DOE's Gasoline/Diesel PM Split Study

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South Coast Air Quality Management District

Participants

- Desert Research Institute and University of Wisconsin Madison
  - Source and ambient measurements and source apportionment
- U.S. Environmental Protection Agency and Clean Air Vehicle Technology Center
  - LD vehicle dynamometer measurements
- West Virginia University
  - MDD and HDD truck dynamometer measurements
- Bureau of Automotive Repair and South Coast Air Quality Management District
  - Light-duty vehicle recruitment
  - Smog check
- California Trucking Associations
  - Heavy-duty vehicle recruitment
- Ralphs Grocery Distribution Center
  - Test site and logistics

Gasoline/Diesel PM Split Study

Objective: To quantify the relative contribution of PM emissions from gasoline- and diesel-powered engines in the South Coast Air Basin

Approach:

- Source testing of SI and CI 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

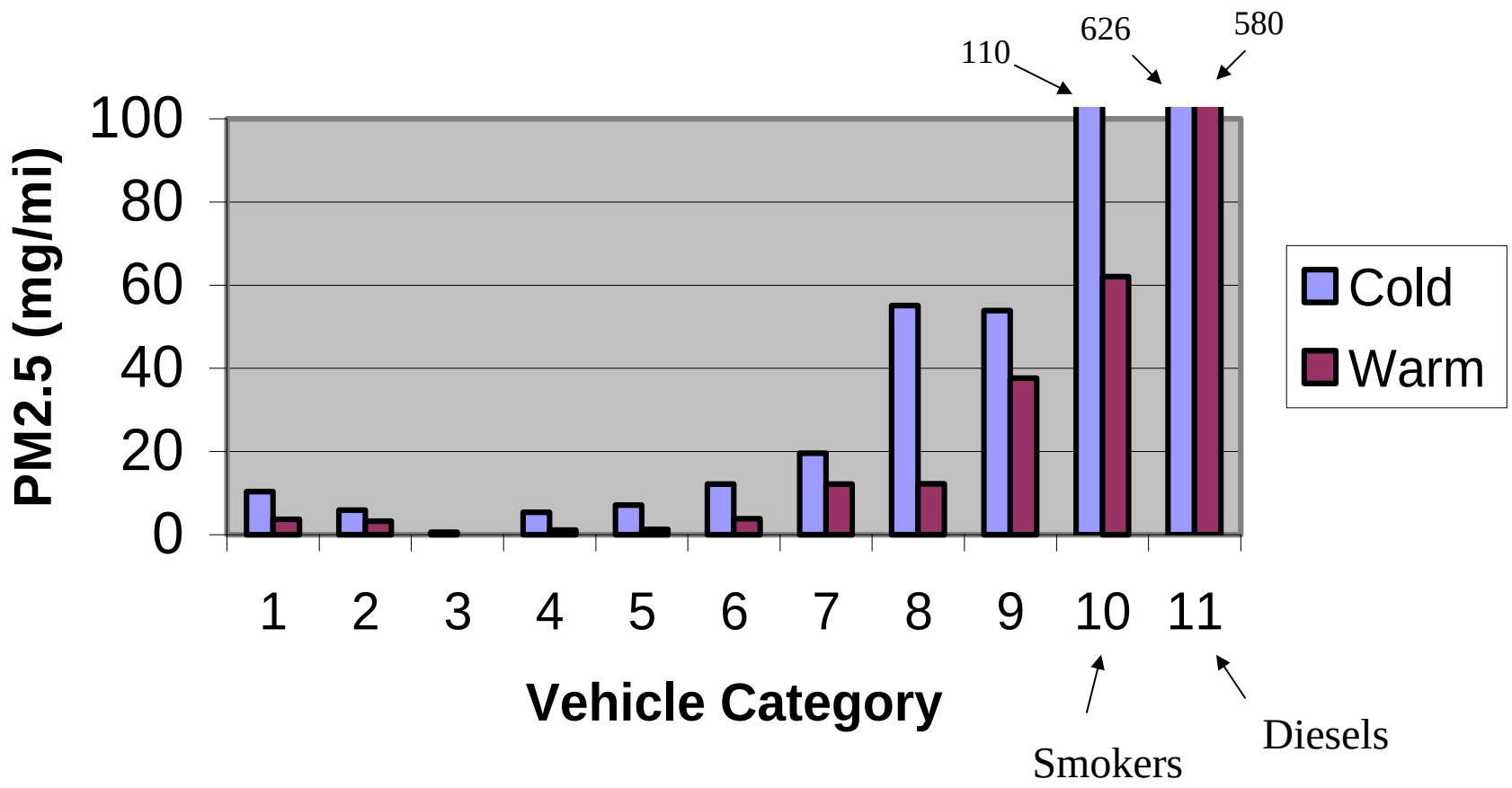
Gasoline/Diesel PM Split Study

Approach (Continued):

- Ambient samples (June -July 2001)
  - Downtown Los Angeles and Azusa - daily 24 hr, four weeks, composite by day-of-week
  - Variety of locations with variable amount of gasoline and diesel traffic
- Chemically analyze source and ambient samples
  - Organic and elemental carbon, ions, elements, semi-volatile and particulate PAH, hopanes, steranes, polar organics and alkanes.
- Construct source profiles
- Perform Chemical Mass Balance (CMB) receptor modeling
- Publish results in peer-reviewed literature

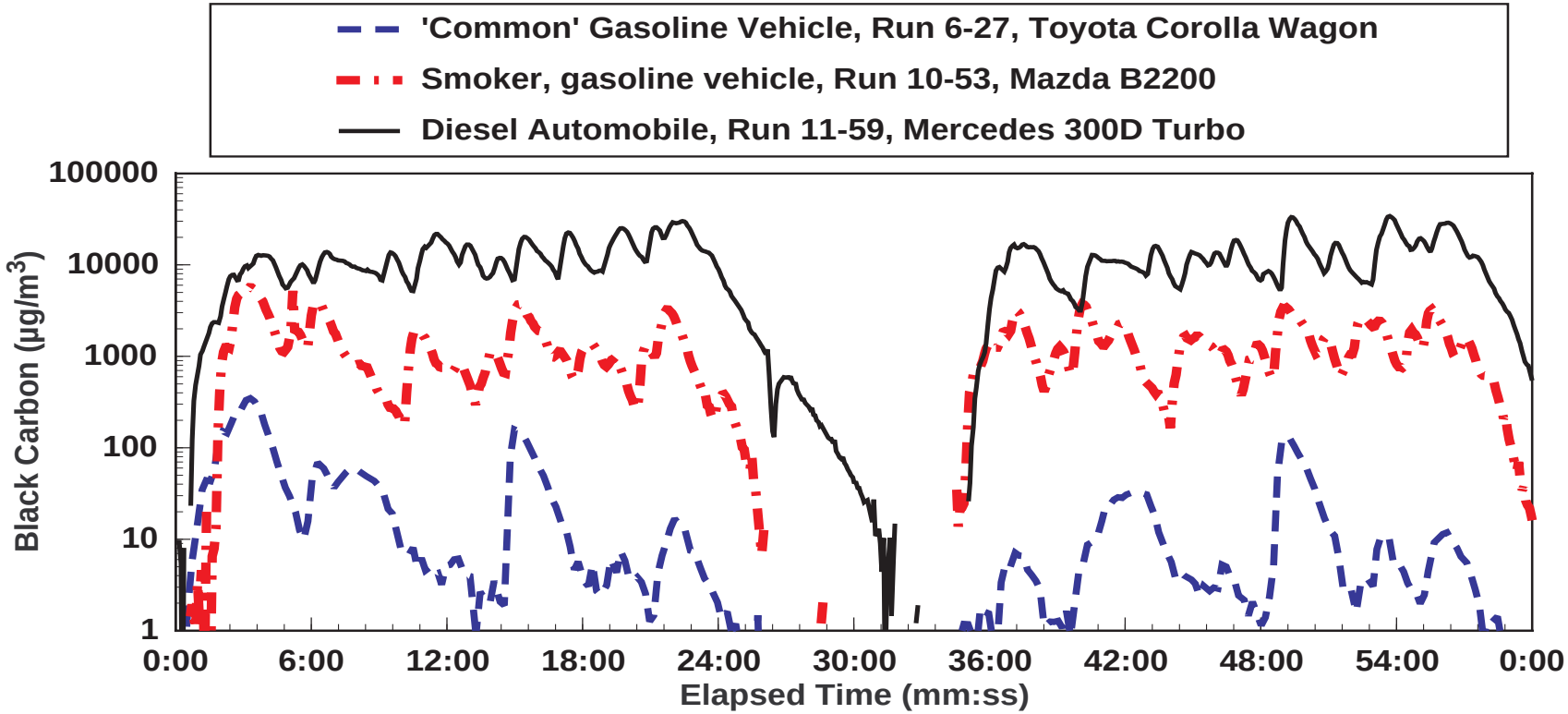
LDV and HDV Exhaust Sampling Systems

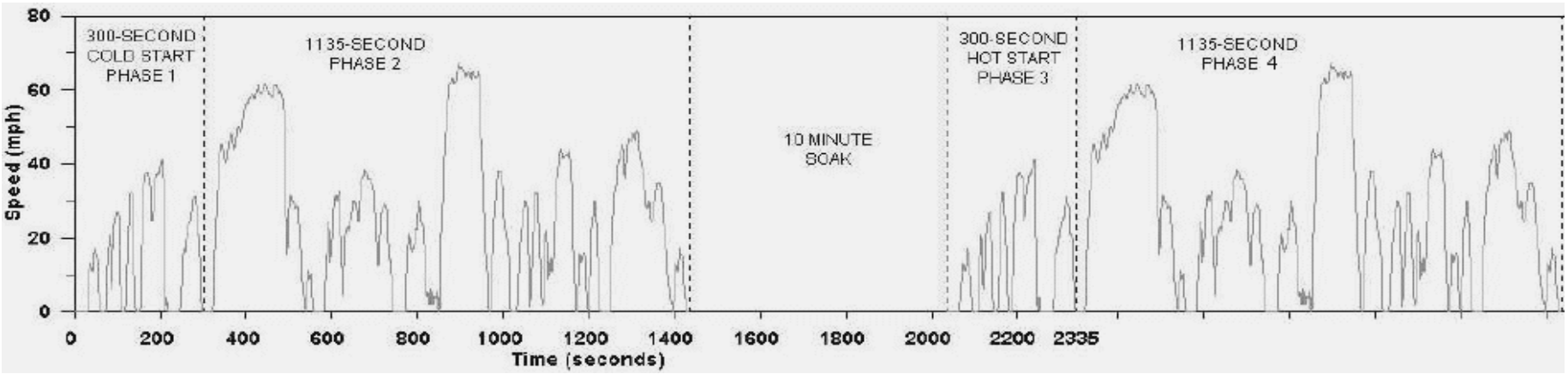
Gasoline/Diesel PM Split Study – Average $PM_{2.5}$ Emission Rates for 11 Categories Tested



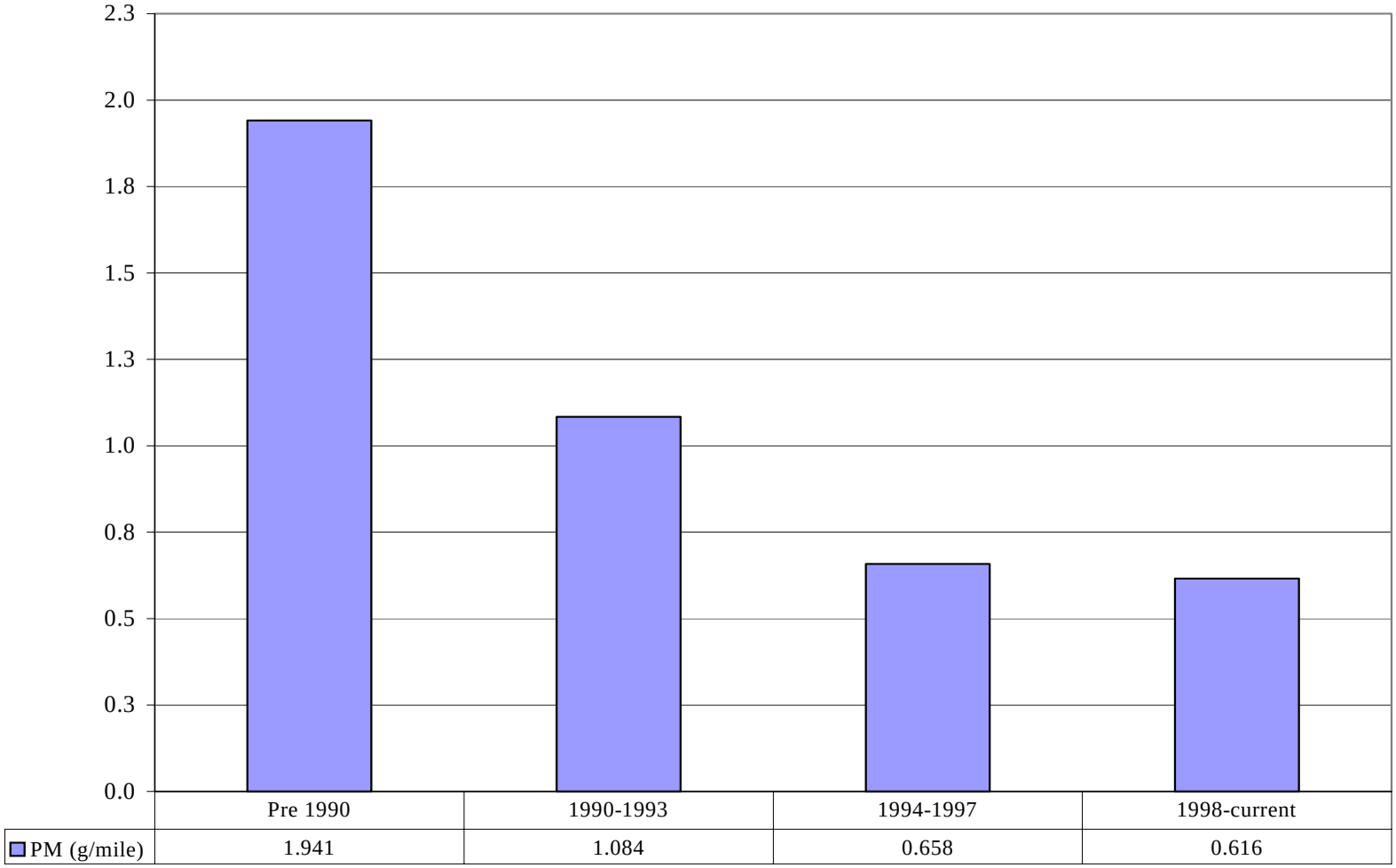
Source: P. Gabele, EPA

Black Carbon During the Modified UC Test Cycle





PM emission rates (g/mi) for PM increase in older vehicles in the 30,001-80,000 lbs. portion of the HD vehicle matrix for a CSHVR test



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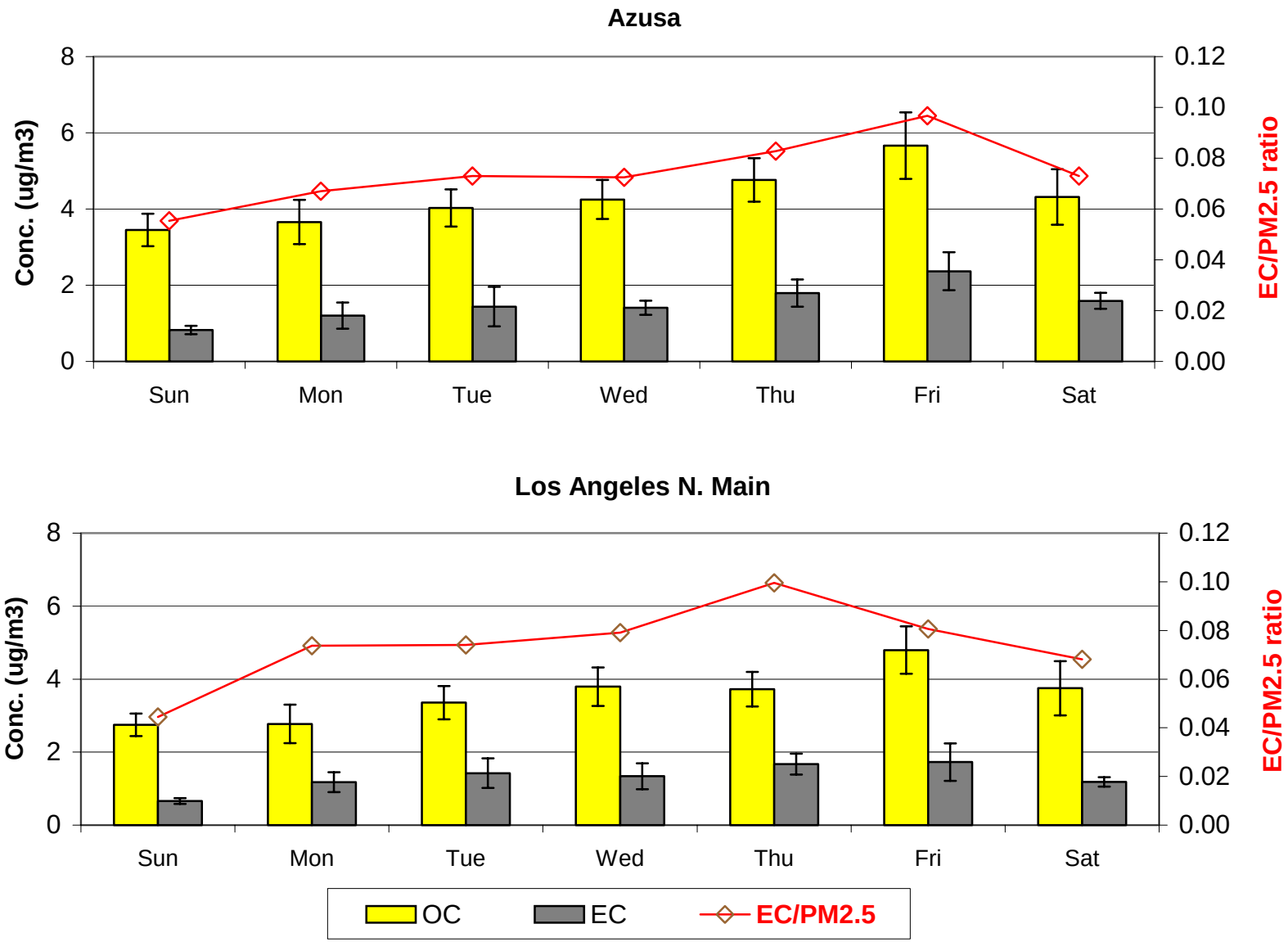
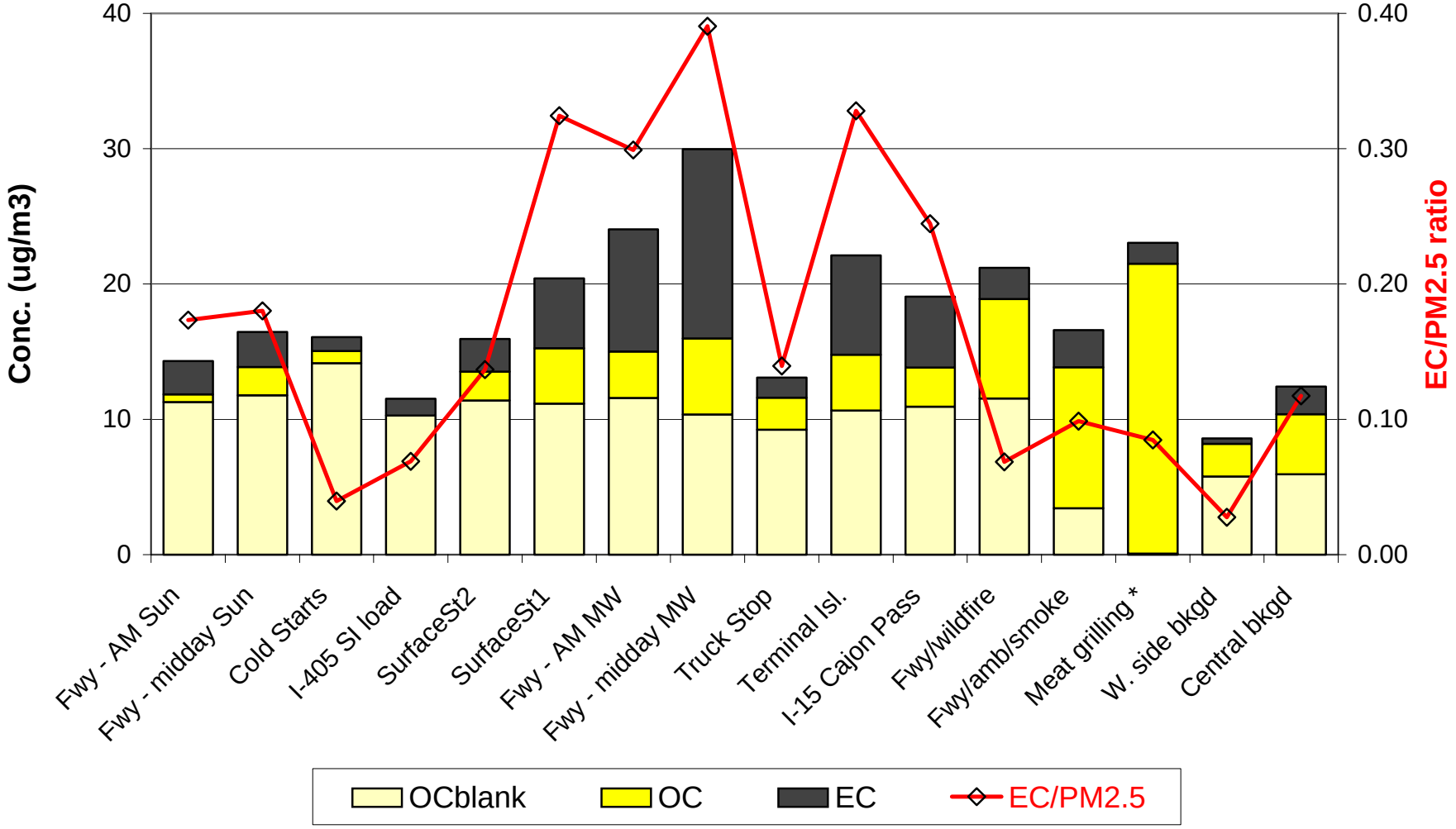
Fixed-Site Ambient Samples – OC, EC and EC/$PM_{2.5}$ Ratios



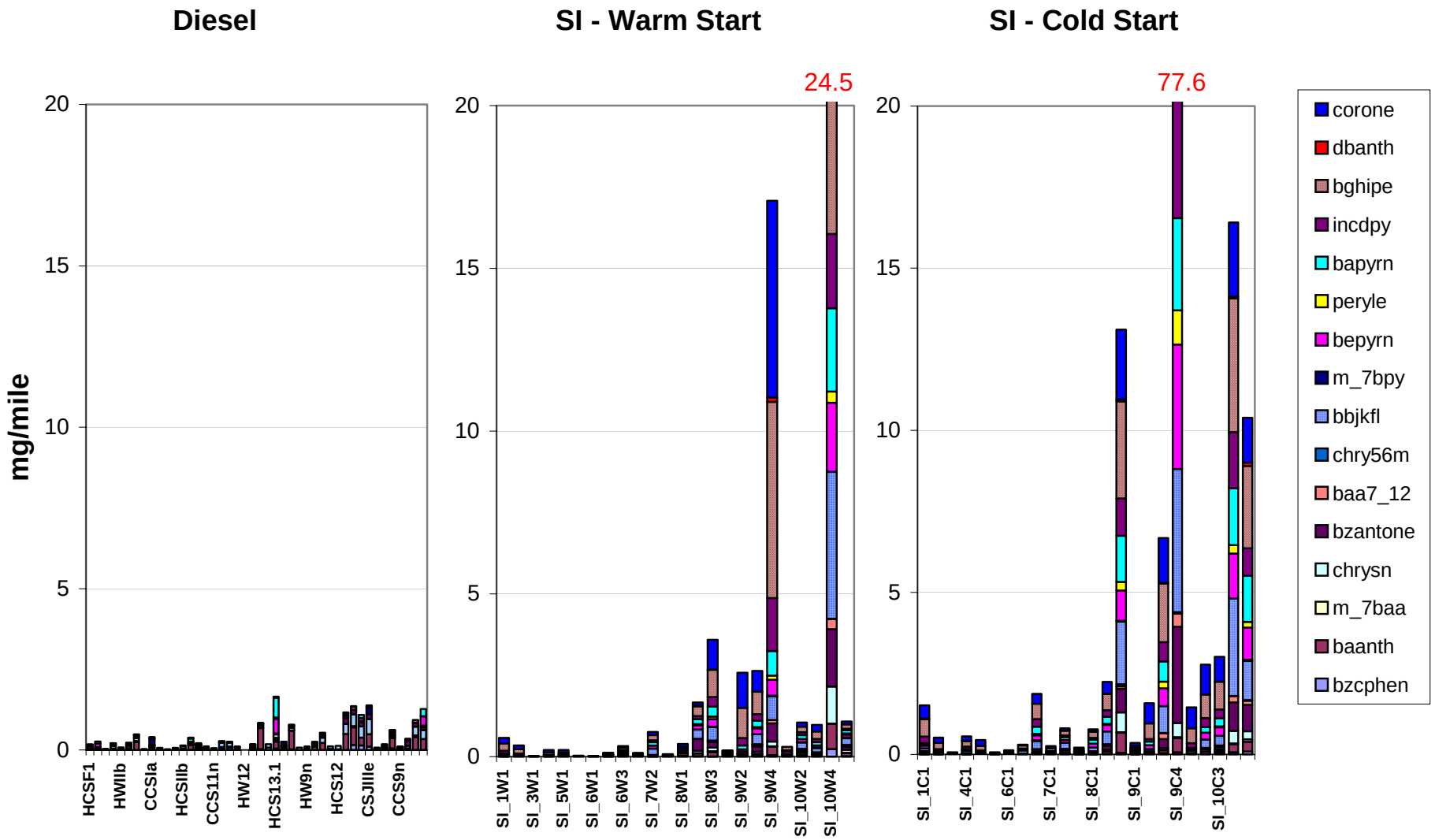
Source-Dominated Ambient Samples

DOE's Gasoline/Diesel PM Split Study
Mobile Ambient Samples – OC, EC and EC/$PM_{2.5}$ Ratios

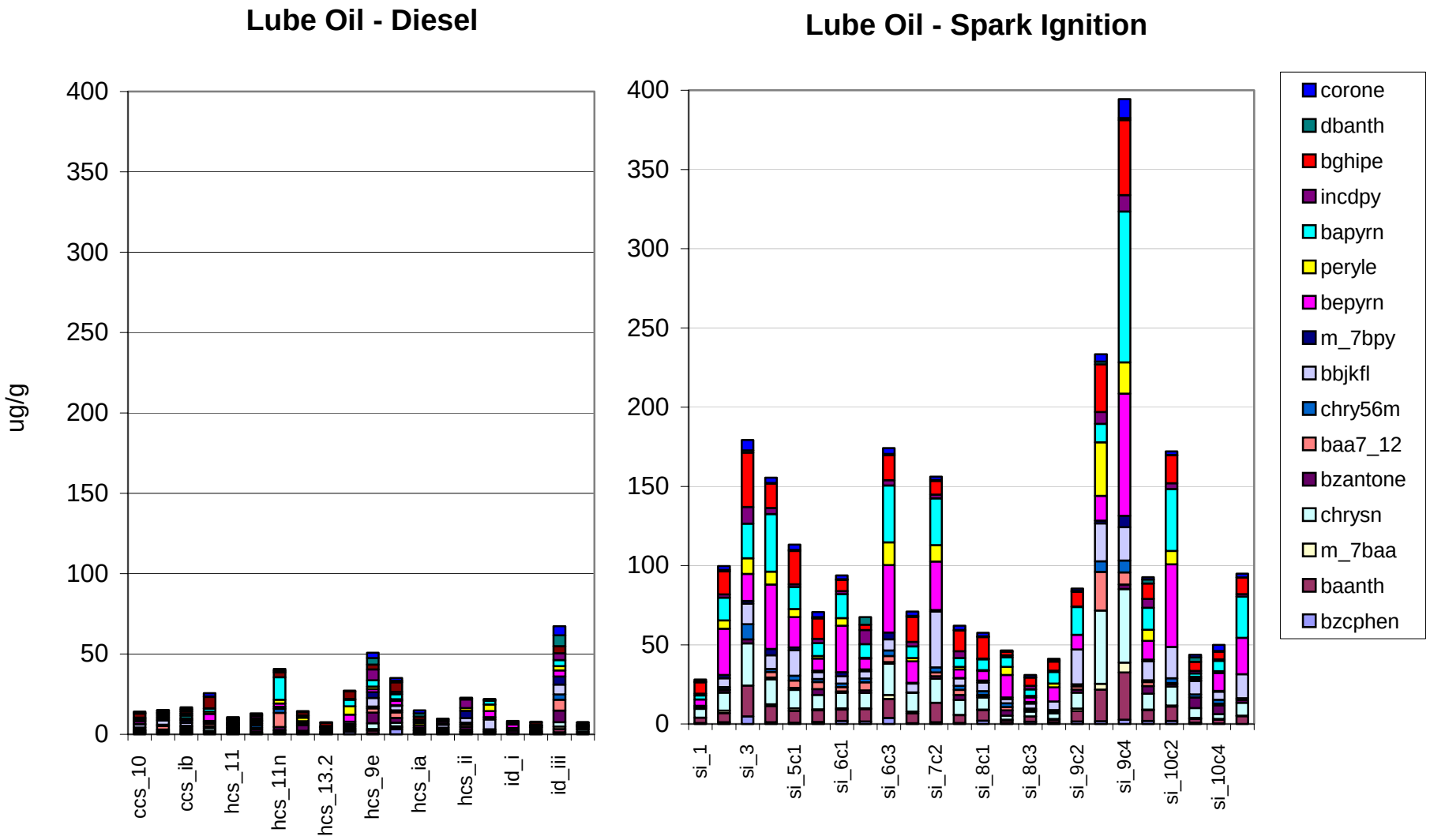


* Concentration divided by 2000.

DOE Gasoline/Diesel PM Split Study
Particle-Phase PAH in Exhaust



DOE Gasoline/Diesel PM Split Study
Particle-Phase PAH in Lubrication Oil



Initial Finding and Observations

- The ten highest PM, HC, CO, and NO_x emitters contributed 66, 66, 58, and 39%, respectively, of the total PM, HC, CO, and NO_x emissions from the 57 gasoline cars tested.
- Gasoline powered ‘smokers’ can rival diesel cars in PM emission rates, but usually have less PM fraction in soot
- Diesel fuel is enriched in volatile- and semi-volatile PAH in comparison with gasoline fuel.
- Used gasoline oil is enriched in PAH, including heavy, particle phase PAH, as compared with used diesel oil.
- Lube oils in gasoline vehicles absorb and concentrate particulate PAHs that are formed during combustion. This is not the case for diesel vehicles.
- Gasoline vehicle exhaust is enriched in particulate PAH as compared with diesel exhaust.

Current Work

- Construct Source Profile from Gasoline/Diesel PM Split
  - 57 light-duty gasoline vehicles and 2 light-duty diesel vehicles.
  - 34 HD vehicles grouped by model year; tested over a variety of cycles, including cold starts and idle
  - Road dust
- Construct Other Profiles
  - Off-road vehicles (CRPAQS)
  - Brake and tire wear (CRPAQS)
  - Wood combustion (CRPAQS)
  - Meat cooking (CRPAQS)
- Perform Chemical Mass Balance receptor modeling
- Publish results in peer-reviewed literature