DOE's Gasoline/Diesel PM Split Study

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Acknowledgments

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South Coast Air Quality Management District

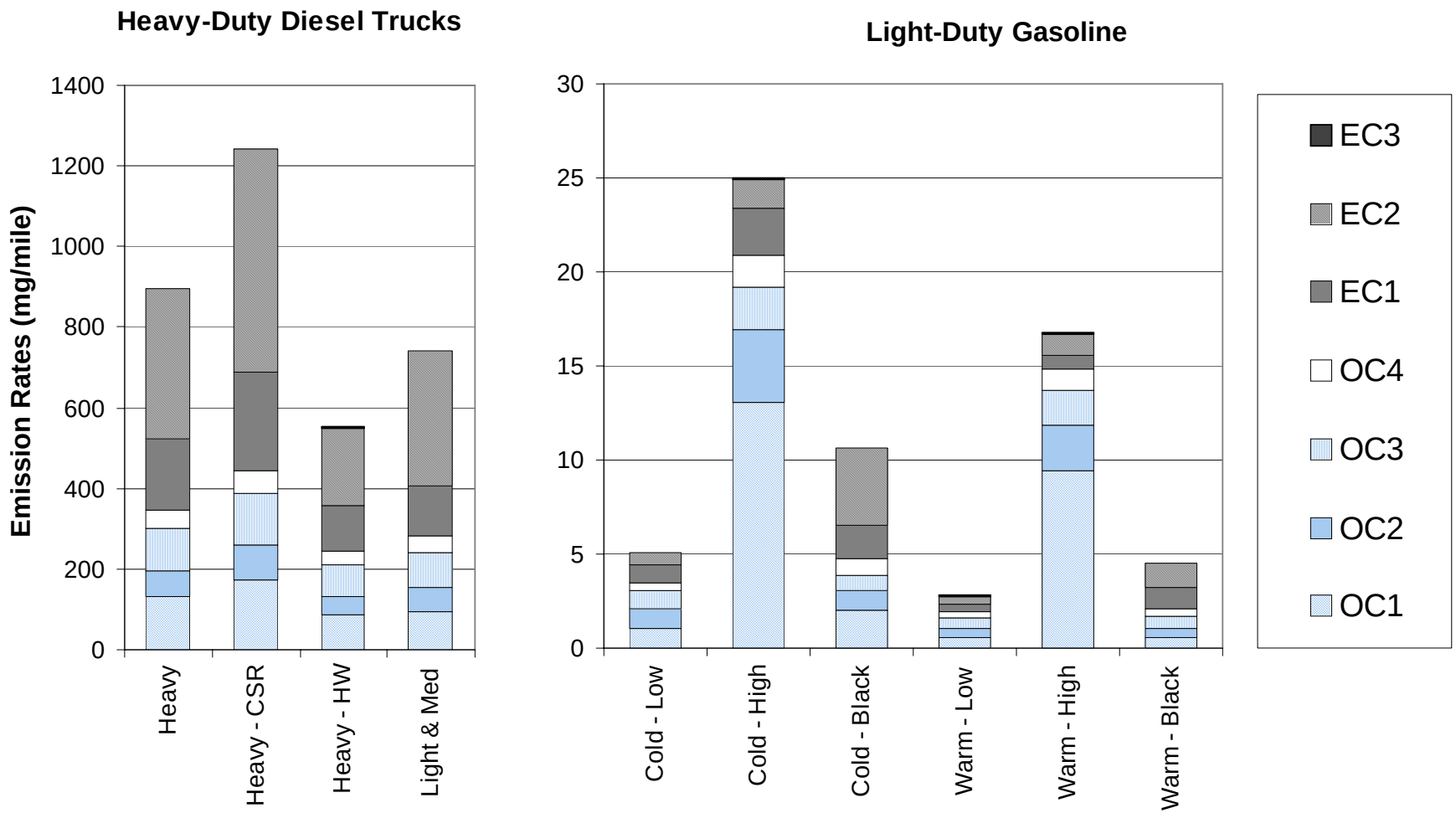
Gasoline/Diesel PM Split Study

Objective: Characterize uncertainties in quantifying the contributions of PM emissions from SI and CI engines in the South Coast Air Basin

Approach:

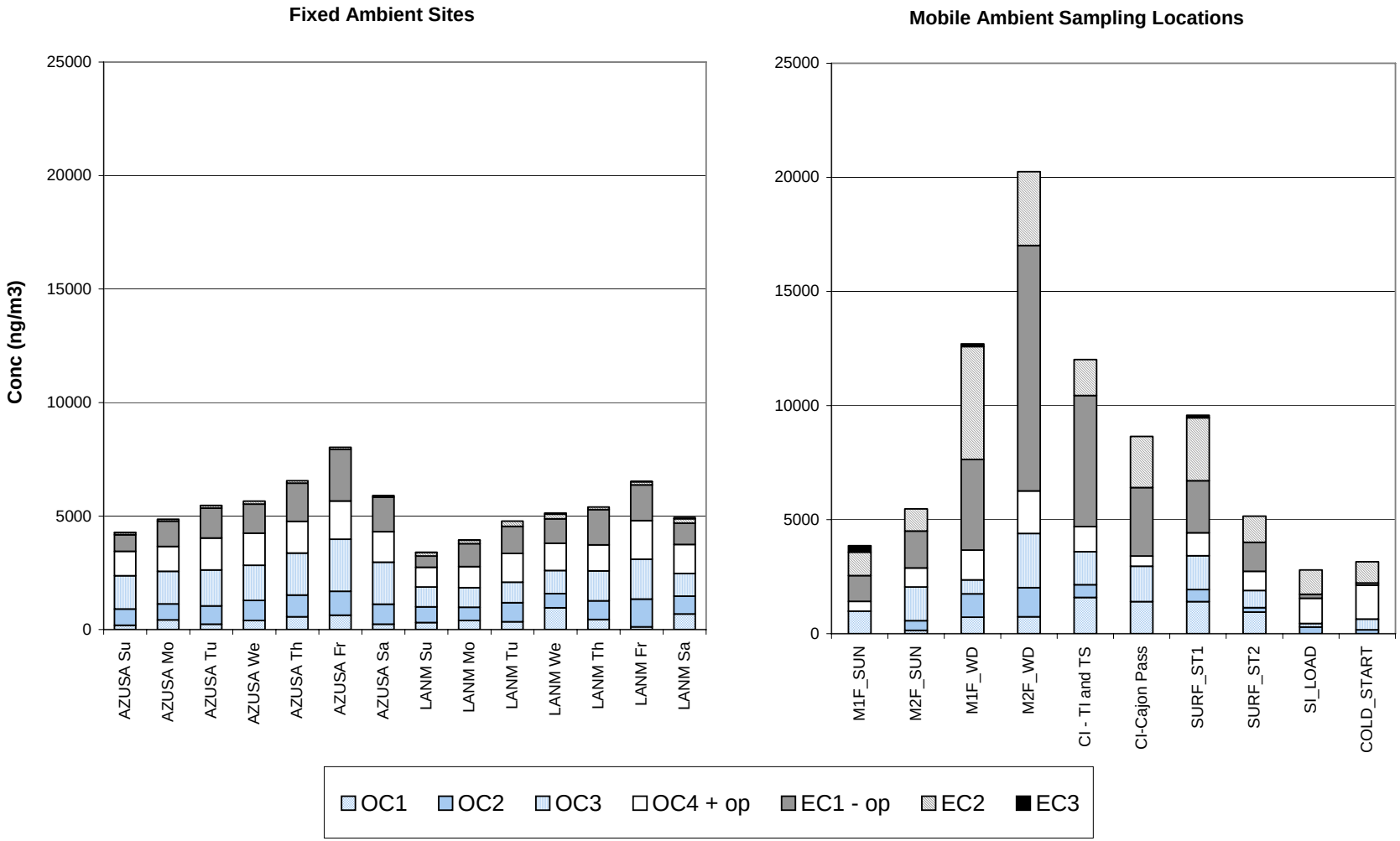
- Source testing of gasoline- and diesel-powered motor vehicles using EPA's and WVU's transportable dynamometers (May-September 2001)
  - 51 LDGV (9 groups of model years and mileage), 6 LDGV smokers and 2 LDDV
  - 32 HDDV (3 weight class and 4 model-years groups) and 2 transit buses
- Ambient samples (June -July 2001)
  - Downtown Los Angeles and Azusa - daily 24 hour for four consecutive weeks, composite by day-of-week
  - Variety of locations with variable amount of gasoline and diesel traffic
- Chemical analysis of parallel source and ambient samples by DRI and UWM.
  - Organic and elemental carbon, ions, elements, semi-volatile and particulate PAH, hopanes, steranes, polar organics and alkanes.
- Double-blind Chemical Mass Balance (CMB) receptor modeling by DRI and UWM.

Vehicle Profiles – Carbon Fractions by IMPROVE-TOR



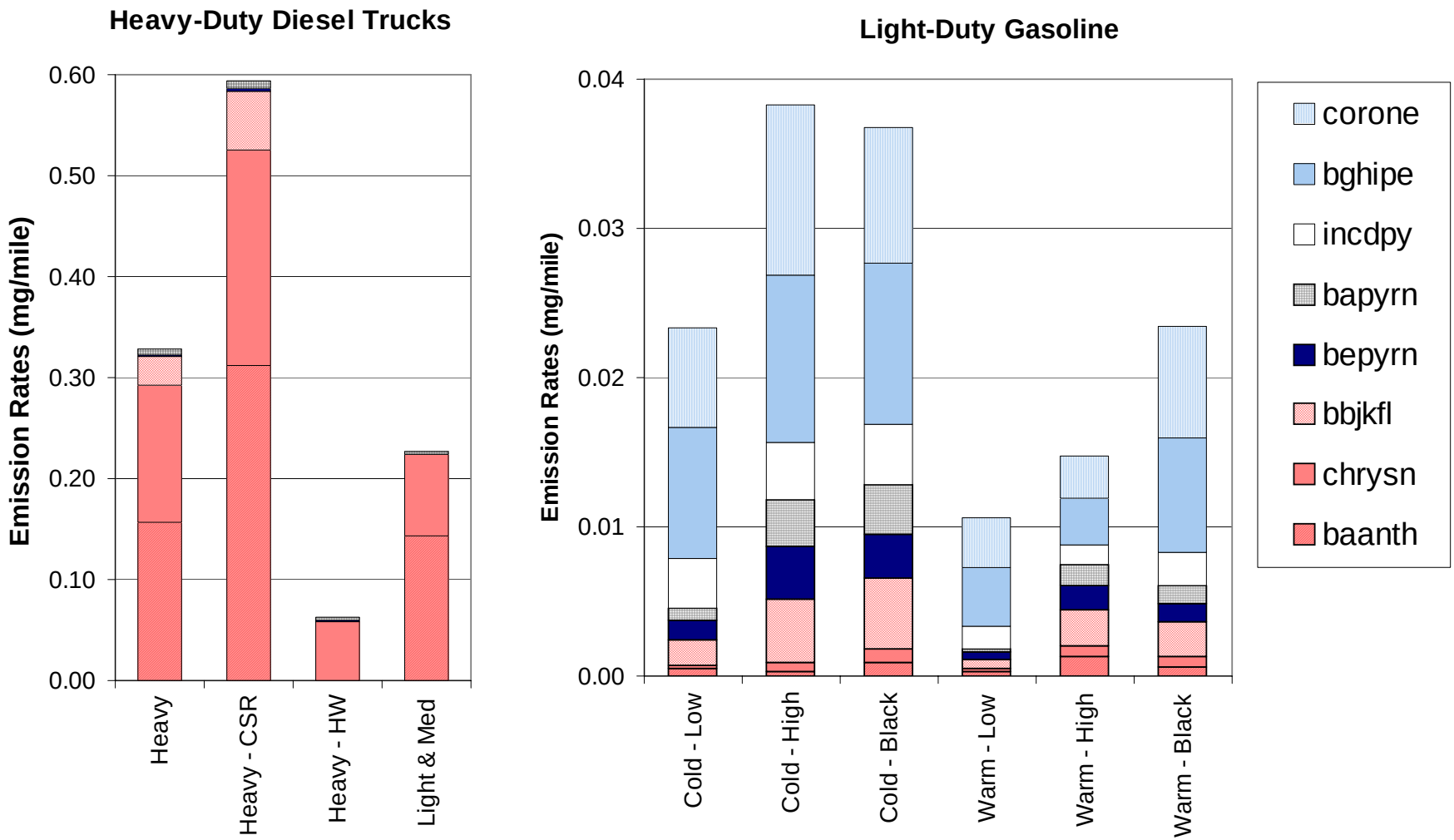
Gasoline/Diesel PM Split Study, Fujita et al., 2005

Distributions of OC and EC fractions (IMPROVE) at Azusa, Los Angeles N. Main and Source Locations



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

Emission Rates of Particulate PAH



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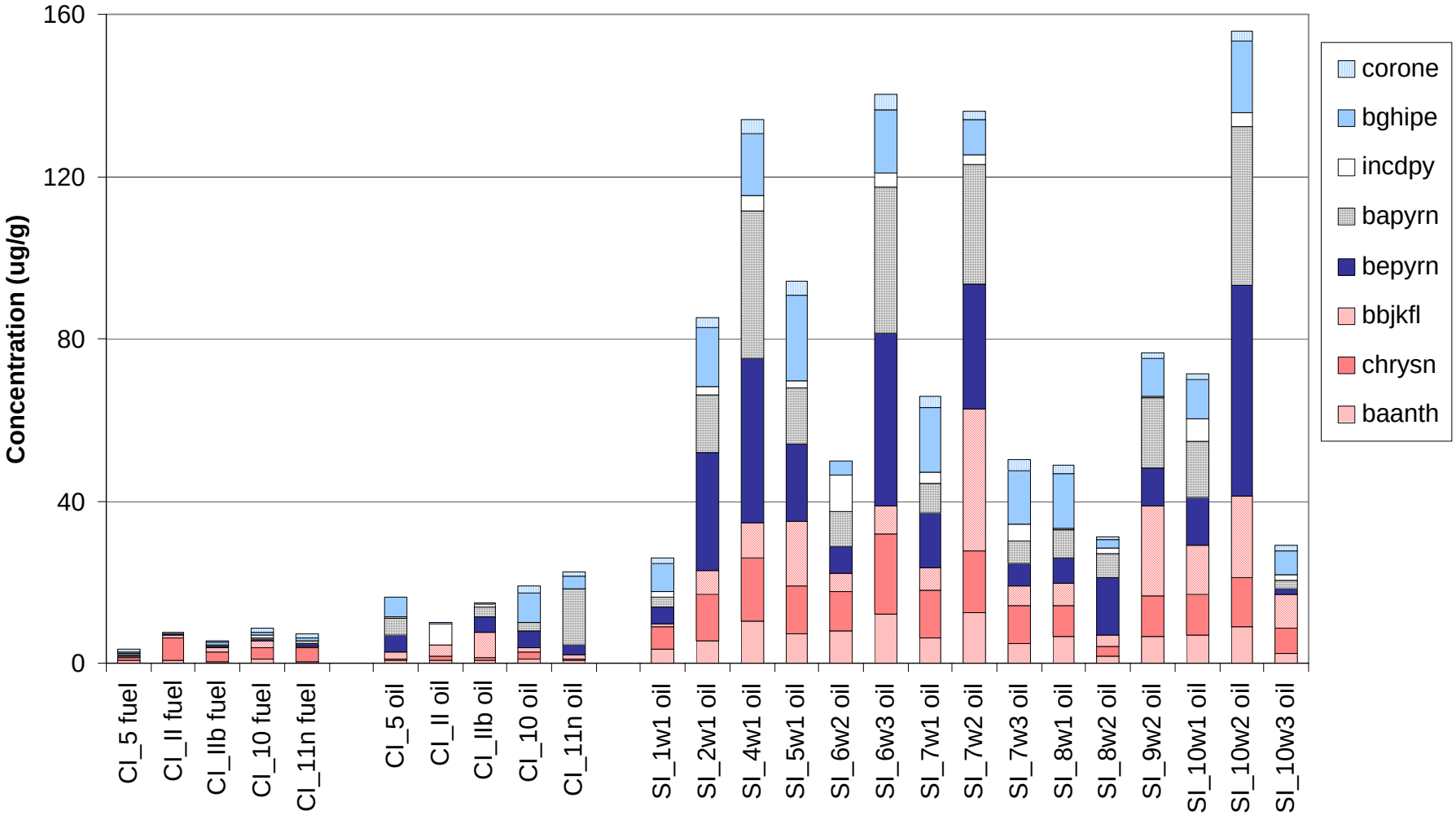
Concentrations of Particulate PAH in Lube Oil



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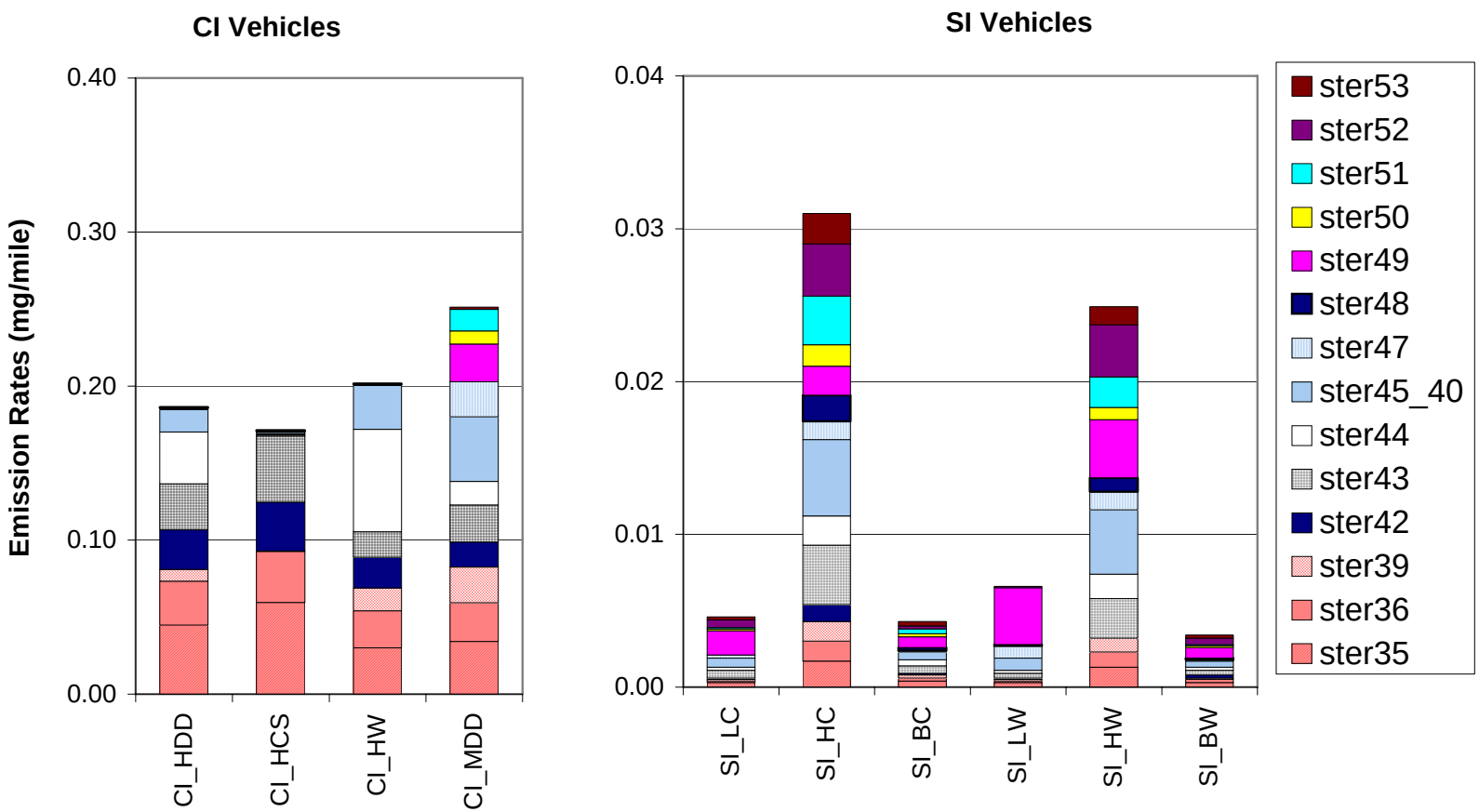
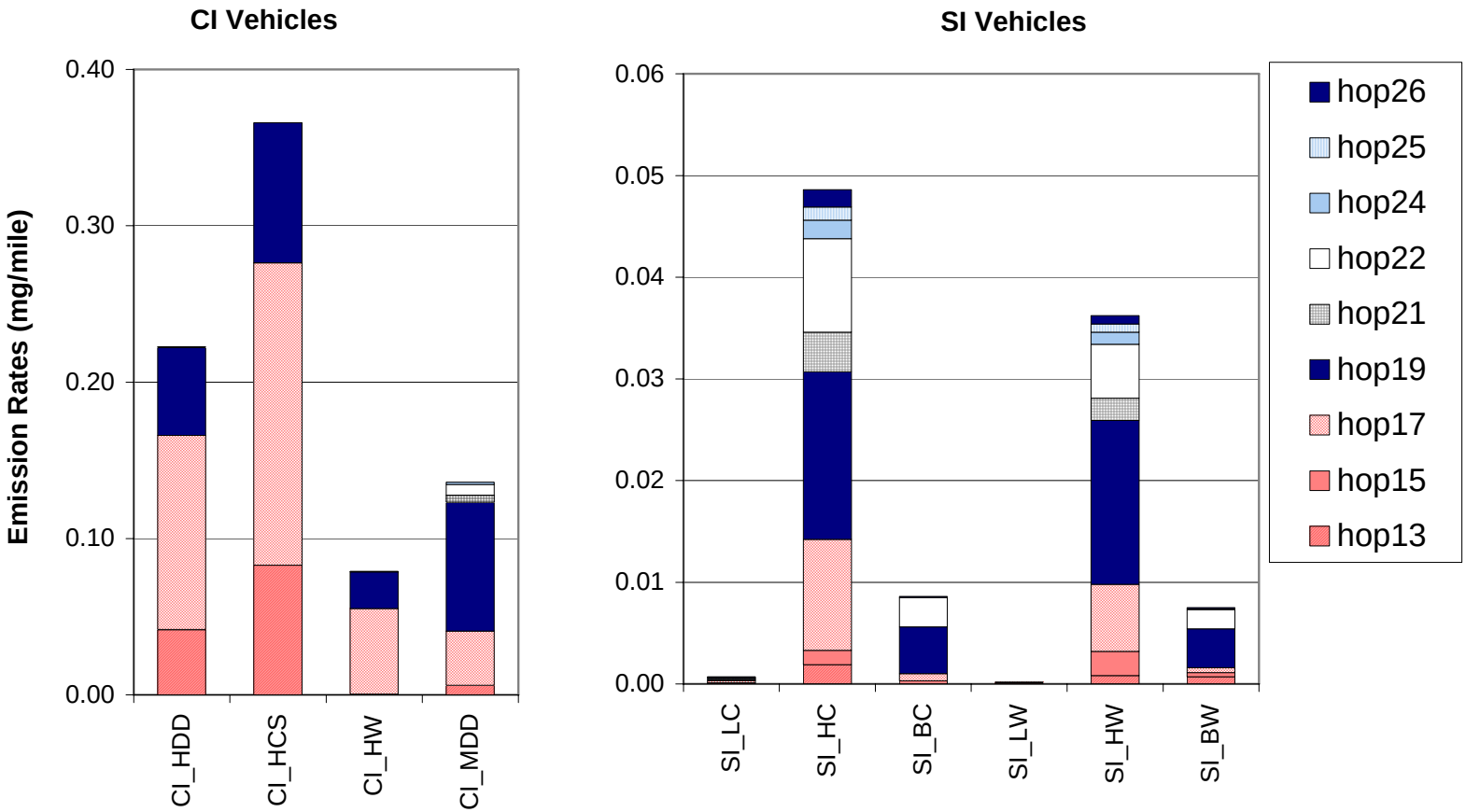
Vehicle Profiles – Emission Rates of Steranes



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

Vehicle Profiles – Emission Rates of Hopanes



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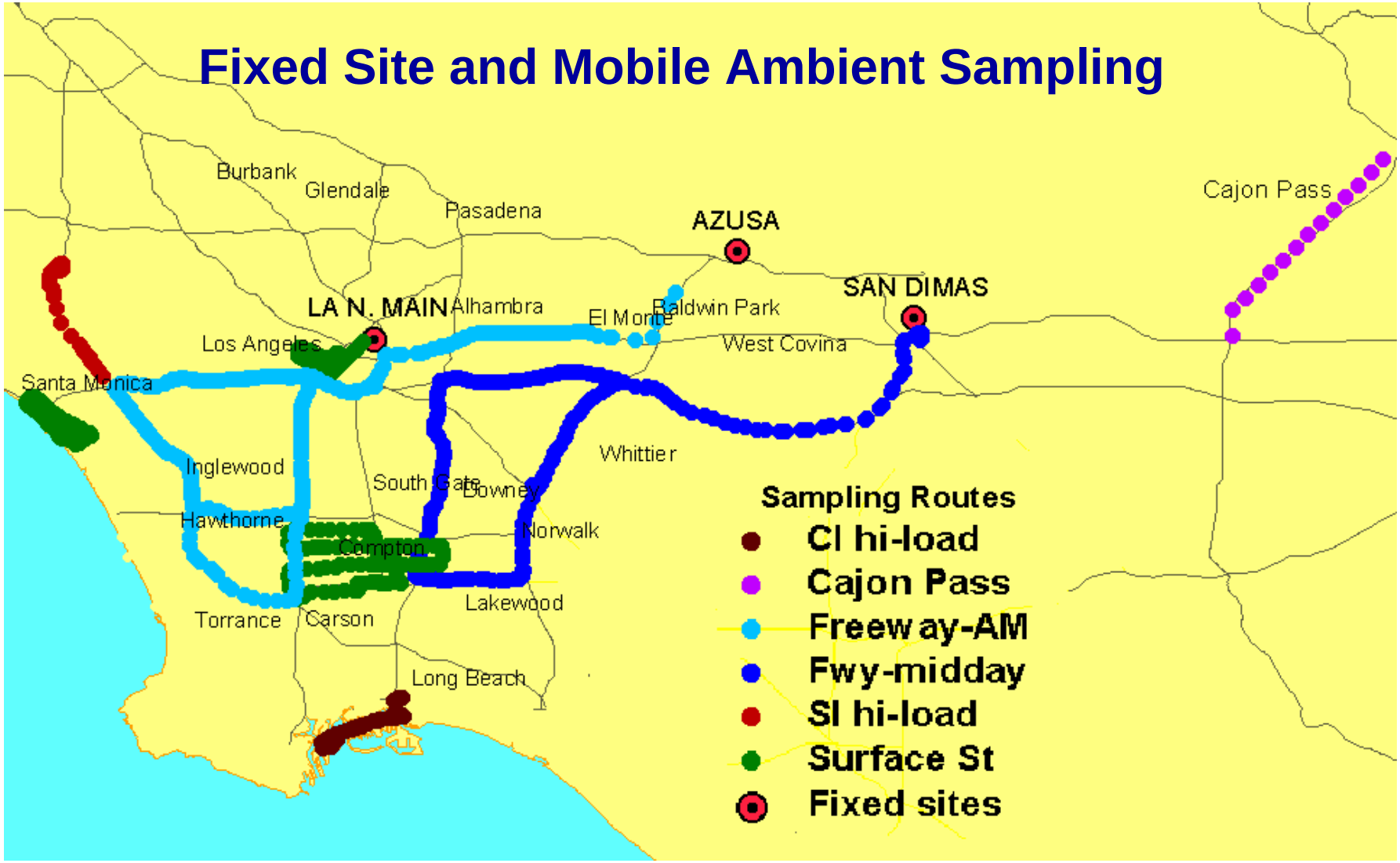
Fixed Site and Mobile Ambient Sampling



- Downtown Los Angeles and Azusa - daily 24 hour for four consecutive weeks, composite by day-of-week
- Variety of locations with variable amount of gasoline and diesel traffic

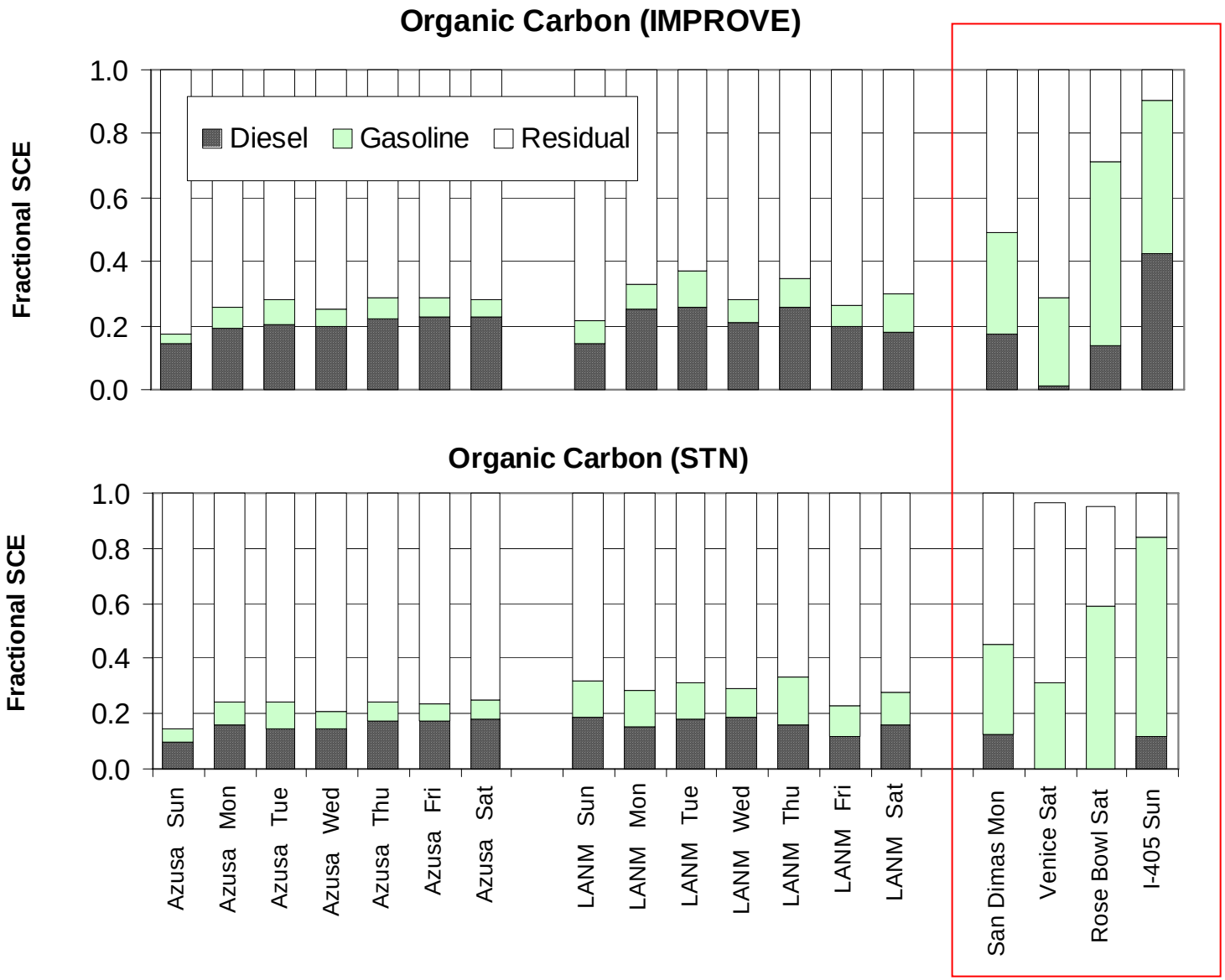
Source Contribution Estimates – Organic Carbon

CI/SI (IMP)

Azusa
Sun – 4.6
WD – 2.5-3.8
Sat – 4.3
LANM
Sun – 2.0
WD – 2.3-3.3
Sat – 1.5

CI/SI (STN)

Azusa
Sun – 1.9
WD – 1.5-2.7
Sat – 2.8
LANM
Sun – 1.5
WD – 0.9-1.3
Sat – 1.3



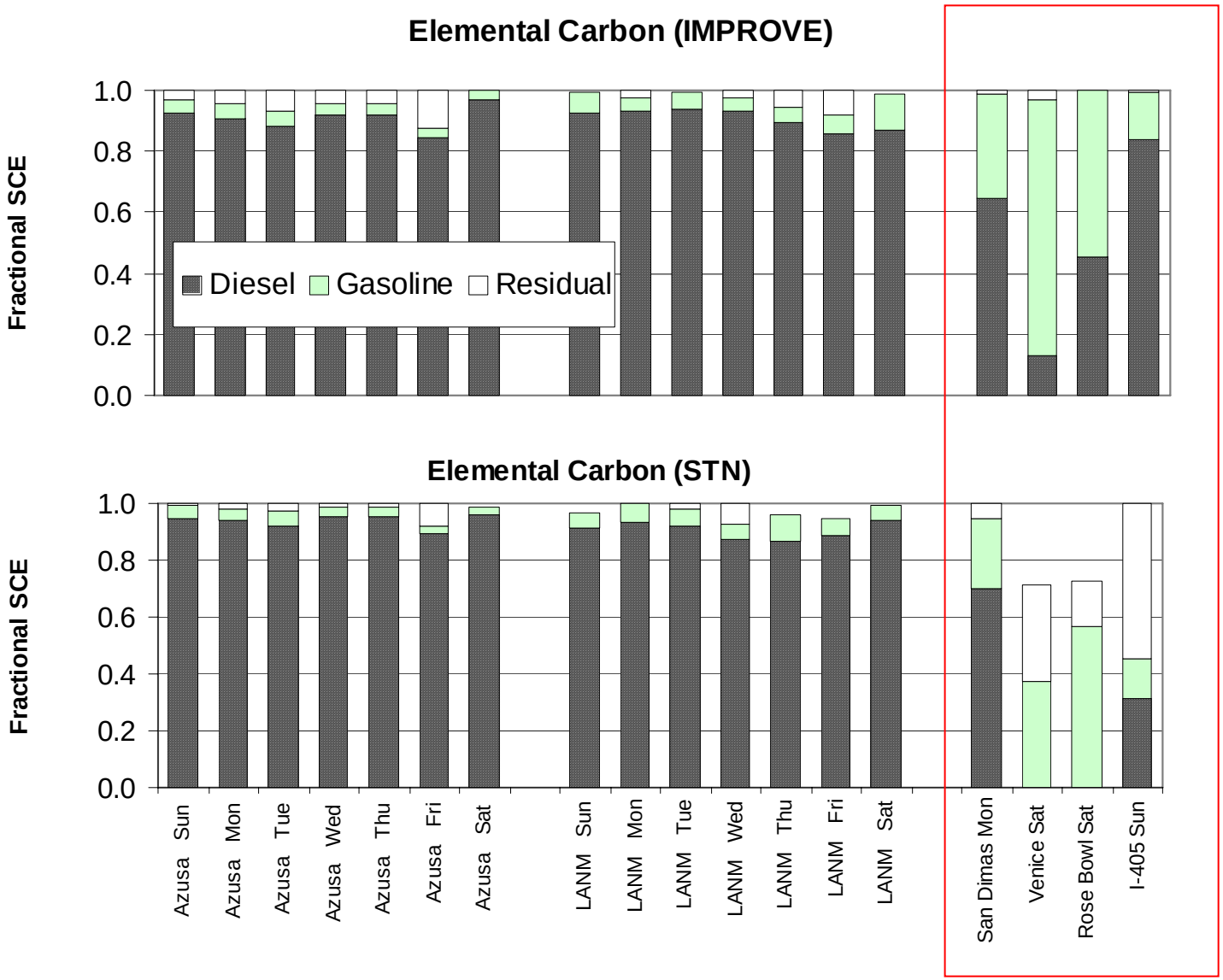
Source Contribution Estimates – Elemental Carbon

CI/SI (IMP)

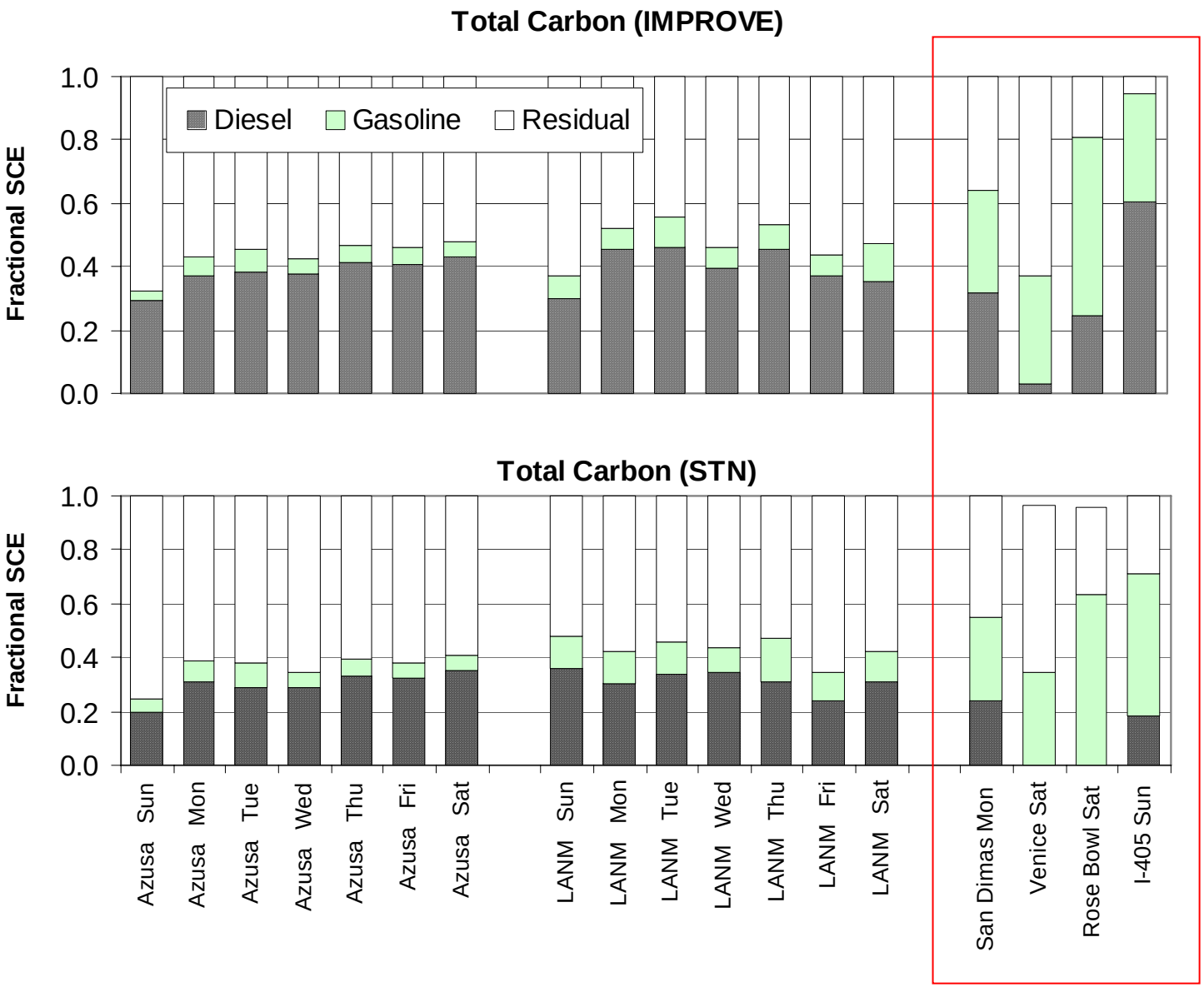
Azusa
Sun – 22
WD – 19-28
Sat – 31
LANM
Sun – 14
WD – 13-21
Sat – 8

CI/SI (STN)

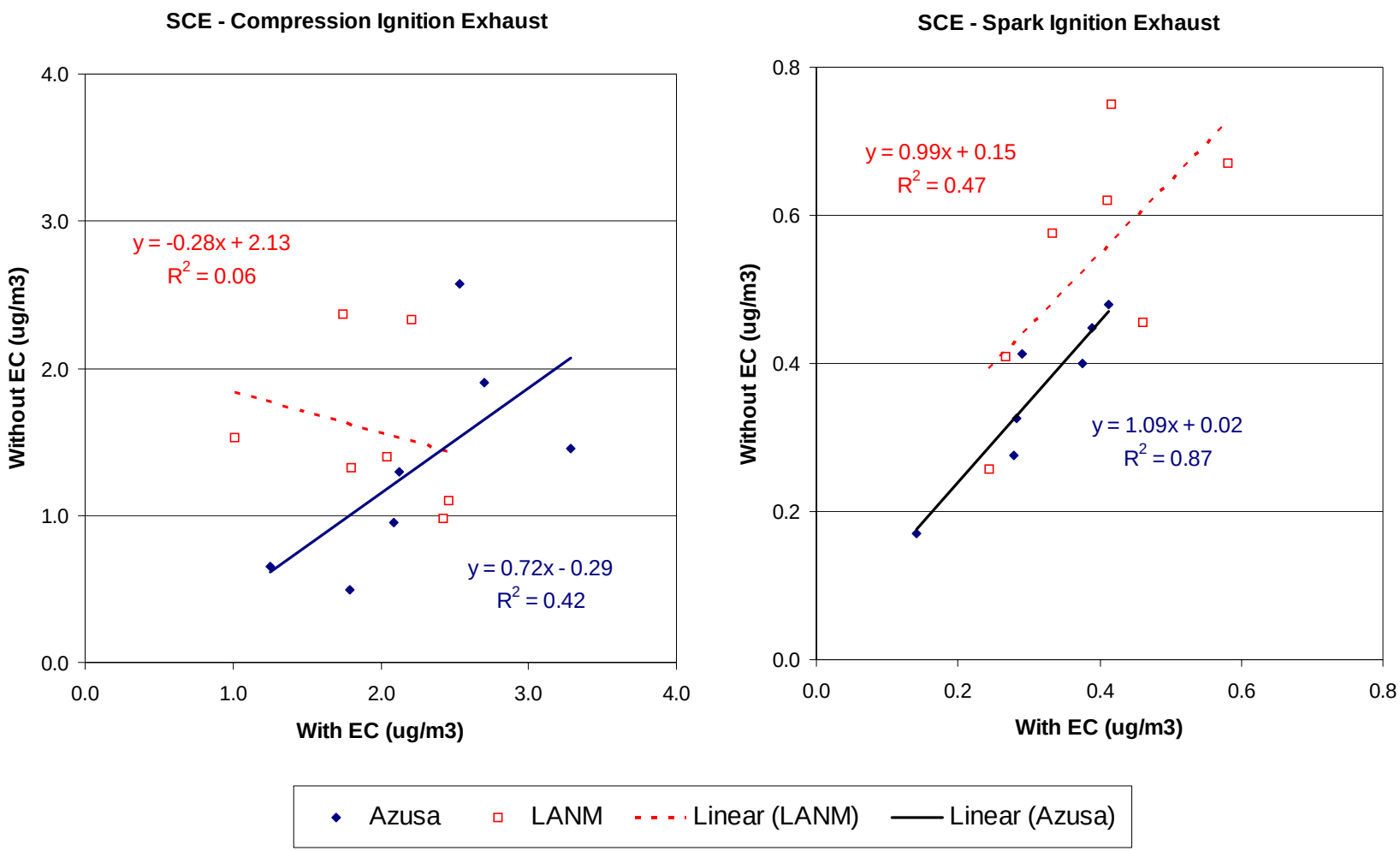
Azusa
Sun – 22
WD – 17-31
Sat – 42
LANM
Sun – 17
WD – 10-18
Sat – 17



Source Contribution Estimates – Total Carbon

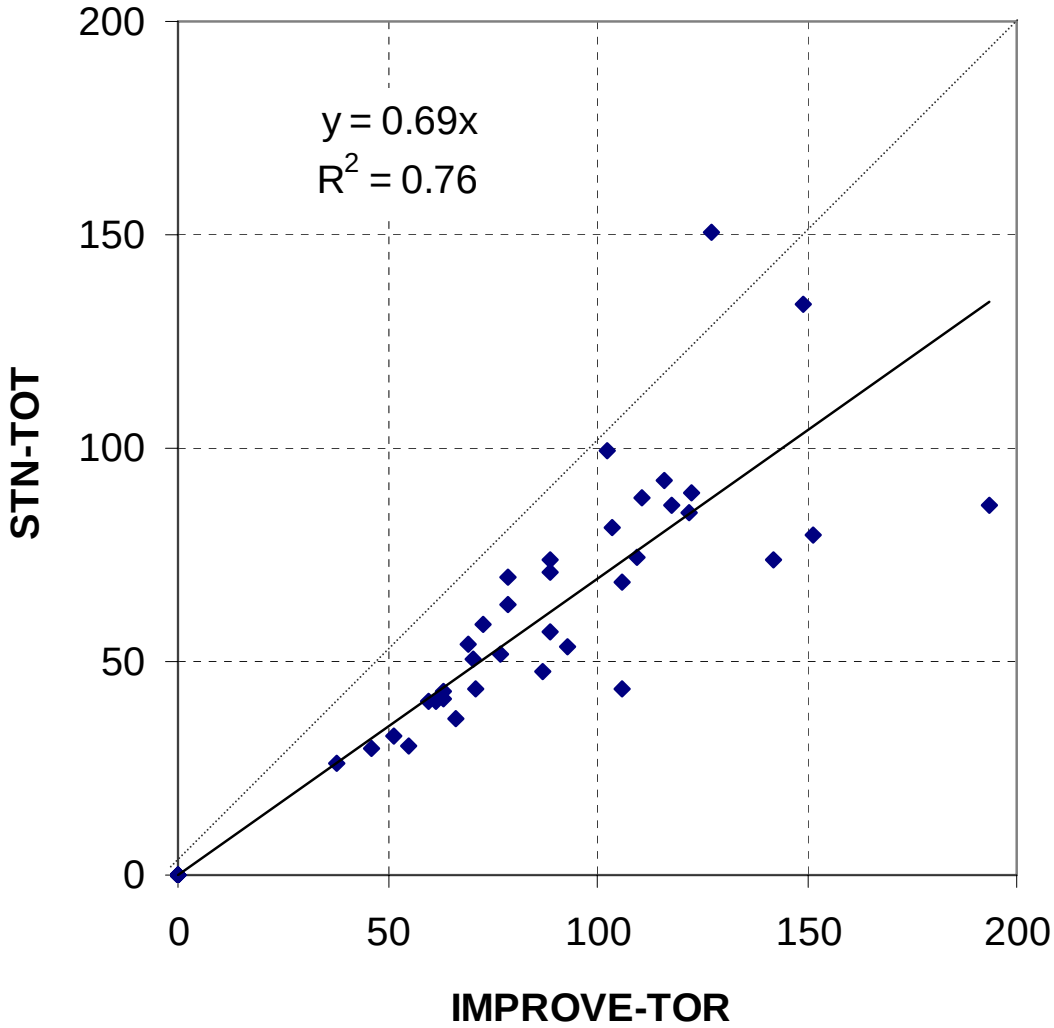


Sensitivity of Apportionments to Use of EC in CMB Fit

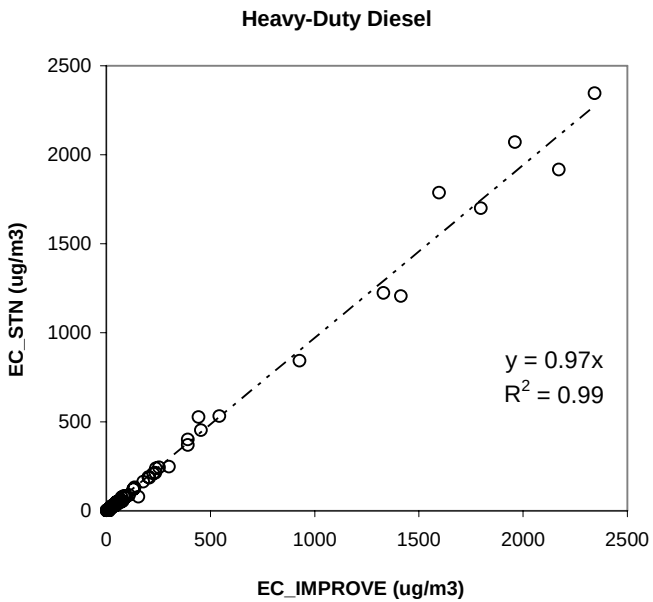


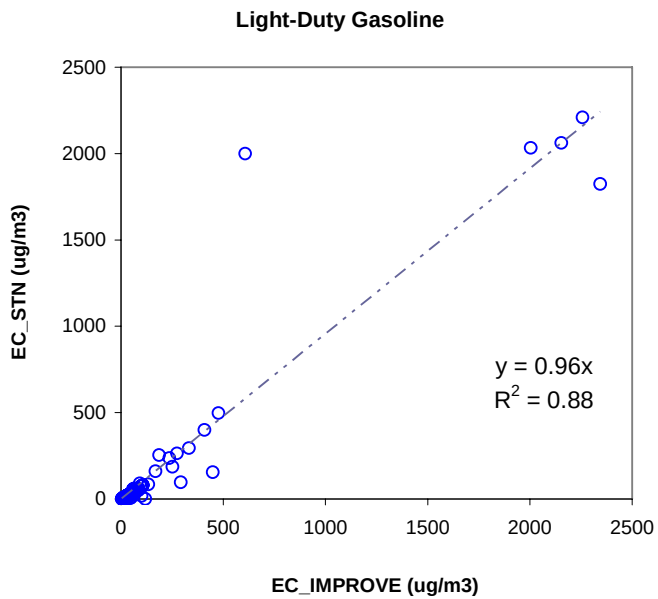
CI apportionment is dependent on EC. SI apportionment is depends on PAHs, Steranes and Hopanes rather than EC.

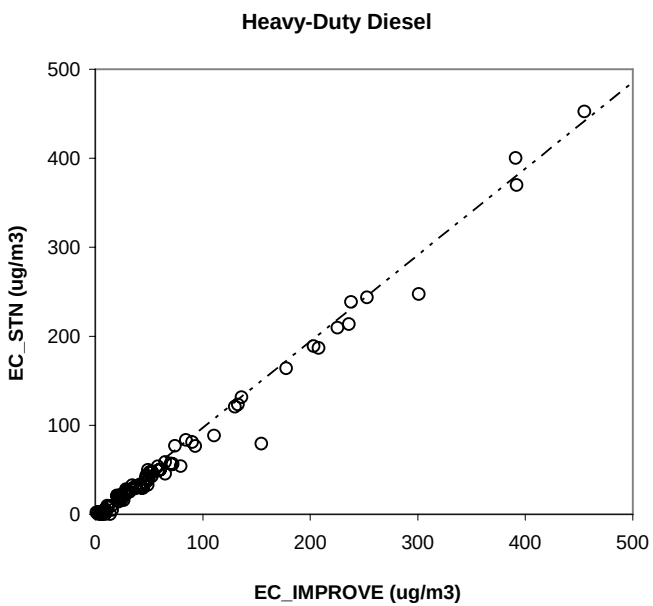
Scatterplot of STN-TOT EC Versus IMPROVE-TOR EC for Ambient Samples (ug/sample)

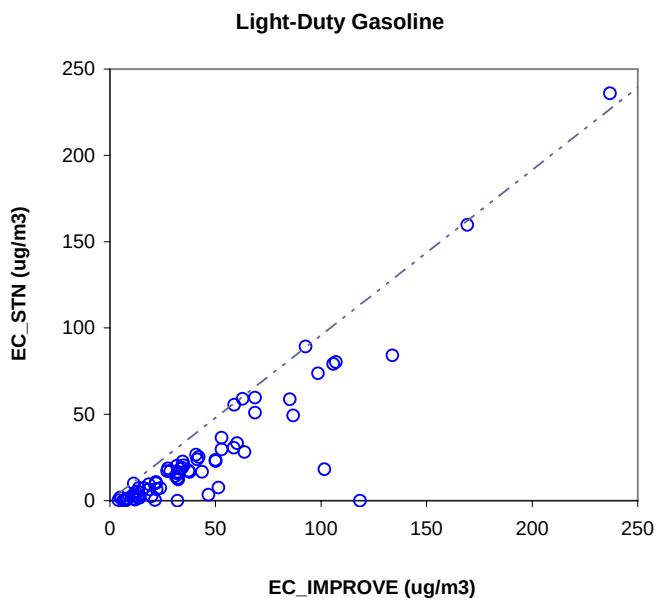


STN versus IMPROVE EC for CI and SI Exhaust Samples

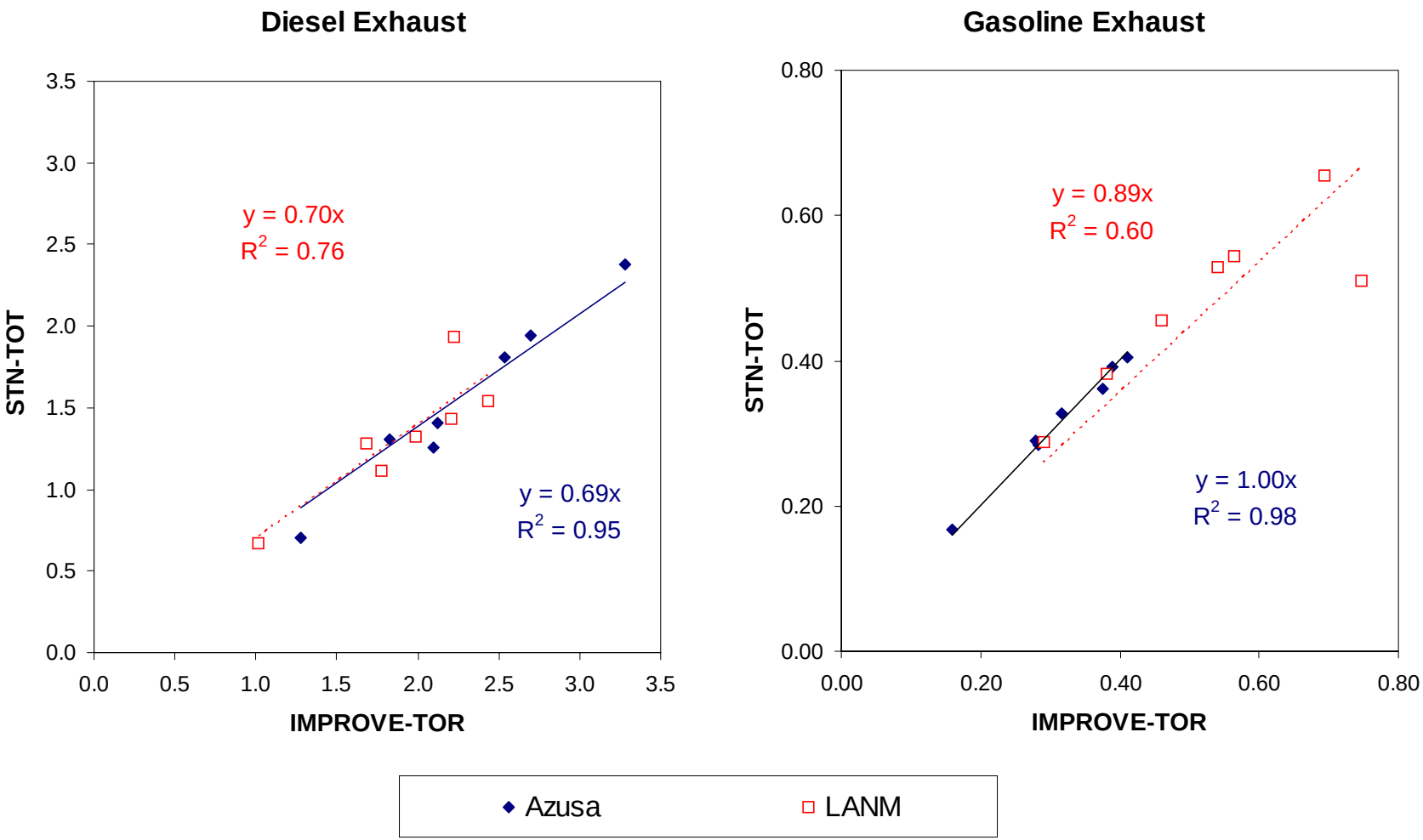








Sensitivity of CMB Apportionments to Carbon Measurement Protocol



IMPROVE-TOR gave ~ 40% higher CI source contributions than STN-TOT.

No effect on SI contributions.

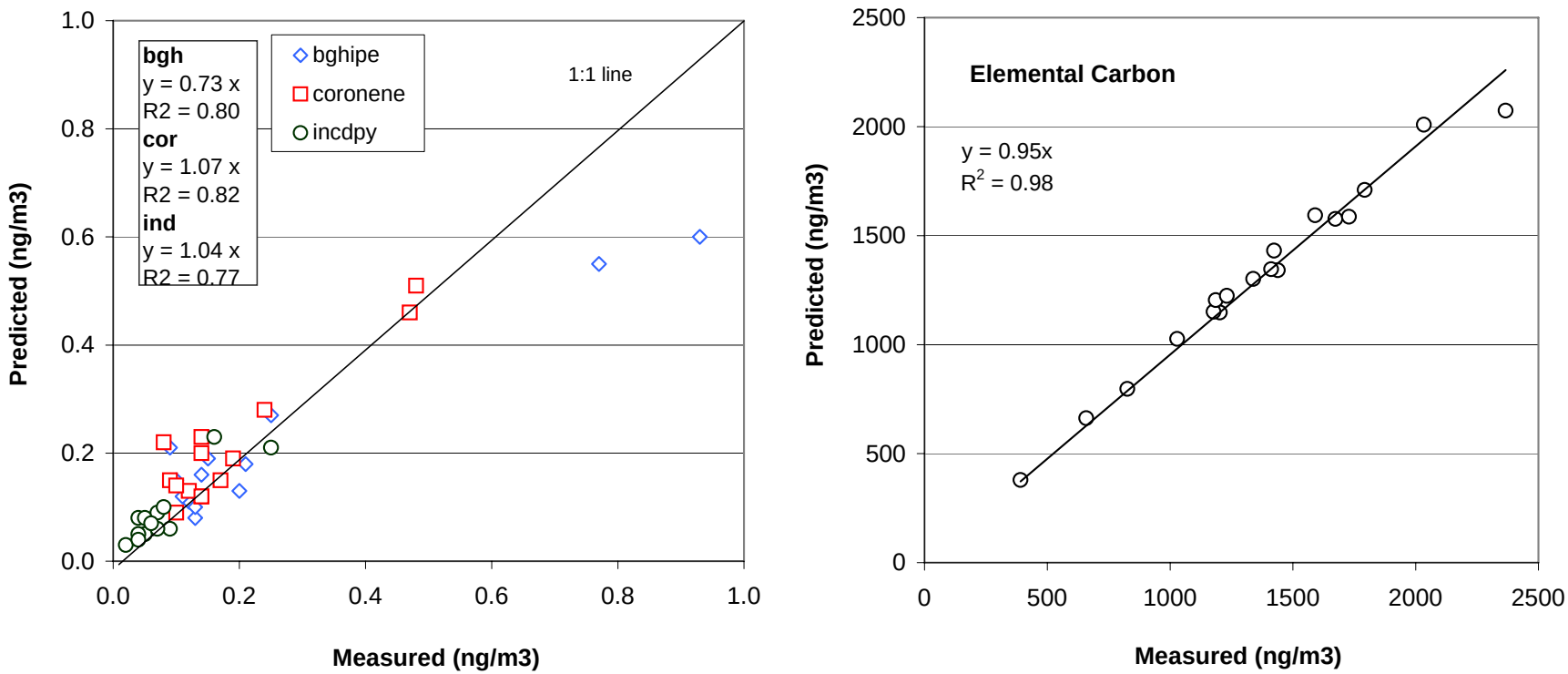


Figure 5. Correlations between measured and CMB-predicted ambient concentrations of indeno[123-cd]pyrene, benzo(ghi)perylene, coronene and "elemental" carbon as measured by the TOR-IMPROVE method.

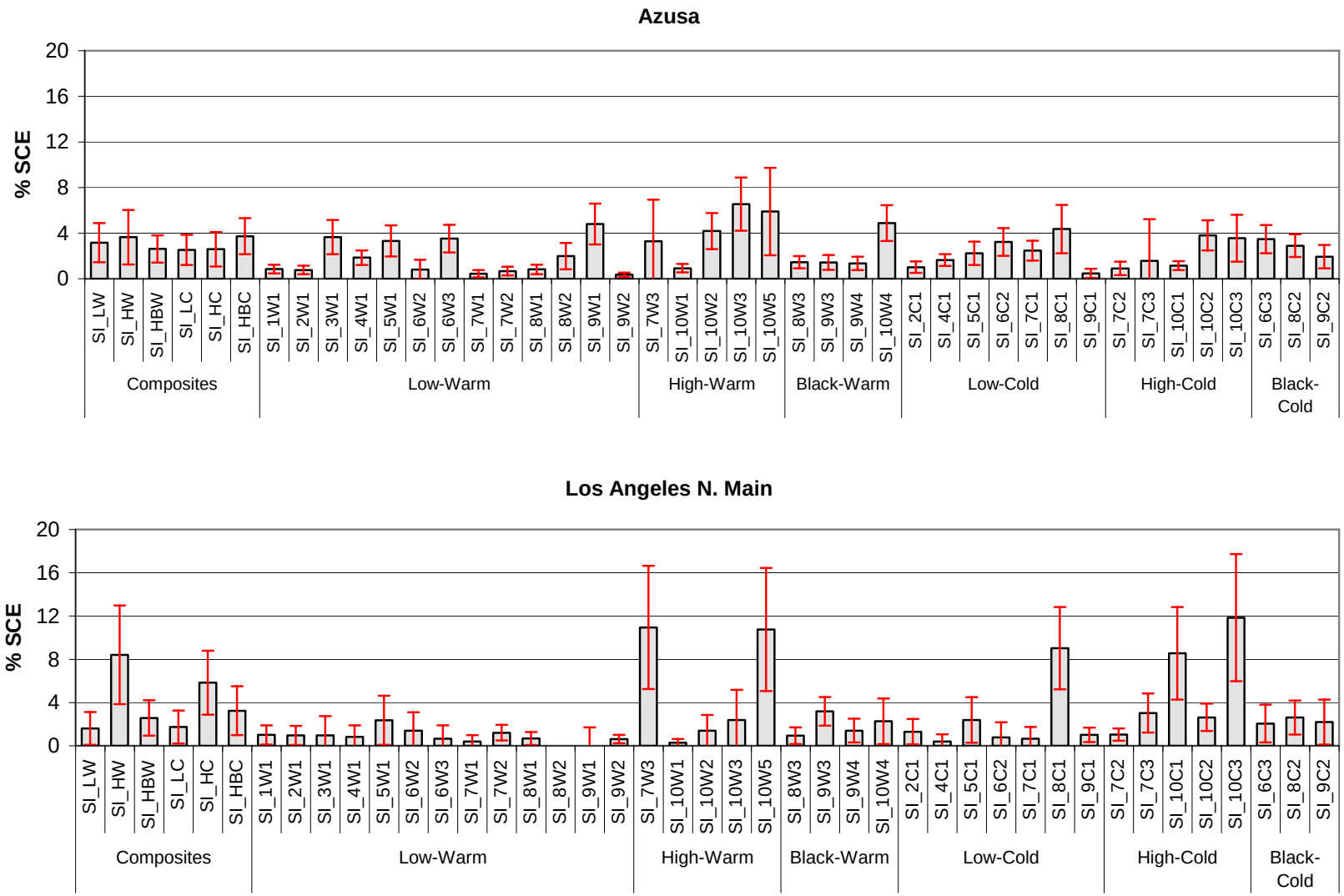


Figure 2a. Variations in CMB source contributions to ambient total particulate carbon with alternative composition profiles for spark-ignition vehicle exhaust. Sensitivity tests were applied to mid-week 24-hour PM samples from Azusa and Los Angeles N. Main.

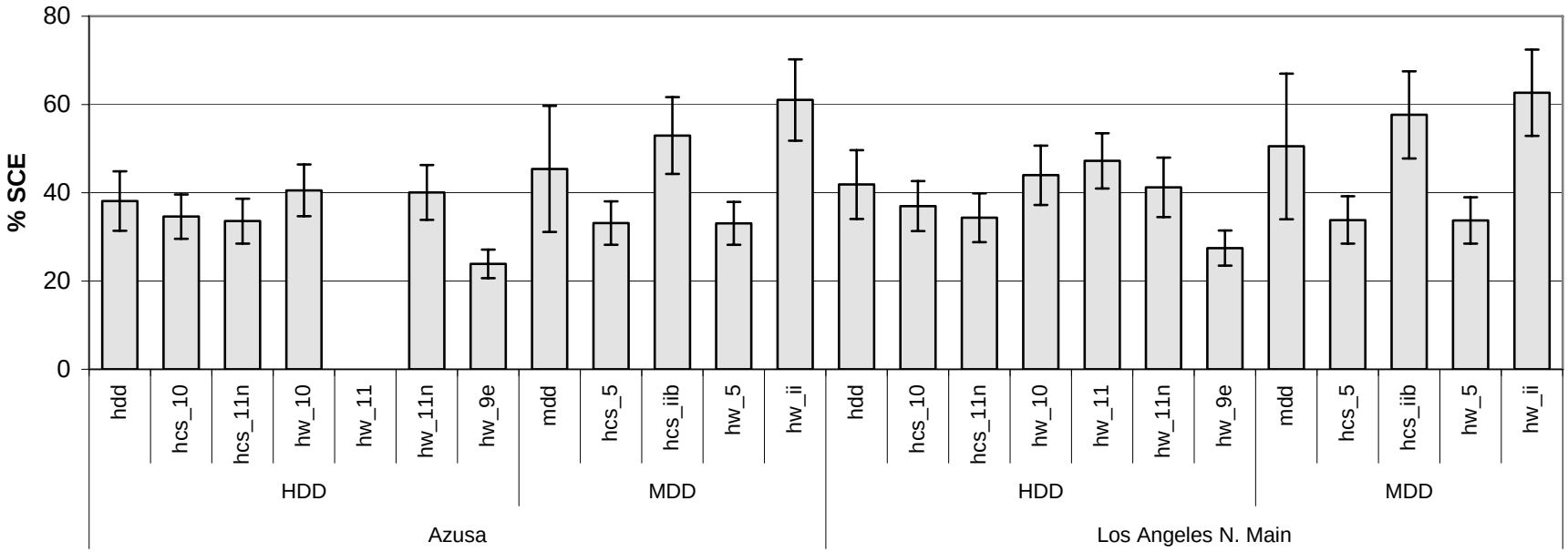


Figure 2b. Variations in CMB source contributions to ambient total particulate carbon with alternative composition profiles for compression-ignition vehicle exhaust. Sensitivity tests were applied to mid-week 24-hour PM samples from Azusa and Los Angeles N. Main.

Summary of Findings

- SI apportionment is most sensitive to indeno[123-cd]pyrene, benzo(ghi)perylene, and coronene and, to lesser extent, steranes and hopanes.
  - SI apportionment is sensitive to abundances of these species in the profile.
  - These PAHs are not detected in most diesel exhaust samples or in diesel fuel or lubrication oil.
  - They are present in used SI engine lubrication oil in similar proportions but concentrations increase with age of the oil.
  - EC emission for SI vehicles are minimal except in cold start and hard accels.
- EC has strong influence on CI apportionment and is therefore dependent on carbon measurement method.
  - CI apportionment is ~ 40% greater using IMPROVE rather than STN data.
- Spatial and temporal variations in relative CI and SI apportionments are large.
  - CI vehicles are the dominant source of EC and TC at Azusa and LANM. More equal apportionment in urban background locations.
  - Significant fraction of the organic carbon during summer in the SoCAB cannot be apportioned to directly-emitted PM emissions from motor vehicles.

Comparison of CMB Results by DRI and UWM

Webcast

The DOE Gasoline/Diesel PM Split Study

California Air Resources Board
Chairman's Air Pollution Seminar Series

Wednesday, September 7, 2005
1:30 p.m. - 3:00 p.m.
Training Room 1 East and West, First Floor
1001 I Street, Sacramento

http://www.arb.ca.gov/research/seminars/doe/doe.htm