

# (On-Road) Mobile Source Emissions and Mitigation Potential

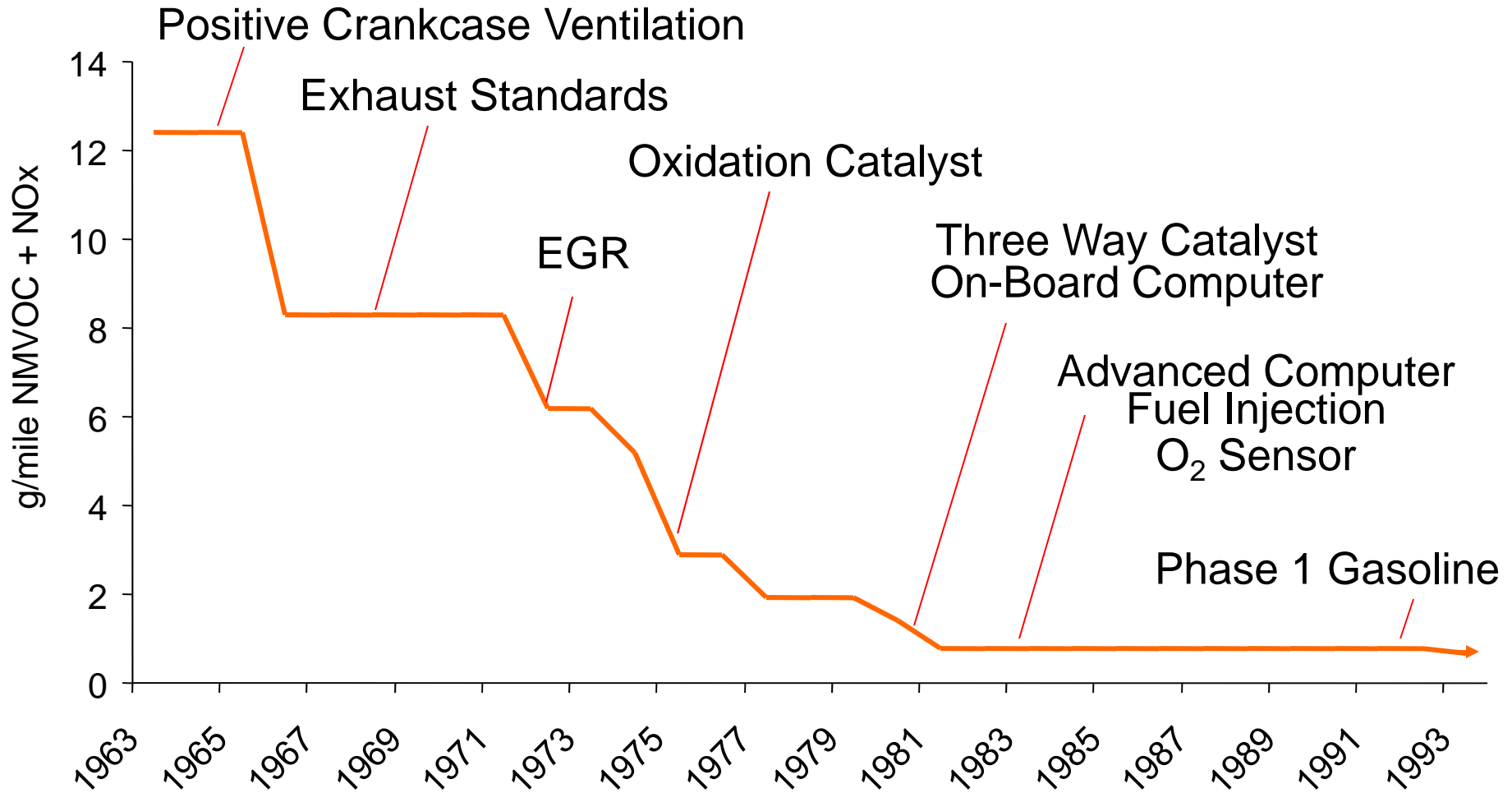
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Workshop on Addressing Black Carbon and Ozone  
as Short-Lived Climate Forcers  
Chapel Hill, NC  
March 4, 2010

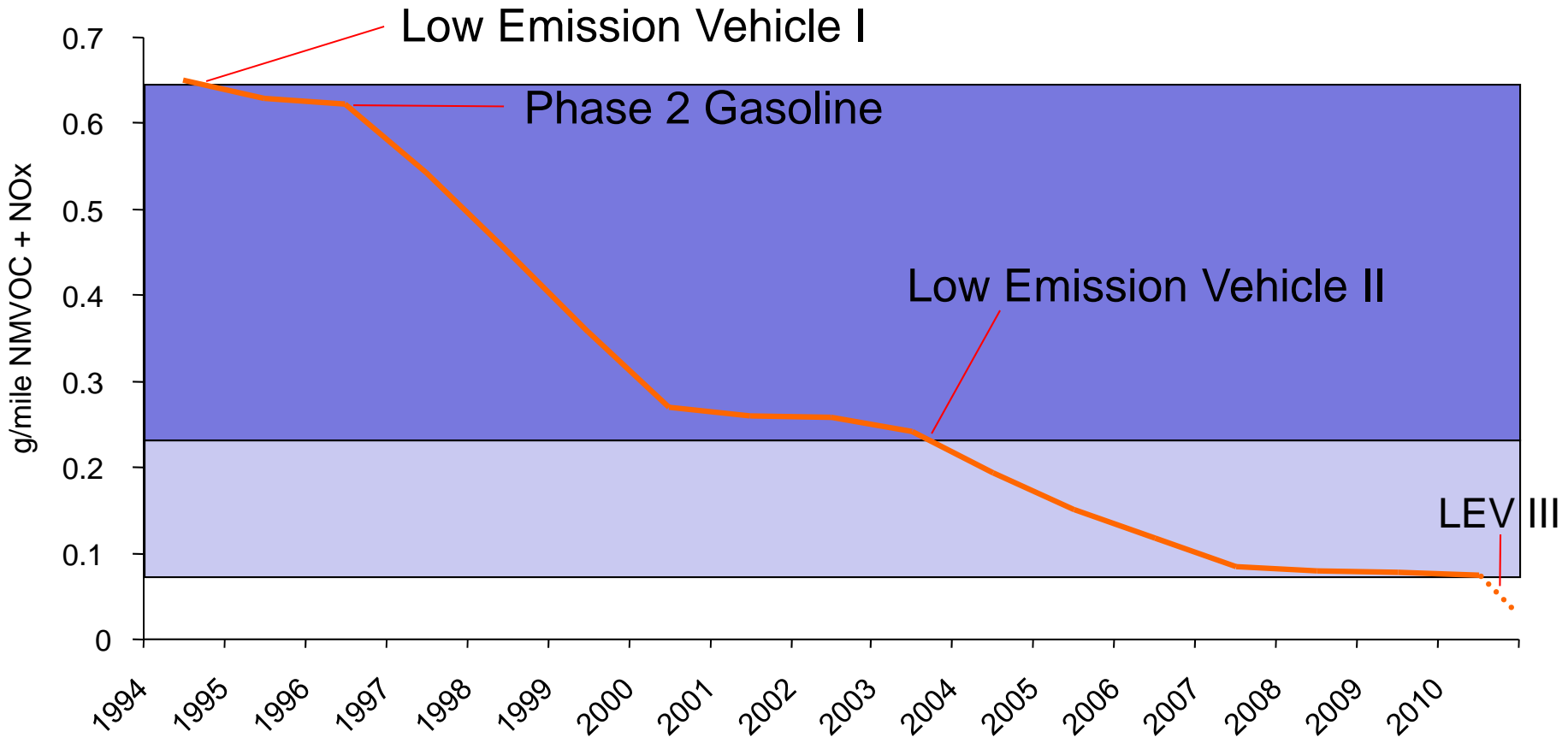
Soot is produced by spark-ignition vehicles...and lots of other sources!  
(from the tailpipe of relatively new (7k mi) Toyota Prius at NREL)



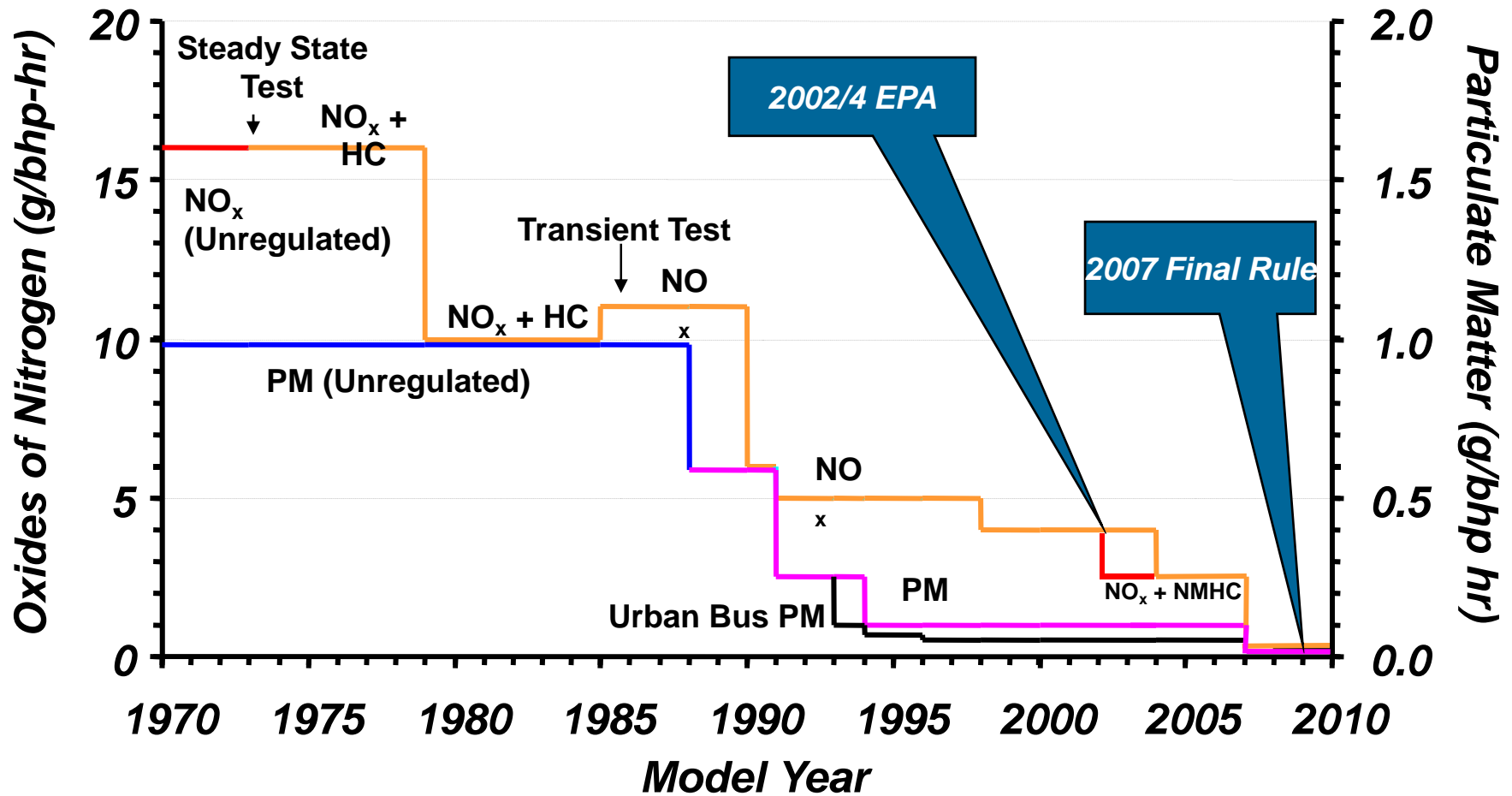
# Evolution of CARB LD Vehicle Standards (Implementation: 1963 – 1993)



# Evolution of CARB LD Vehicle Standards (Implementation: 1994 – 2010 and beyond!)

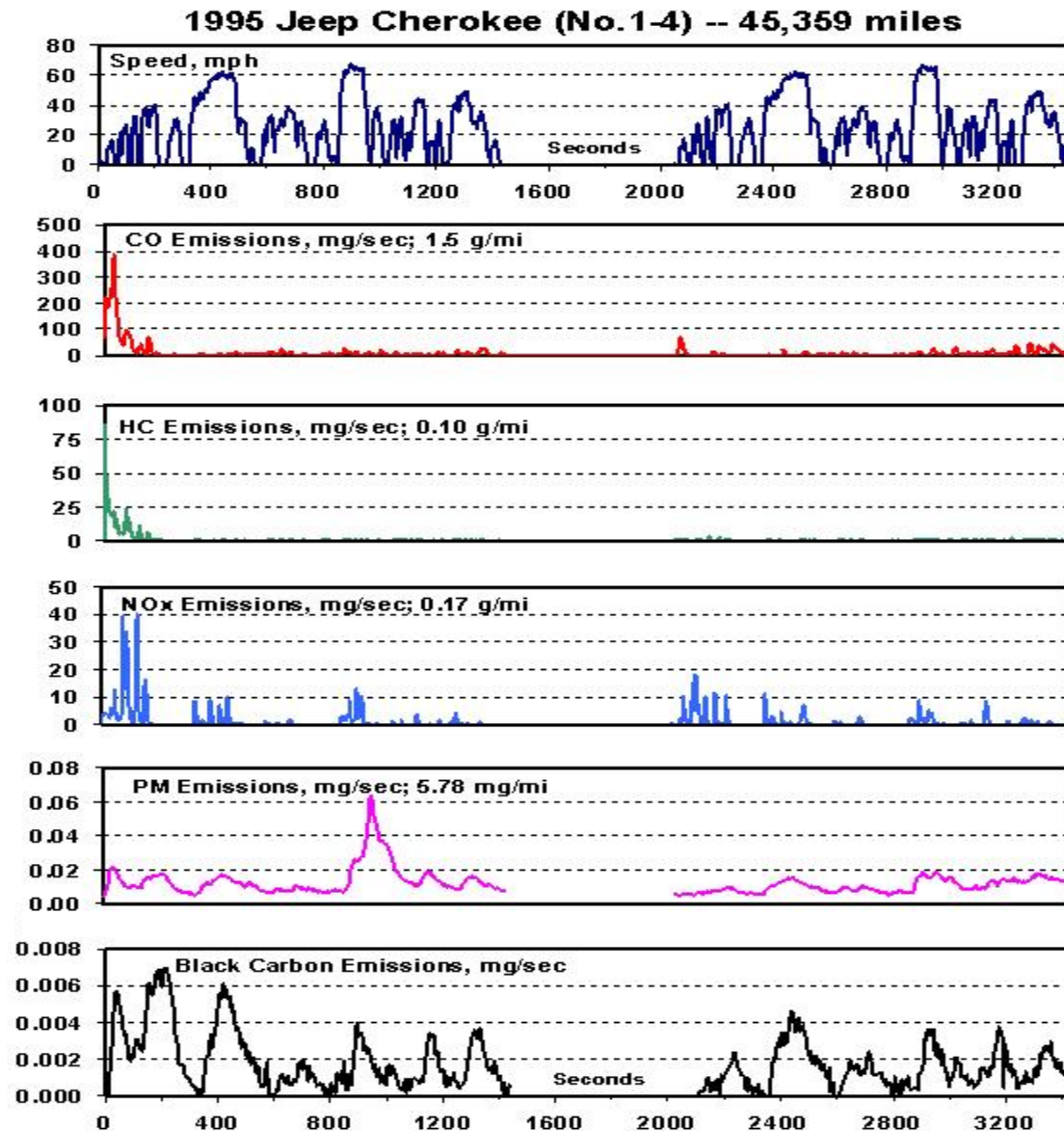


# HD Diesel Emission Standards US EPA



# Sec-by-sec emissions from a 5-yr old SUV

## DOE/NREL Gasoline/Diesel PM Split Study



Ref: Lawson *et al.*,  
14<sup>th</sup> On-Road  
Vehicle Emissions  
Workshop, 2004

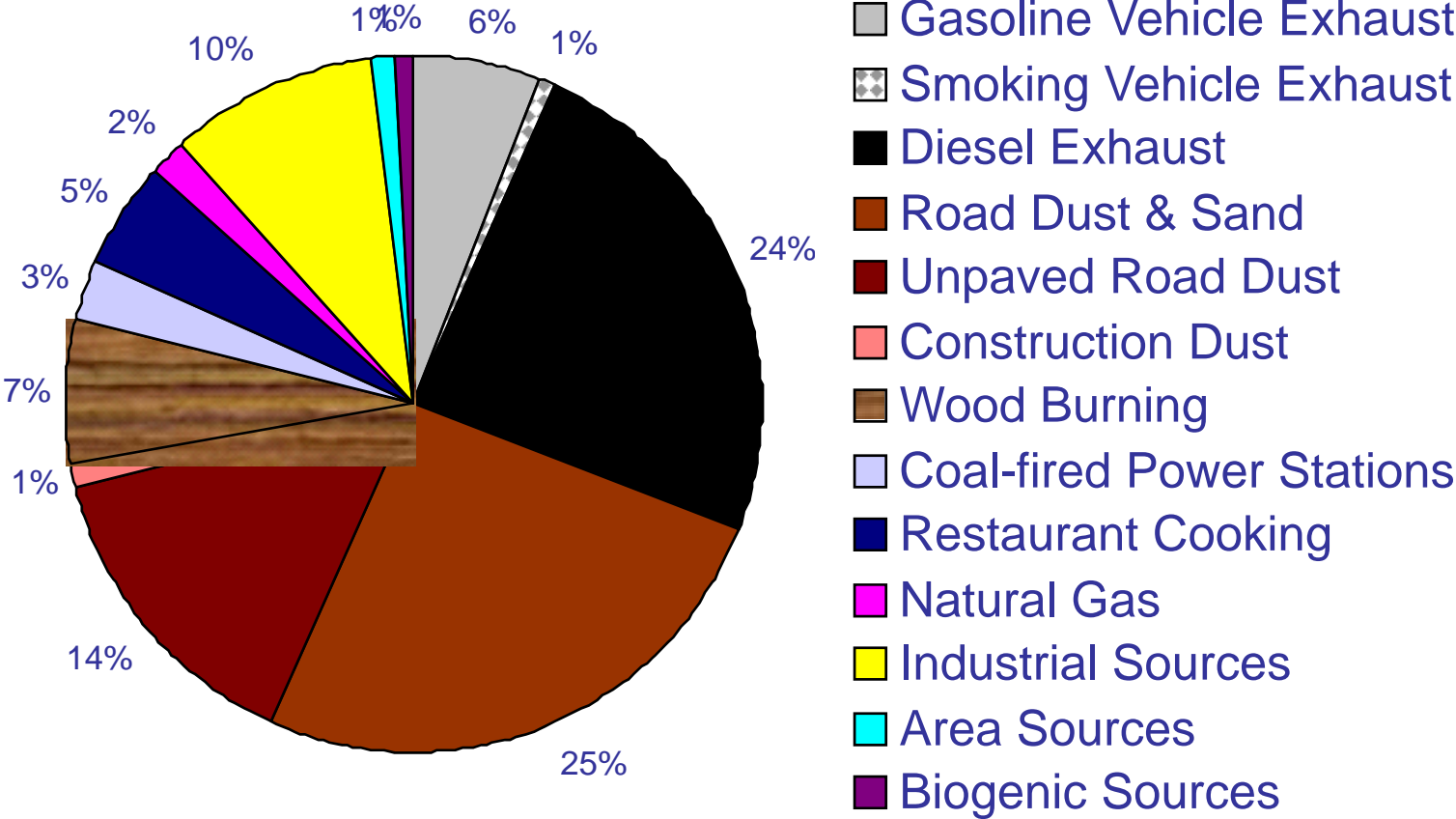
# PM Emissions from “Mobile Sources”



PM from light-duty vehicle “normal” emitter’s tailpipe = <1-2 mg/mile  
PM from new 2007-compliant heavy-duty diesel trucks = 1-4 mg/mile  
PM from Amy Winehouse’s open window at 60 mph = 5 mg/mile

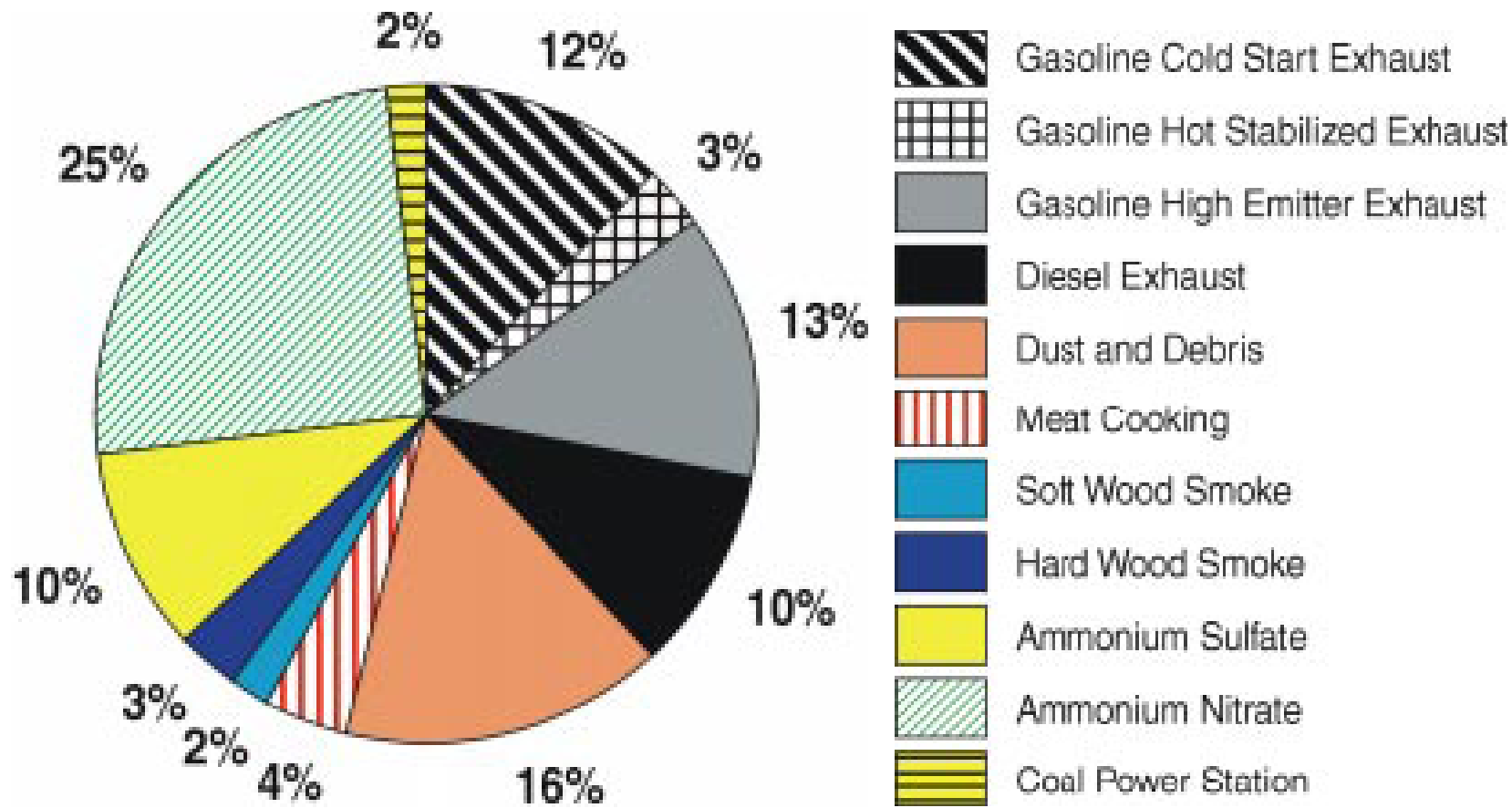
What do we need to do to  
improve our mobile source  
emission inventories?

# Denver Winter PM<sub>2.5</sub> Inventory, 1995



Ref: Denver Regional Air Quality Council, "Blueprint for Clean Air," April 24, 1998

24-hour average  $PM_{2.5}$  blame apportionment at Welby during the Winter 1997 NFRAQS episode periods, using receptor modeling with detailed speciation. Sources of ammonium nitrate and ammonium sulfate not identified.



Refs: Watson and Fujita *et al.* (1998); Lawson *et al.* (1998)

If HC, CO, NO<sub>x</sub> and PM emissions from new vehicles are so low, why are we having problems with urban ozone PM (black carbon) and downwind ozone?

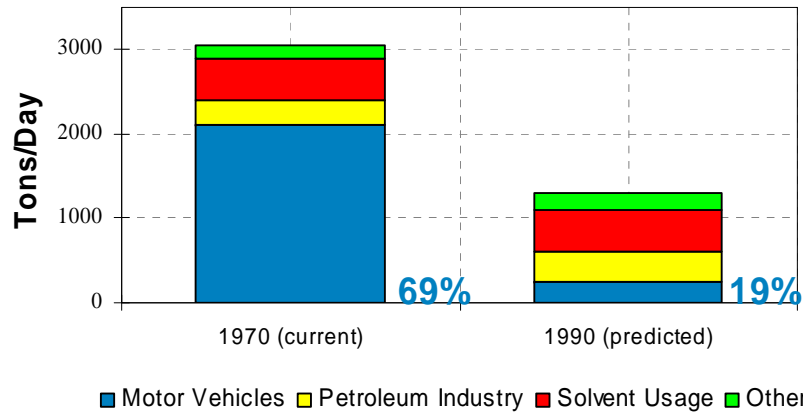
# Projected Contributions of Mobile Sources to SoCAB Air Quality

- “It is apparent that by 1980, motor vehicles will not be the major source of hydrocarbons and oxides of nitrogen, and greater emphasis will have to be placed on emissions from nonvehicular sources.” – *Air Pollution Control in California, 1971 Annual Report*, page 34.
- “However, contribution to VOC by mobile sources is reduced due to CARB regulations over time. Area sources become major contributors to VOC emissions (from 27 percent in 2002 to 42 percent in 2020).”, Draft 2007 AQMP, Appendix III, page III-2-14.

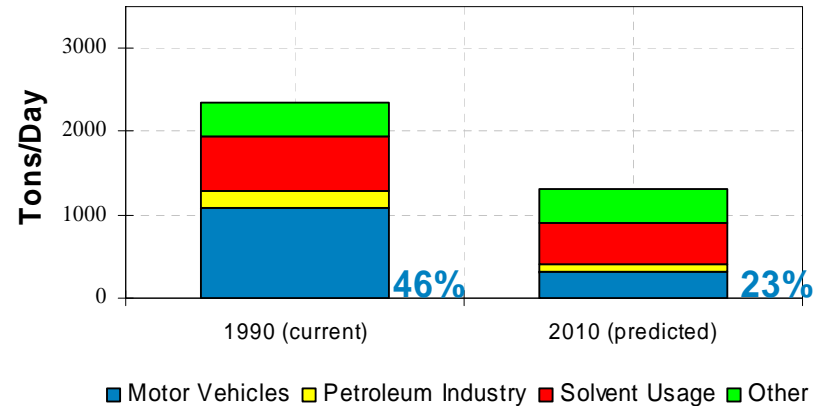
# SoCAB HC Inventories

## “Current” vs. Future

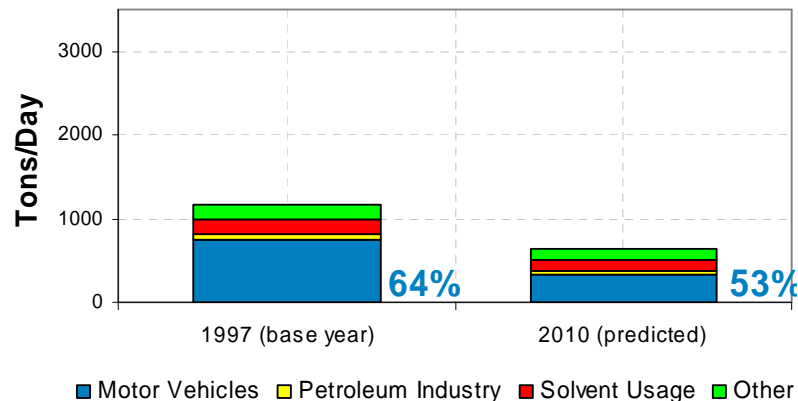
**South Coast Air Basin-1970  
Current and Future HC Inventories**



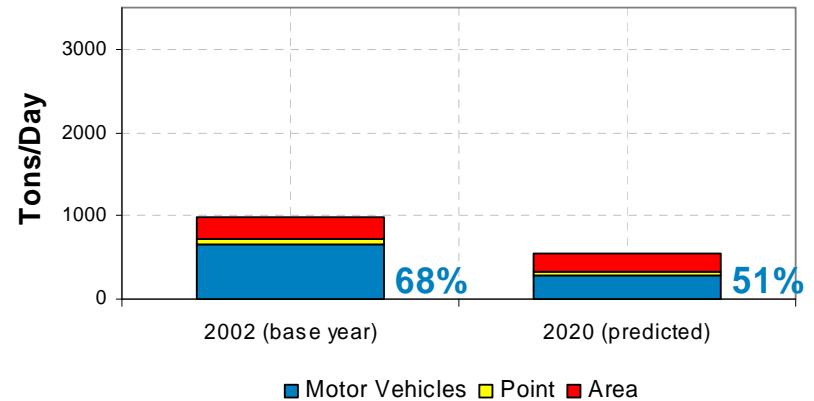
**South Coast Air Basin-1990  
Current and Future HC Inventories**



**2003 South Coast AQMP  
Base Year and Future HC Inventories**



**2007 South Coast AQMP (Draft)  
Base Year and Future VOC Inventories**

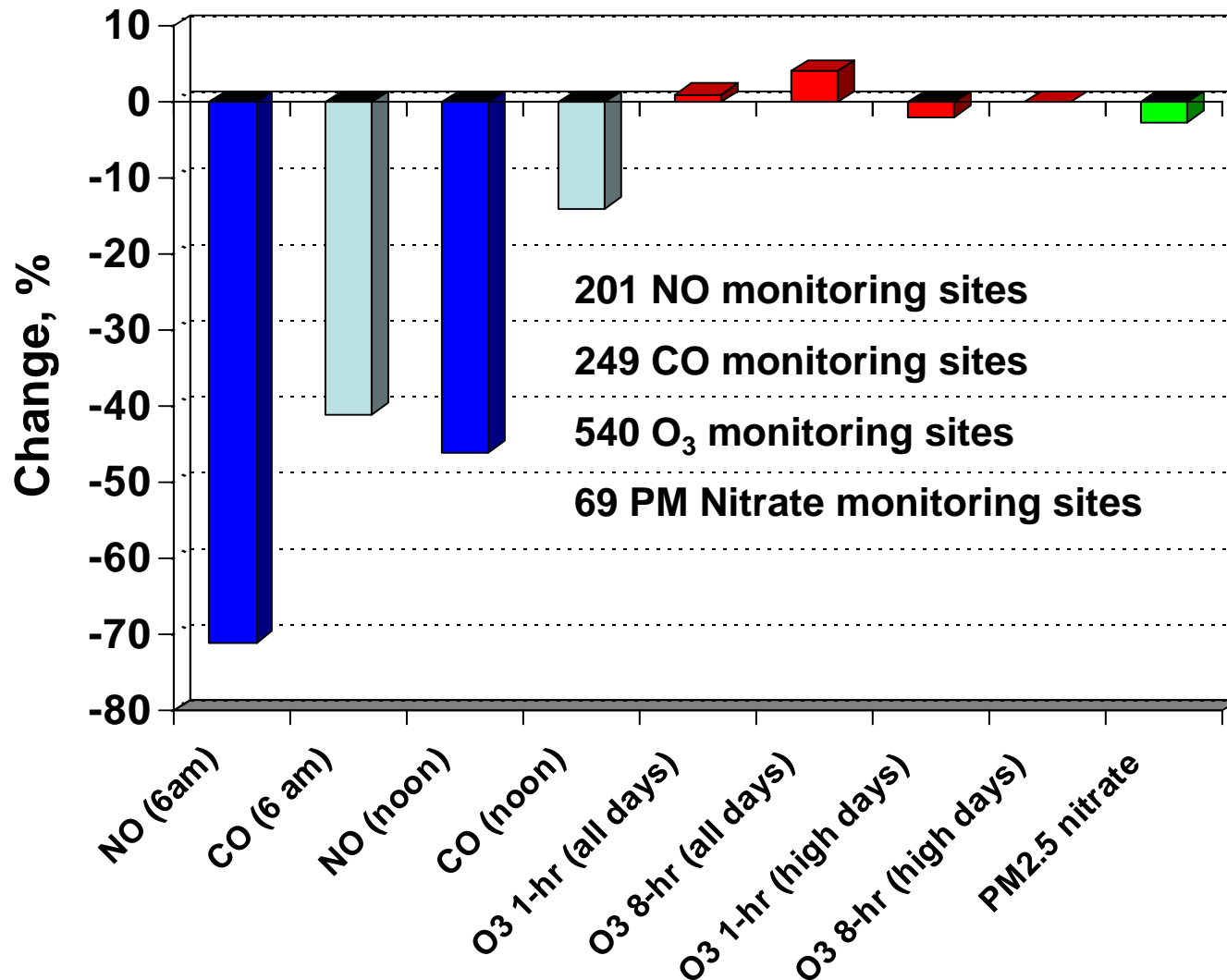


# Weekend Ozone Effect


One of the two major reasons ozone attainment is so difficult: When  $\text{NO}_x$  reductions  $>$  HC reductions, ambient urban (and downwind?) ozone levels do not decrease and increase in many locations


# Wednesday-to-Sunday Pollutant Changes

## Median Values, 23 States, 1998-2003



# 1987-2000 VOC & NOx (and Beyond)

 Mean Wednesday  
 $\pm 1$  sigma

 Mean Sunday  
 $\pm 1$  sigma

## Monitoring Stations

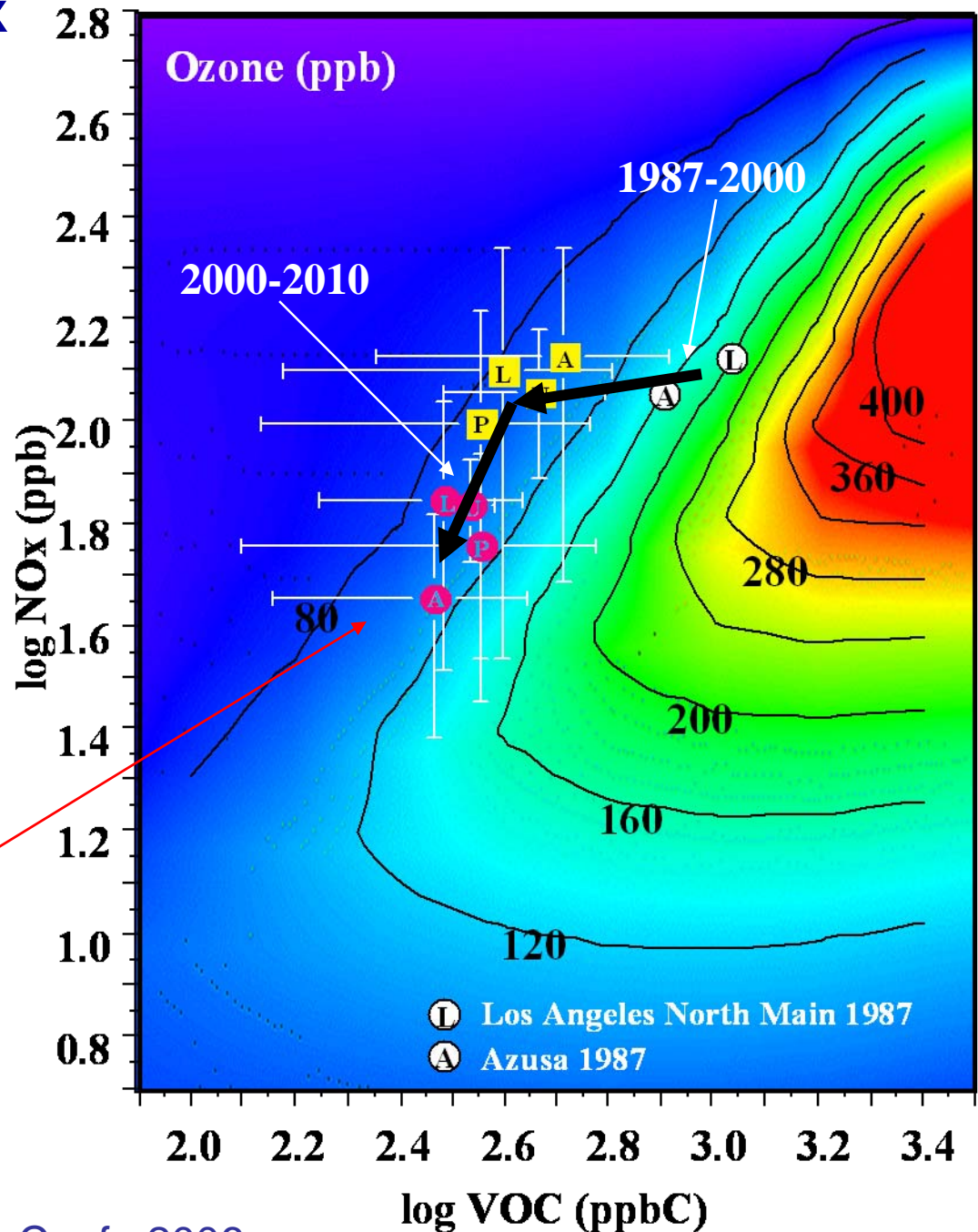
A – Azusa

L – Los Angeles, N. Main

P – Pico Rivera

U – Upland

**Weekday VOC and NOx  
 emissions in 2010 are  
 projected to be similar to  
 weekend emissions in  
 2000.**



# Nationwide On-Road Idle HC Emissions

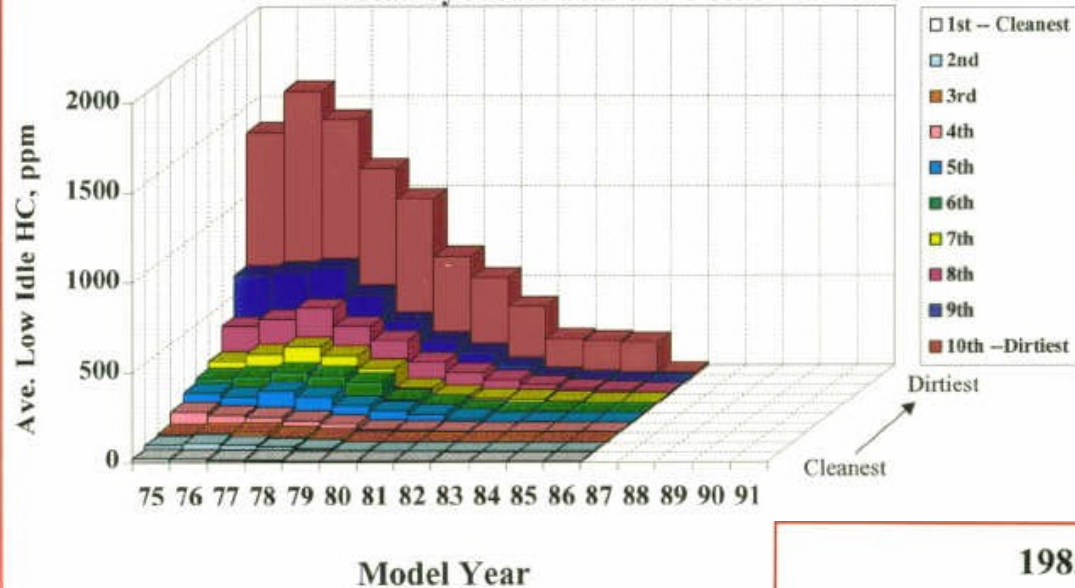
EPA's 1985 National Tampering Survey

6498 vehicles

## 1985 EPA National Tampering Survey

### Low Idle HC Emissions

#### Mean by Model Year and Decile n = 6498



On average, fleet emissions increase as vehicles age; mean fleet emissions driven by high emitters

Most new cars are clean; a few new vehicles are dirty; most old cars are “clean”

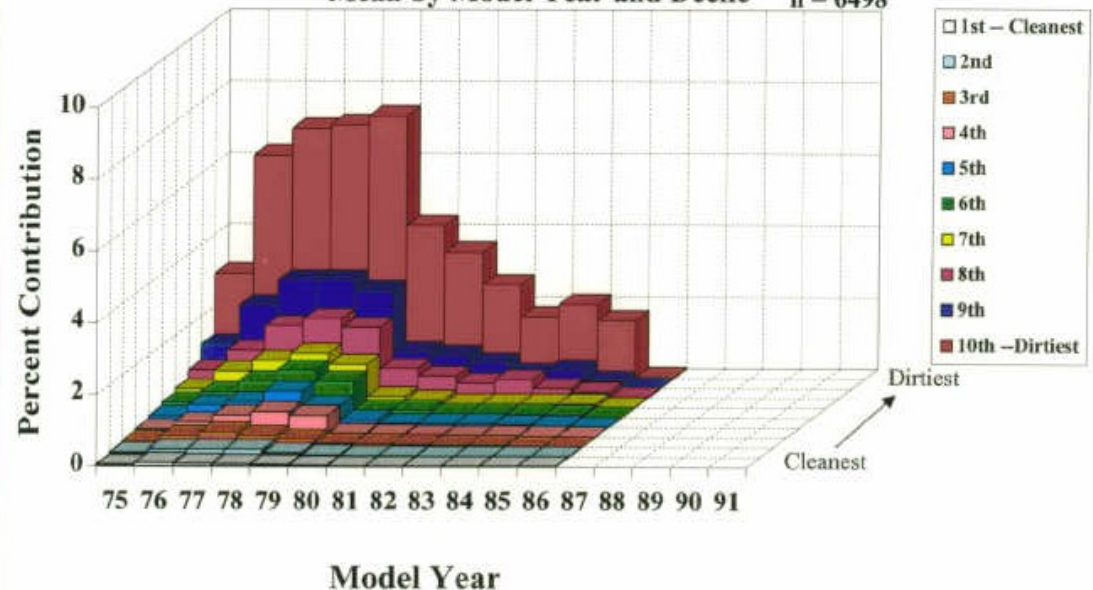
New vehicles irrelevant to air quality

Ref: Lawson *et al.* , 1993,1996

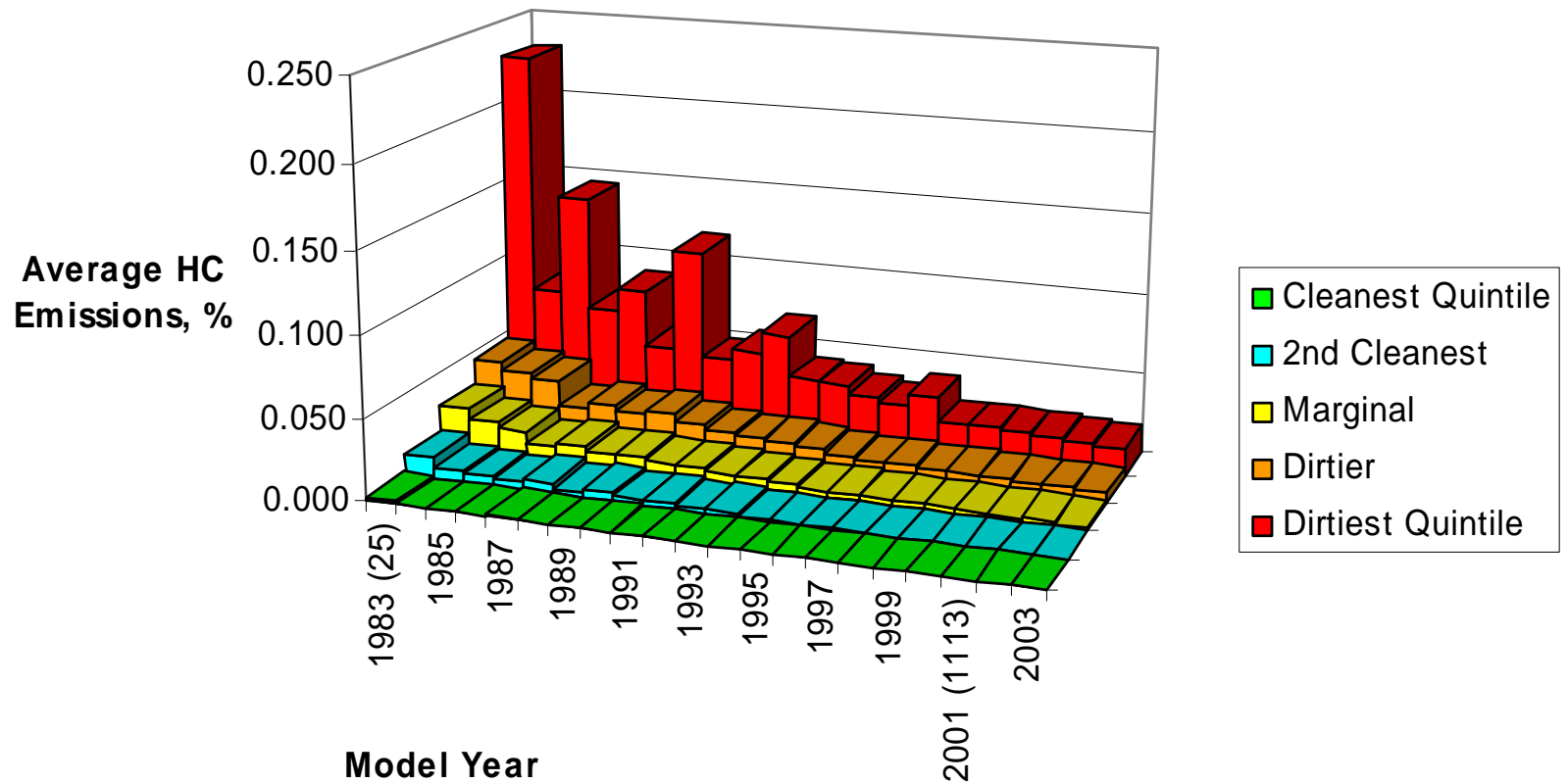
## 1985 EPA National Tampering Survey

### Contribution to Low Idle HC Emissions

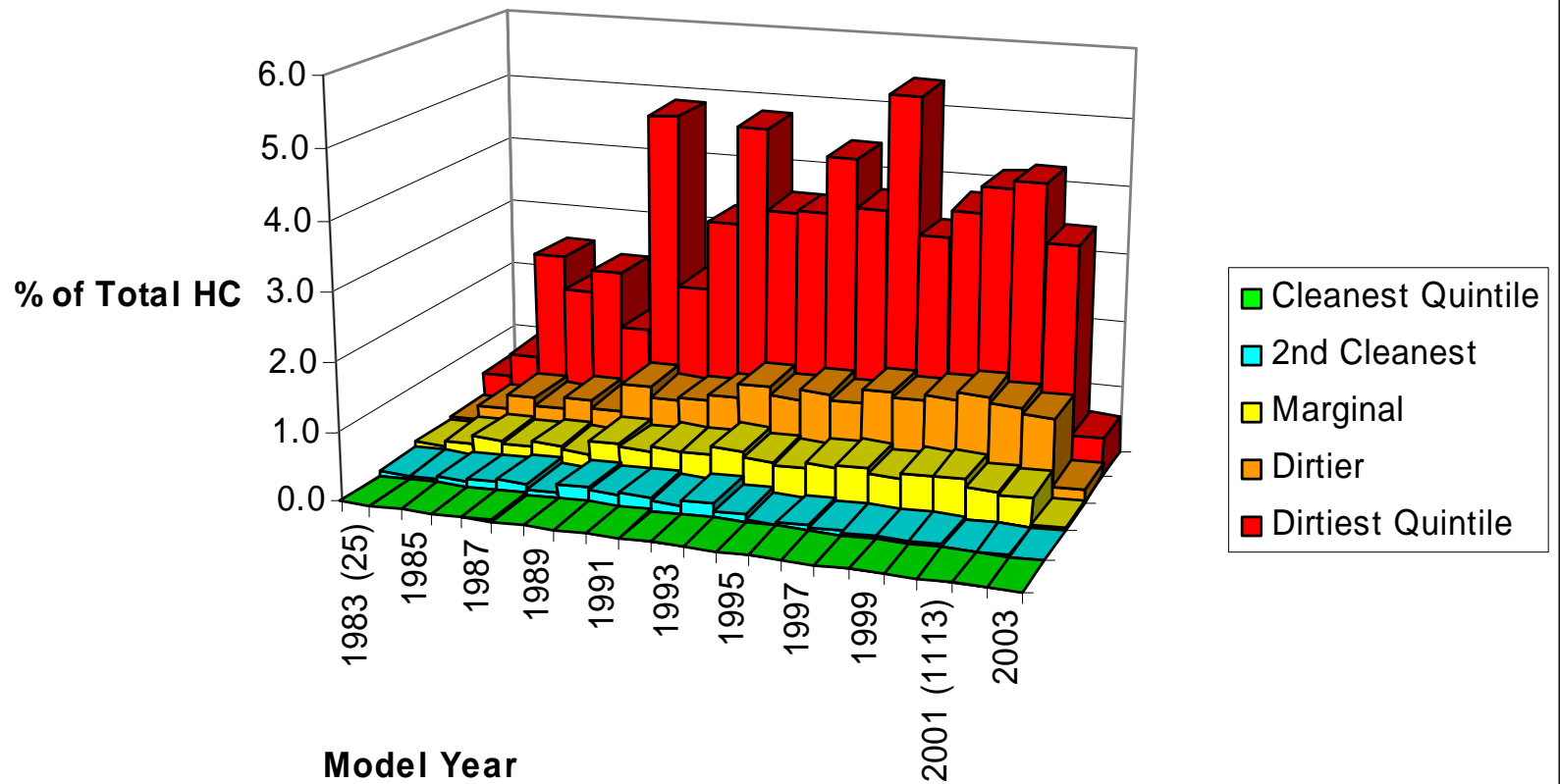
#### Mean by Model Year and Decile n = 6498



### Speer Blvd. RS HC Emissions by Quintile 10,015 Measurements, Dec. 3, 5, 6, 2002

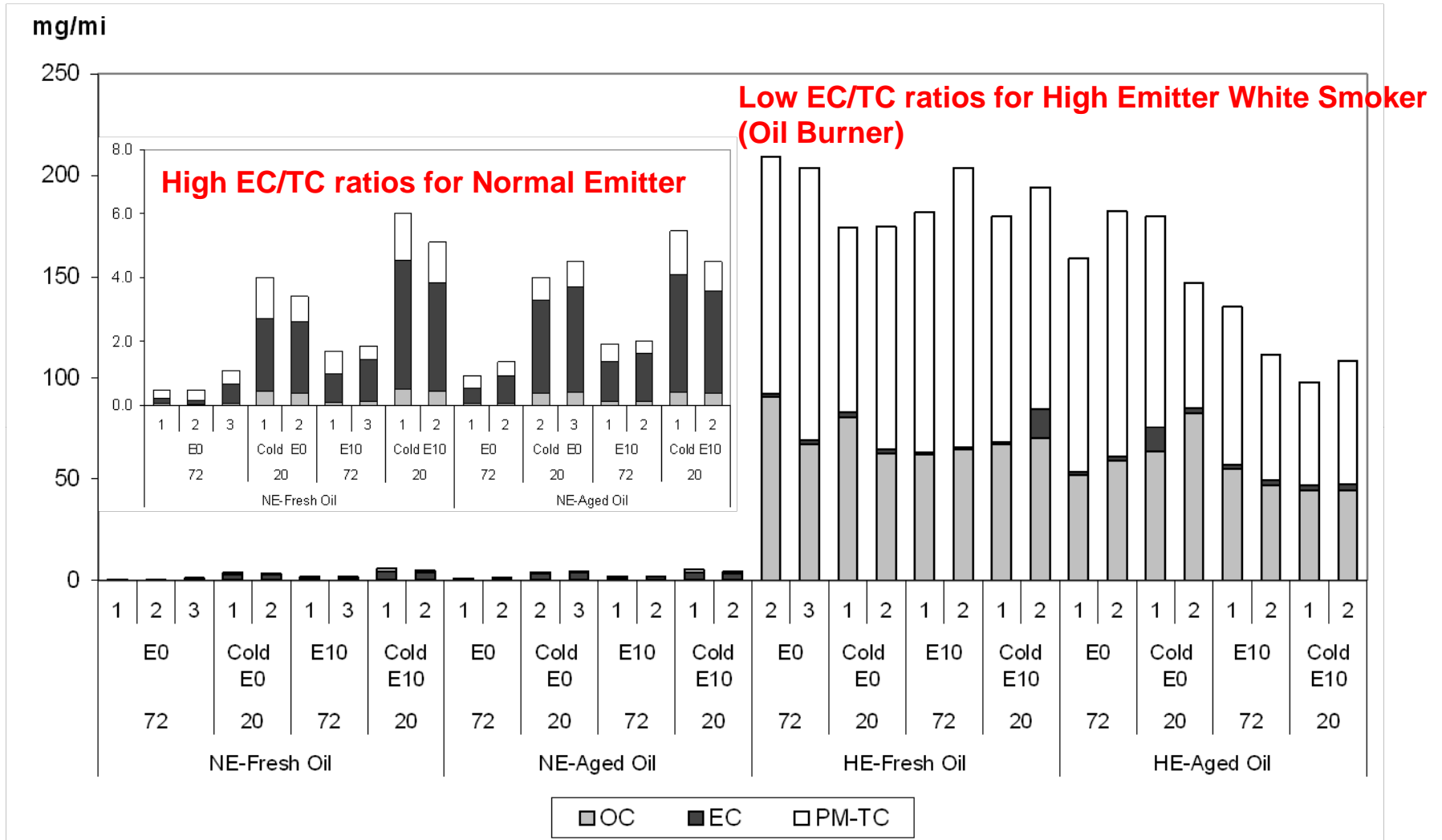


## Contribution to Total HC Emissions by Quintile 10,015 RS Measurements, Speer Blvd., Dec. 3, 5, 6, 2002



# Light-Duty Vehicle OC, EC and PM Emissions

## Quantifying influence of fuels (biofuels), lubricant age, temperature, and drive cycle on PM emissions



# (On-Road) Mobile Source Emissions and Mitigation Potential – Conclusions

- Ambient data must be reconciled with current inventories for ozone precursors and black carbon; there is little effort in this area [Good inventories  $\Rightarrow$  Good policy]
- All new LD and HD on-road vehicles are “clean;” new LD irrelevant to air quality; tightening LD standards does almost nothing to improve air quality
- For urban (and downwind) ozone: when NO<sub>x</sub> reductions > HC reductions, there is no ozone reduction, and it increases in many locations
- For black carbon, it comes from LD and HD vehicles; I/M programs have been a near-failure in reducing on-road emissions of black carbon and ozone precursors
- High emitters (LD, MD, and HD) have to be quickly identified, diagnosed, and repaired or scrapped: Medicar program?