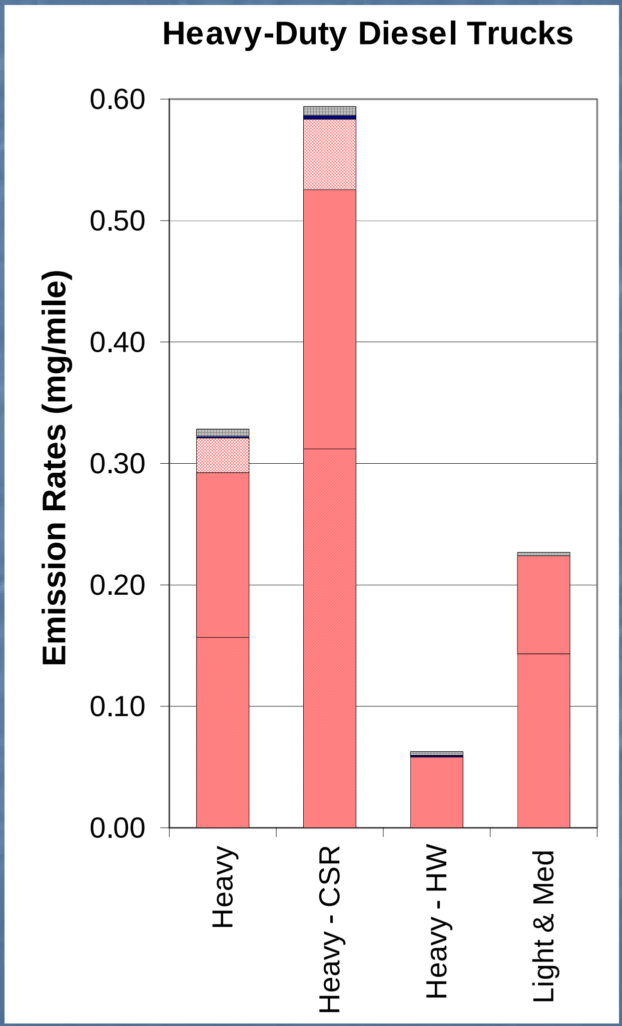

Gasoline/Diesel PM Split Study

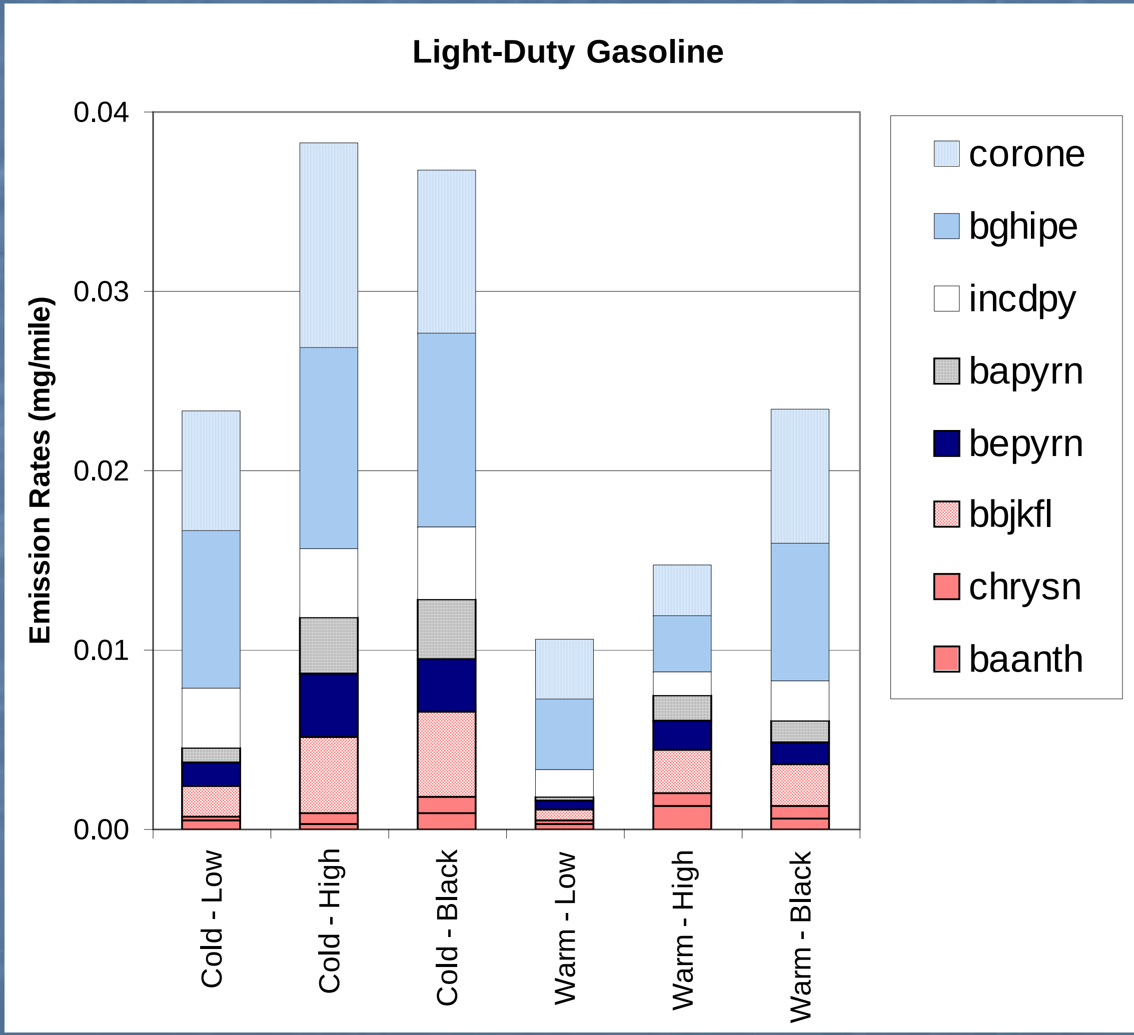
# Photoacoustic Black Carbon Versus STN-TOT EC and IMPROVE-TOR EC and EC2




Black Carbon
(Photoacoustic)
1-Minute Averages
Diamond Bar
ALAMEDA ST
Lynwood
Long Beach
Sept. BC (ug/m3)
0 - 10
10 - 20
20 - 40
40 - 60
60 - 100
100 - 150
Freeways
shoreline
Health Effects Institute Project RFA03-1

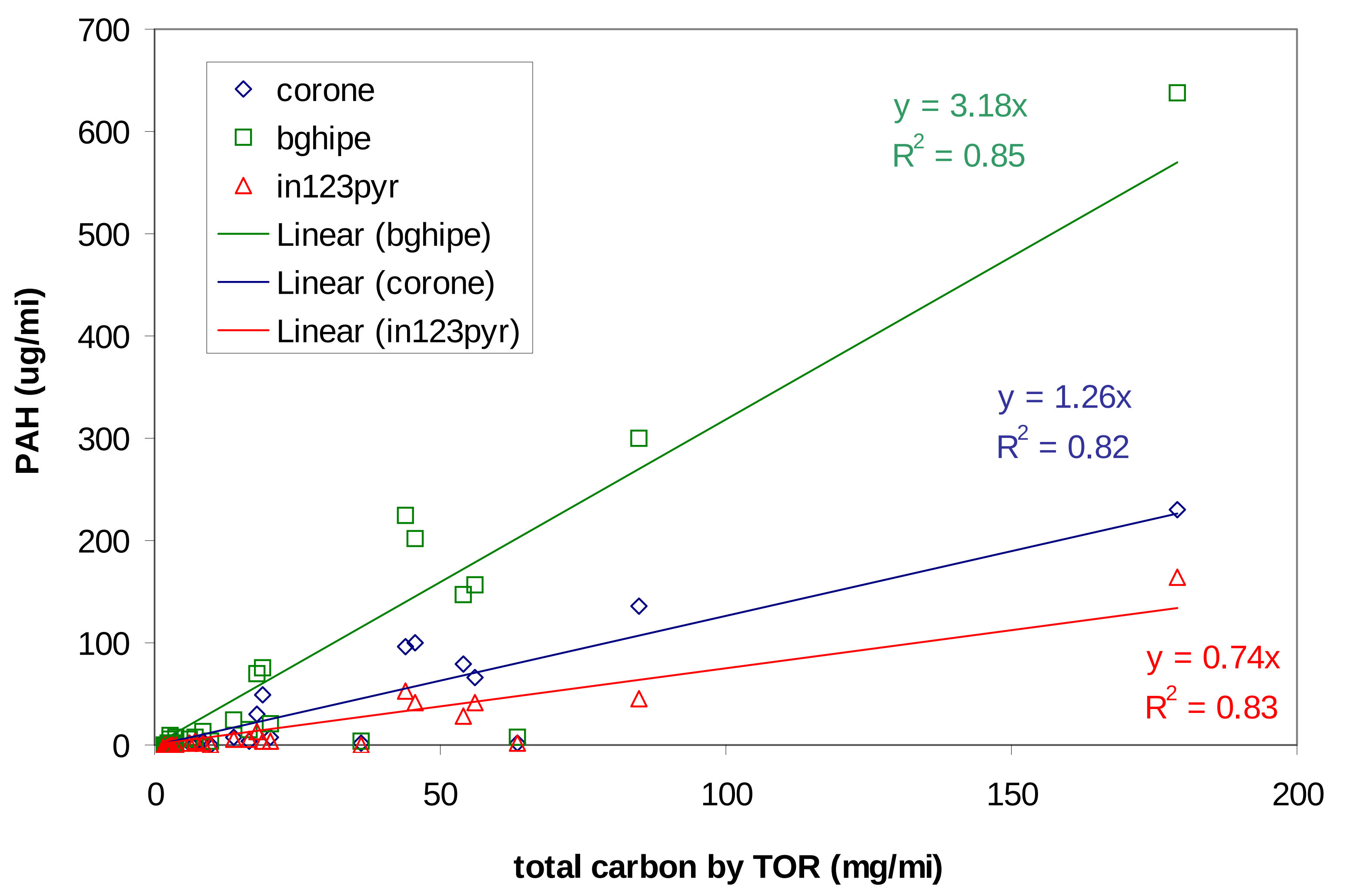
# Emission Rates of Particulate PAHs



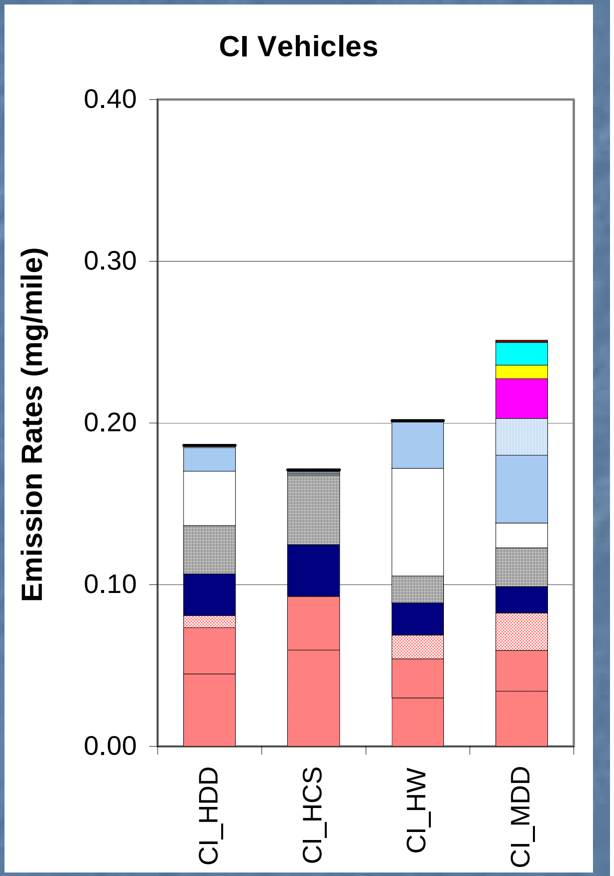



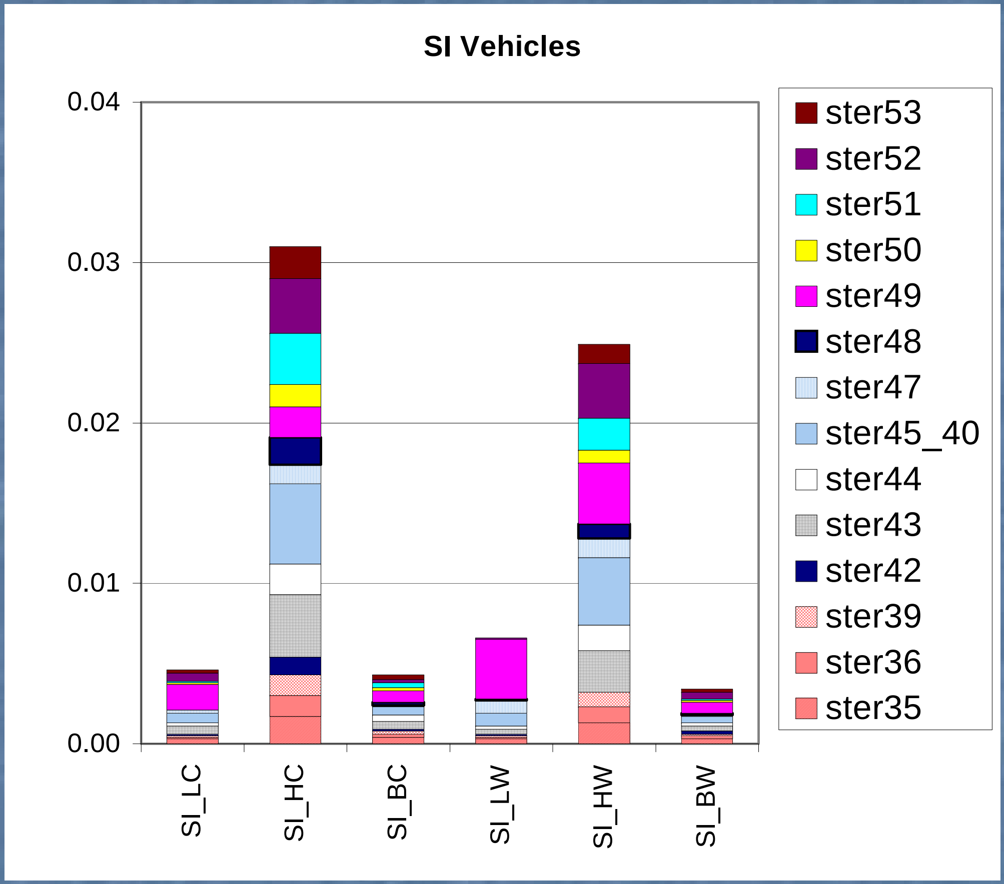

Gasoline/Diesel PM Split Study, Fujita et al., 2006

# Correlations of Potential Marker PAHs with Total Carbon



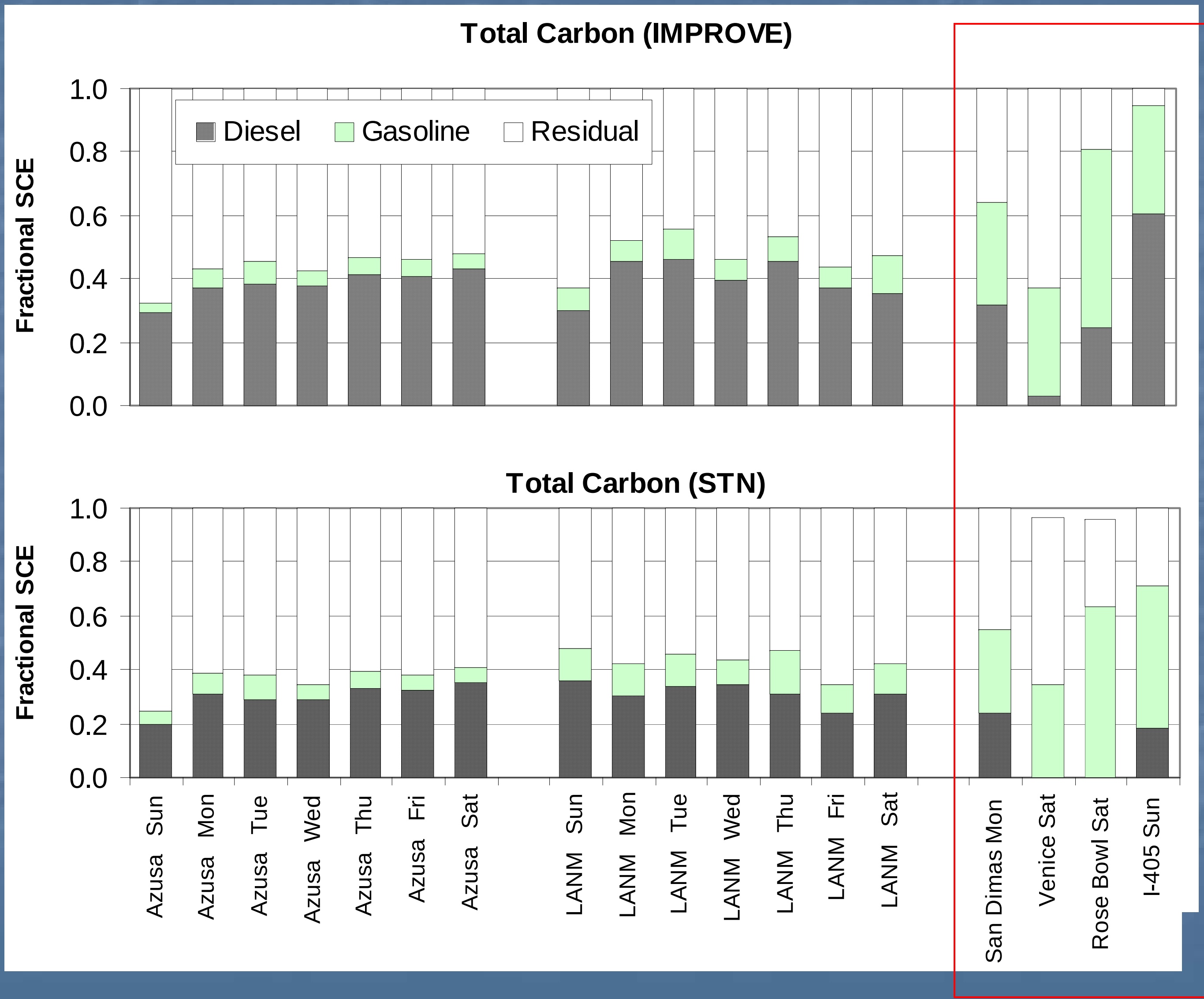
# Steranes in Vehicle Exhaust Profiles



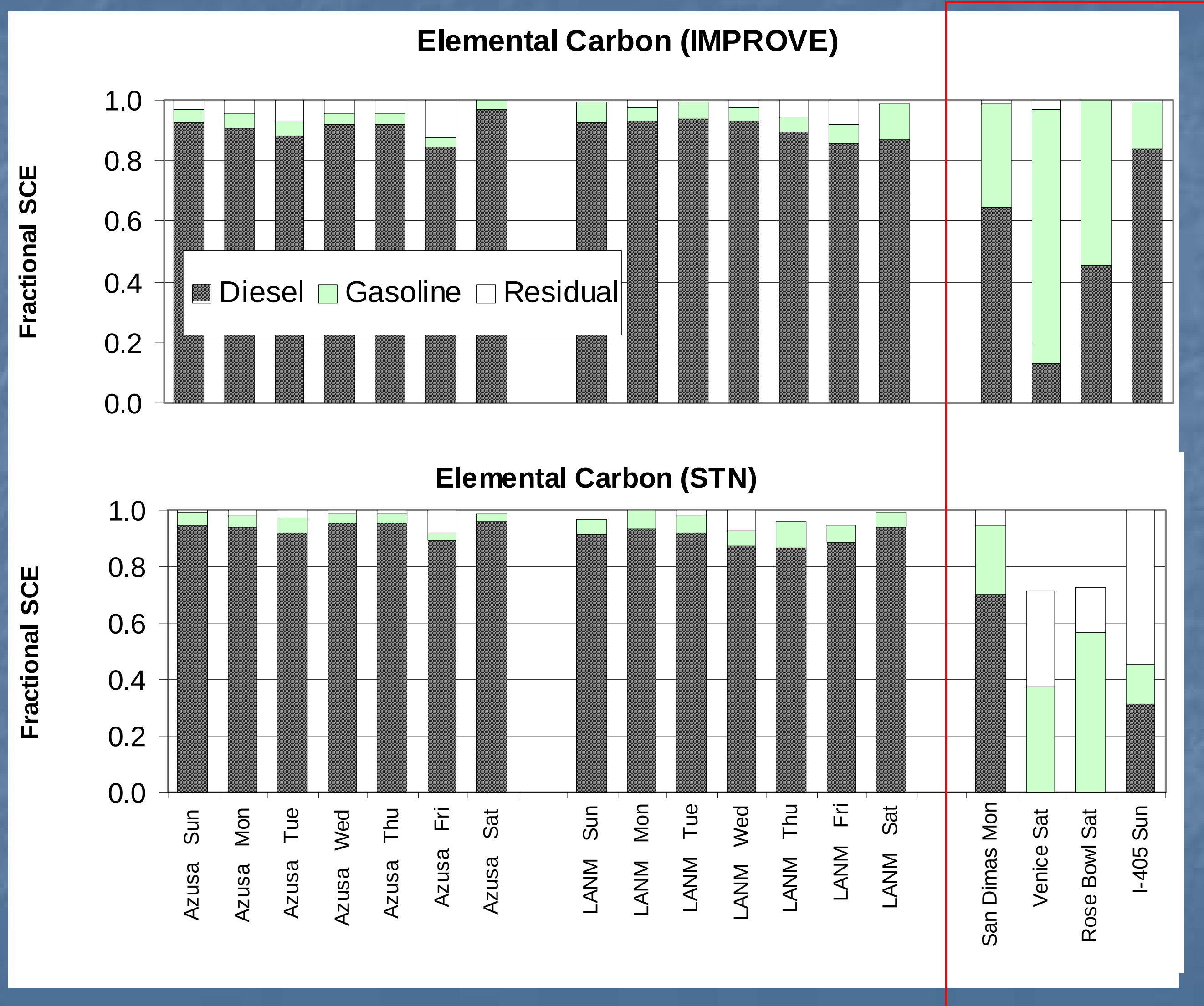

Gasoline/Diesel PM Split Study, Fujita et al., 2005

# Total Carbon Source Contributions by Chemical Mass Balance Receptor Modeling




Gasoline/Diesel PM Split Study, Fujita et al., 2006

# Elemental Carbon Source Contributions by Chemical Mass Balance Receptor Modeling




Gasoline/Diesel PM Split Study, Fujita et al., 2006

# Summary

- Motor vehicles are important sources of ultrafine particles especially on-road and near-road.
- Ultrafine particles in vehicle exhaust contain higher OC relative to EC. Particle size distributions change rapidly.
- SI apportionments were most sensitive to PAHs ( indeno[123-cd]pyrene, benzo(ghi)perylene, and coronene) and higher molecular weight steranes and hopanes. EC had little effect on SI apportionment.
- CI apportionments were mainly dependent upon EC. CI contributions were greater with IMPROVE.
- CI and SI apportionments varied with location and time.
  - CI vehicles were the dominant source of EC and TC at Azusa and LANM.
  - More equal apportionment at other locations that are more regionally representative.
  - TC was attributed mostly to SI vehicles in high automotive traffic locations .

# References

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Fujita, E. M., D. E. Campbell, W. P. Arnott, B. Zielinska (2005). Evaluations Of Source Apportionment Methods for Determining Contributions Of Gasoline and Diesel Exhaust to Ambient Carbonaceous Aerosols. To be submitted.