Weekend Ozone Effect –
The Weekly Emission Control Experiment

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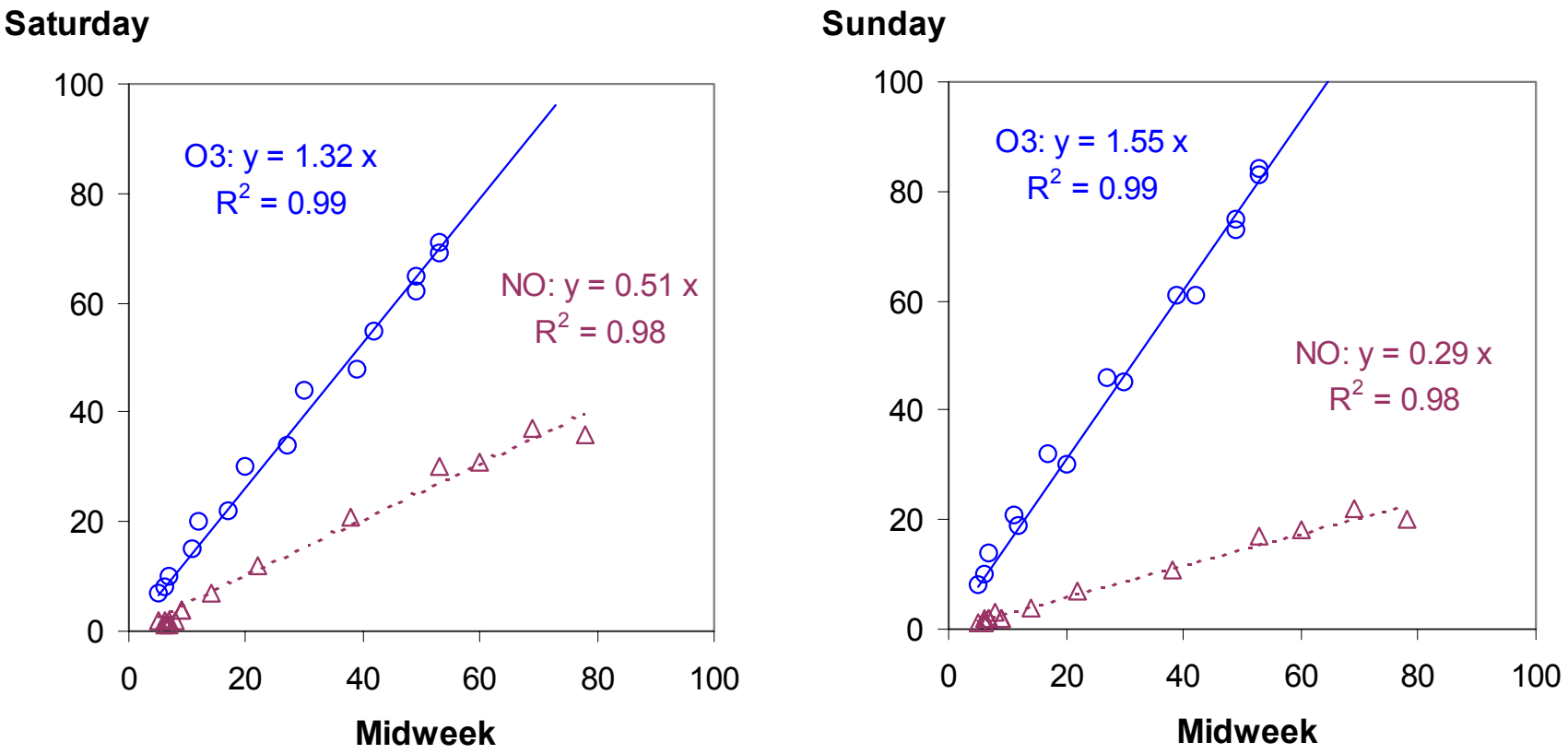
Special Issues on the Weekend Ozone Effect – July 2003 Studies Co-sponsored by DOE/NREL, CRC, and ARB

Correlations of Saturday and Sunday Versus Midweek*
Hourly Daytime (0600 to 2000, PDT) O_3 and NO at Azusa, 1999-2000



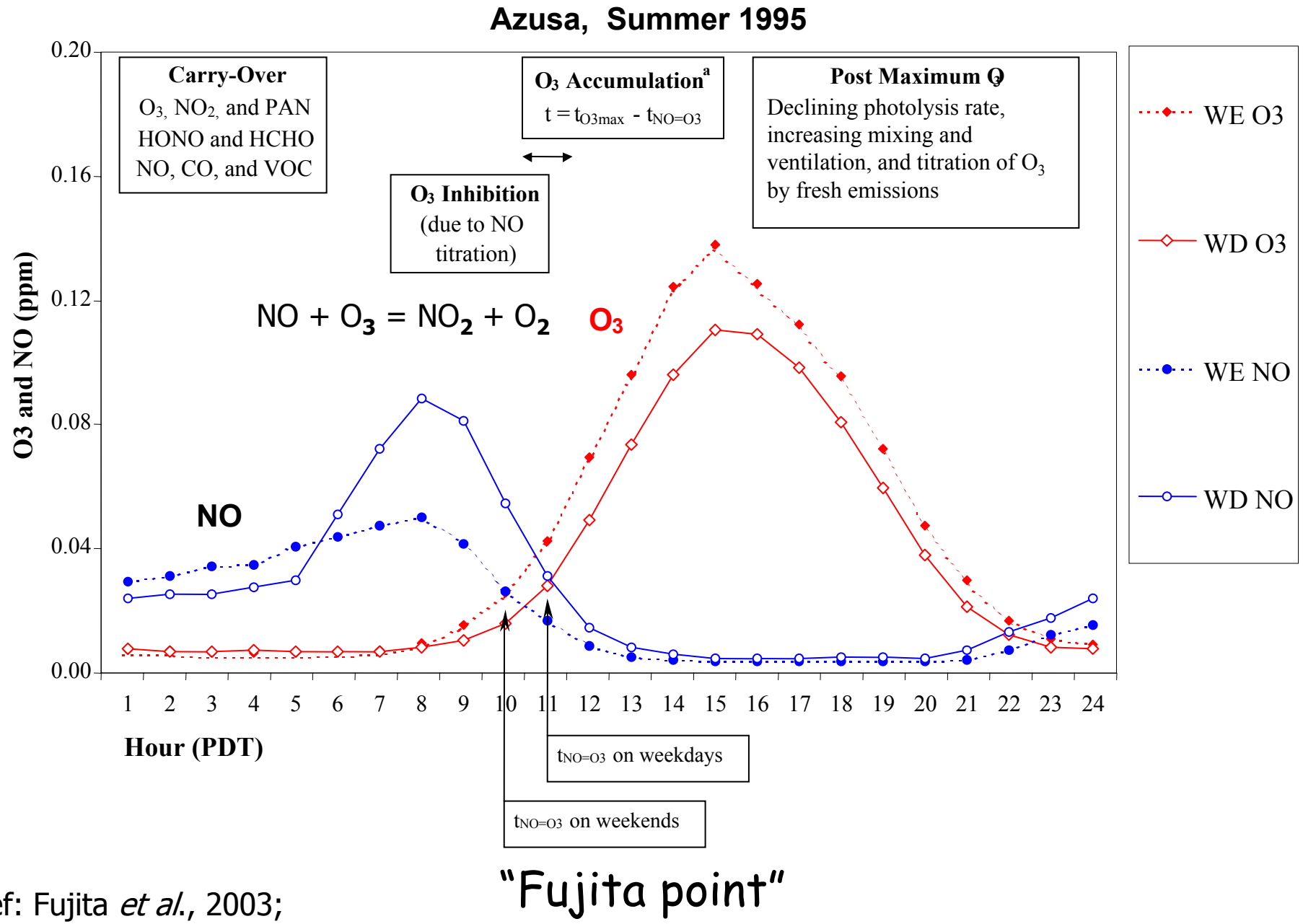
* Tuesday to Thursday

Ref: Fujita *et al*., 2003

Weekday/Weekend NO and O_3 Changes
South Coast Air Basin, 1999-2002

Site	Nitric Oxide (NO) Data 1999 – 2002		Ozone (O_3) Data 1999 – 2002	
	Sat slope	Sun slope	Sat slope	Sun slope
Anaheim	0.69	0.39	1.11	1.17
Azusa	0.69	0.37	1.35	1.46
Banning	0.47	0.34	0.98	0.80
Burbank	0.79	0.52	1.24	1.37
Costa Mesa	0.53	0.34	1.07	1.02
El Toro	No Data	No Data	1.13	1.14
Fontana	0.70	0.32	1.36	1.41
Glendora	0.69	0.41	1.32	1.39
Hawthorne	0.48	0.53	1.00	1.08
La Habra	0.41	0.17	1.32	1.44
Lake Elsinore	0.38	0.14	1.06	0.99
Lake Gregory	No Data	No Data	1.31	1.28
LA - N. Main	0.76	0.47	1.25	1.30
Lynwood	0.36	0.07	1.19	1.30
N. Long Beach	0.45	0.32	1.29	1.17
Pasadena	0.73	0.44	1.27	1.39
Perris	No Data	No Data	1.12	1.06
Pico Rivera	0.78	0.46	1.32	1.39
Pomona	0.78	0.43	1.44	1.58
Redlands	No Data	No Data	1.18	1.20
Reseda	0.75	0.47	1.10	1.13
Rubidoux	0.89	0.53	1.23	1.21
San Bernardino	0.67	0.42	1.26	1.32
Santa Clarita	0.40	0.18	1.08	1.18
Upland	0.58	0.26	1.32	1.39
W. LA-VA Hospital	0.63	0.44	1.07	1.14
Basin Average	0.62	0.36	1.21	1.25

Source: D. Campbell, DRI



Ref: Fujita *et al.*, 2003;
Lawson, 2003

Conclusions by Study Investigators

Hypotheses	Importance for Ozone Formation	Confidence Level
1. NOx emissions reduction	**Significant**	**High**
2. NOx timing (NOx “boost”)	Insignificant	**High**
3. Pollutant carryover near the ground	Small	**High**
4. Pollutant carryover from aloft	Insignificant	Medium
5. Increased weekend VOC emissions	Small to Insignificant	Medium
6. Increased photolysis due to decreased PM	Small to Insignificant	Medium

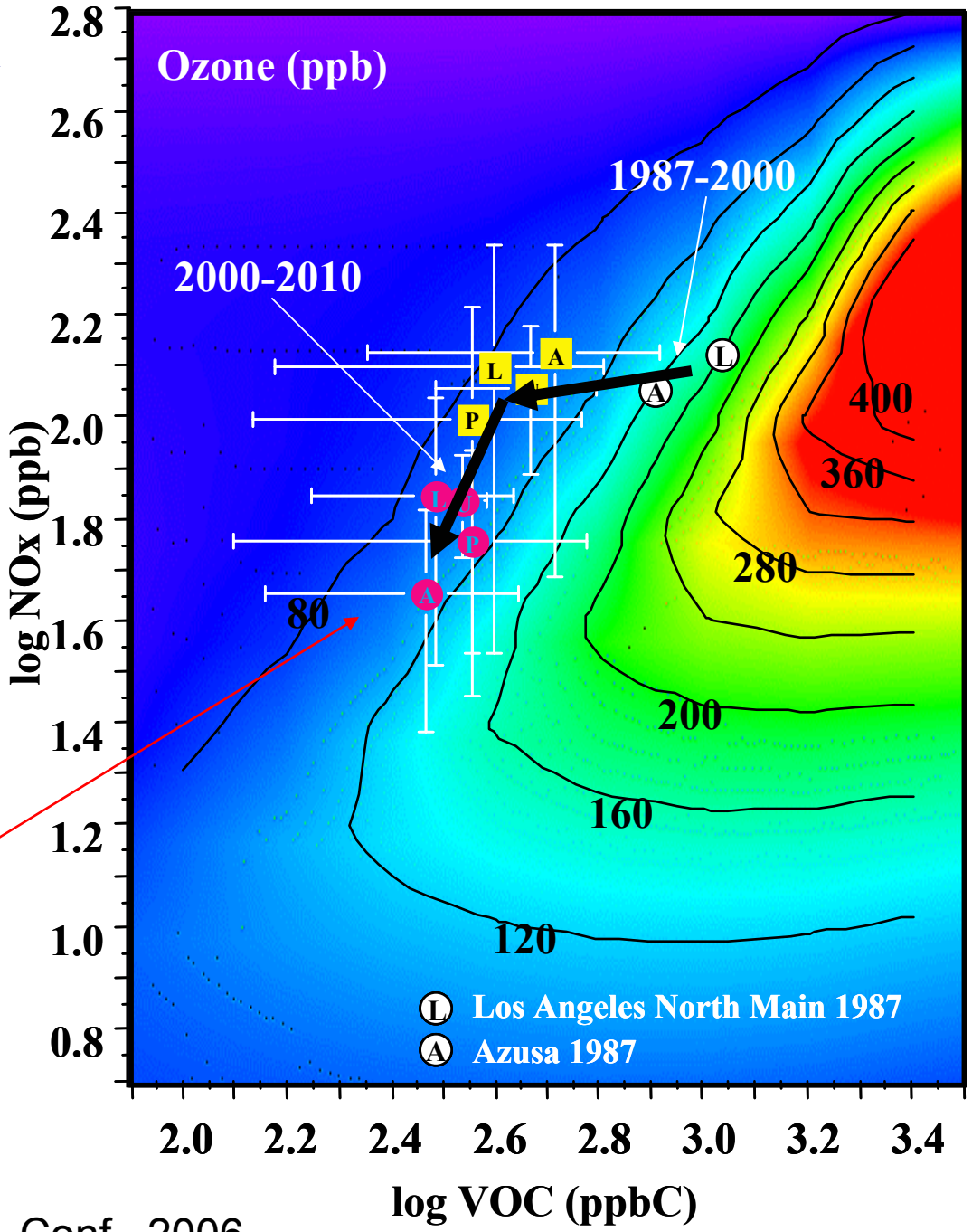
1999-2000 VOC & NOx

Mean Wednesday
± 1 sigma

Mean Sunday
± 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.



Ref: Fujita *et al.*, 99th AWMA Nat'l. Conf., 2006

3 Questions to Address

1. What are the main causes/explanations for the slow down in ozone air quality improvements over the recent years?

   A. What new programs in the SoCAB have reduced NOx since ~1998? (RECLAIM and Moyer?) Weekend ozone studies suggest that local and national ozone reductions will be more difficult, given that there is increased emphasis on NOx reductions rather than on VOC reductions (similar to what happens currently on weekends relative to weekdays in SoCAB and remainder of United States).

2. What could be done differently to more effectively reduce ozone levels given the need to attain fine particle standards?

   A. Focus on high-emitting HC (and CO) LD vehicles; not being found/fixed/repaired by current Smog Check program. These few vehicles (~5% of on-road fleet) produce disproportionately high amounts of HC, PM, and air toxics. Also, Blanchard and Tanenbaum (2003) reported no statistically significant difference between weekday and weekend PM nitrate in Southern California, despite large weekend NO reductions.

3. What research and development should be emphasized in the near future to further air quality improvement and our understanding of the issues?

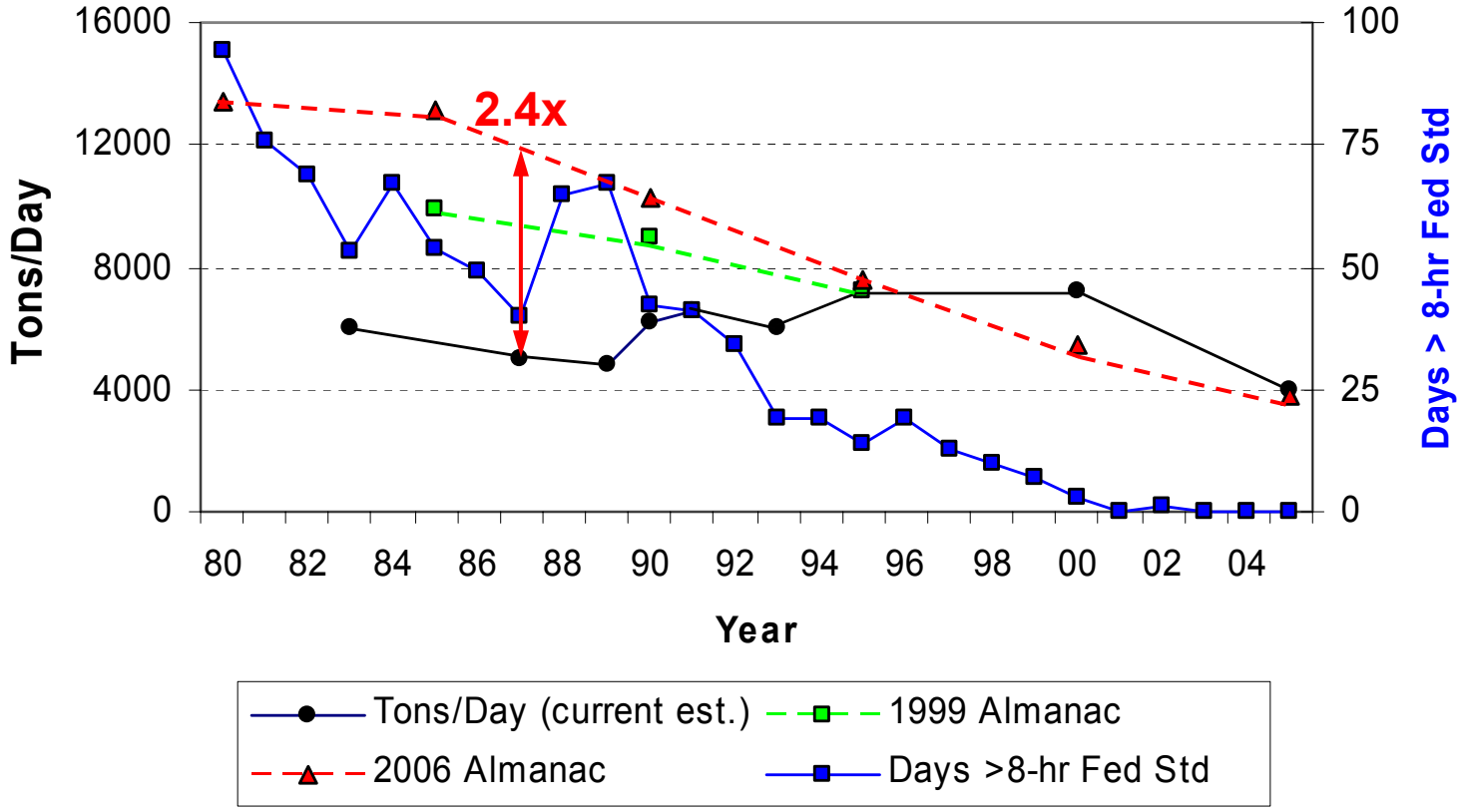
   A1. Implement AQMP recommendation for Smog Check enhancement to identify/ repair/verify repairs (or scrap) high-emitting HC (and CO vehicles). Would produce immediate benefit in air quality. Tightening Smog Check failure cutpoints/more frequent testing will do little to improve air quality because failure of Smog Check program is a human behavior problem, not a technological problem.

   A2. Understand why current ambient VOC speciation does not match existing inventory. 55 PAMS species are mobile-source/gasoline-related…what about solvent and other sources? We need to have a top-down study ASAP to understand if current ambient data match current inventory. Previous air quality simulation modeling has been incorrect because inventories have greatly underestimated mobile source emissions.

Fundamental Problem: Mobile Source Emission Inventory

South Coast Air Basin CO Trends

Ambient vs. Inventory, 1980-2005



1987 SCAQS Tunnel Study (funded by CRC): On-road mobile emissions were 2.7 and 3.8 times higher for CO and NMHC than EMFAC7C model predictions

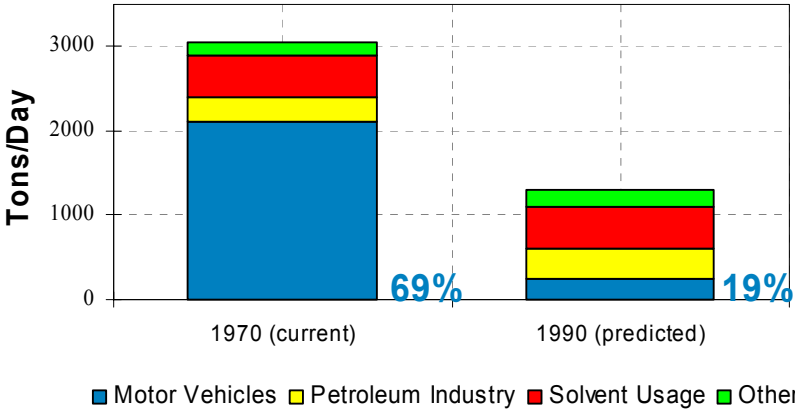
Projected Contributions of Mobile Sources to SoCAB Air Quality

- "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.

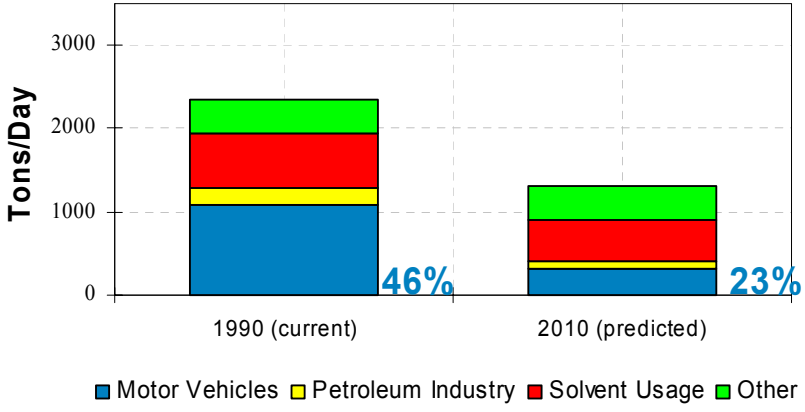
SoCAB HC Inventories

"Current" vs. Future

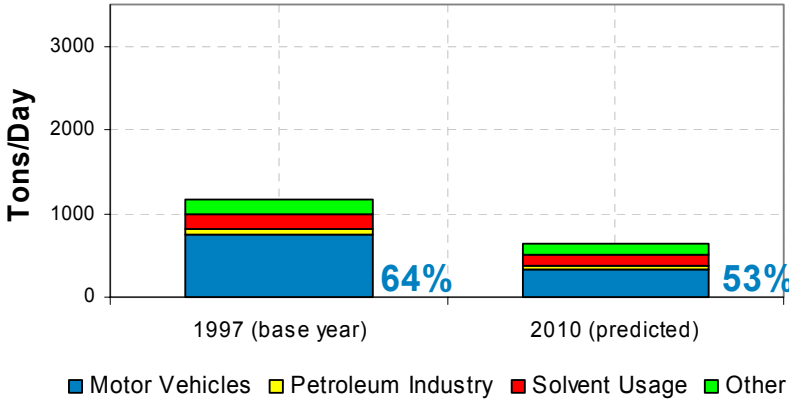
South Coast Air Basin-1970
Current and Future HC Inventories



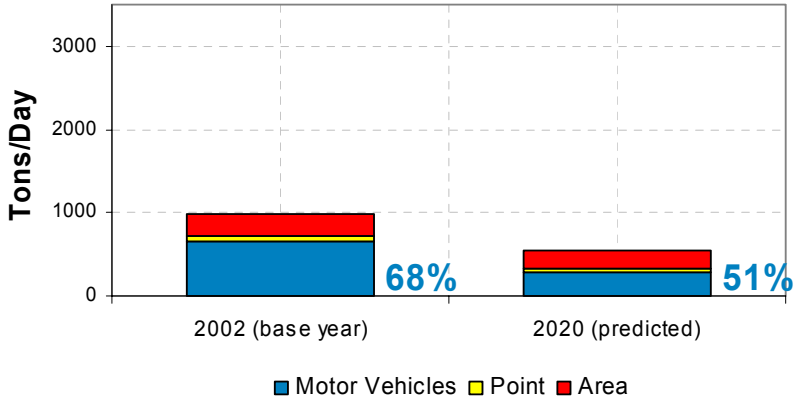
South Coast Air Basin-1990
Current and Future HC Inventories



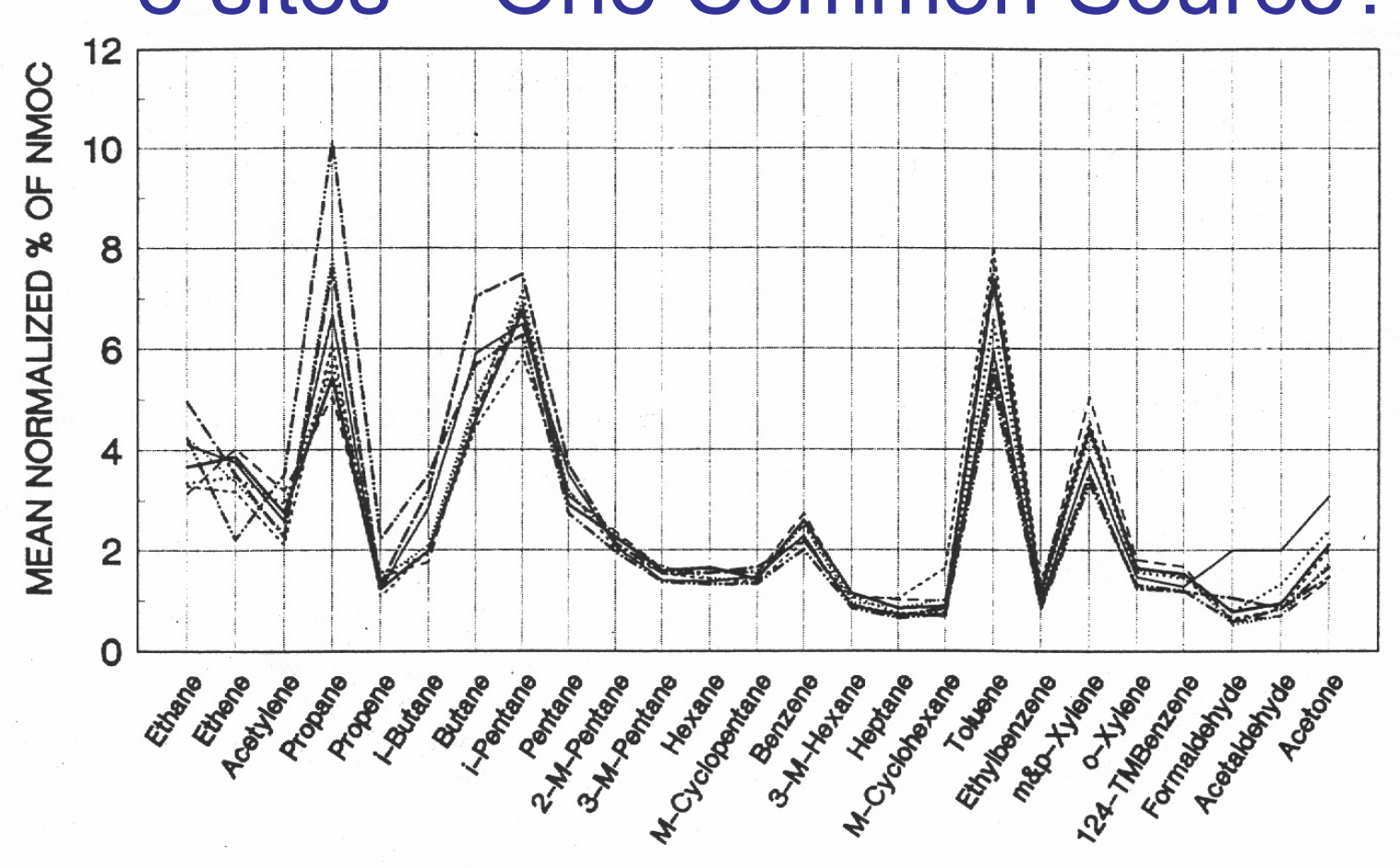
2003 South Coast AQMP
Base Year and Future HC Inventories



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



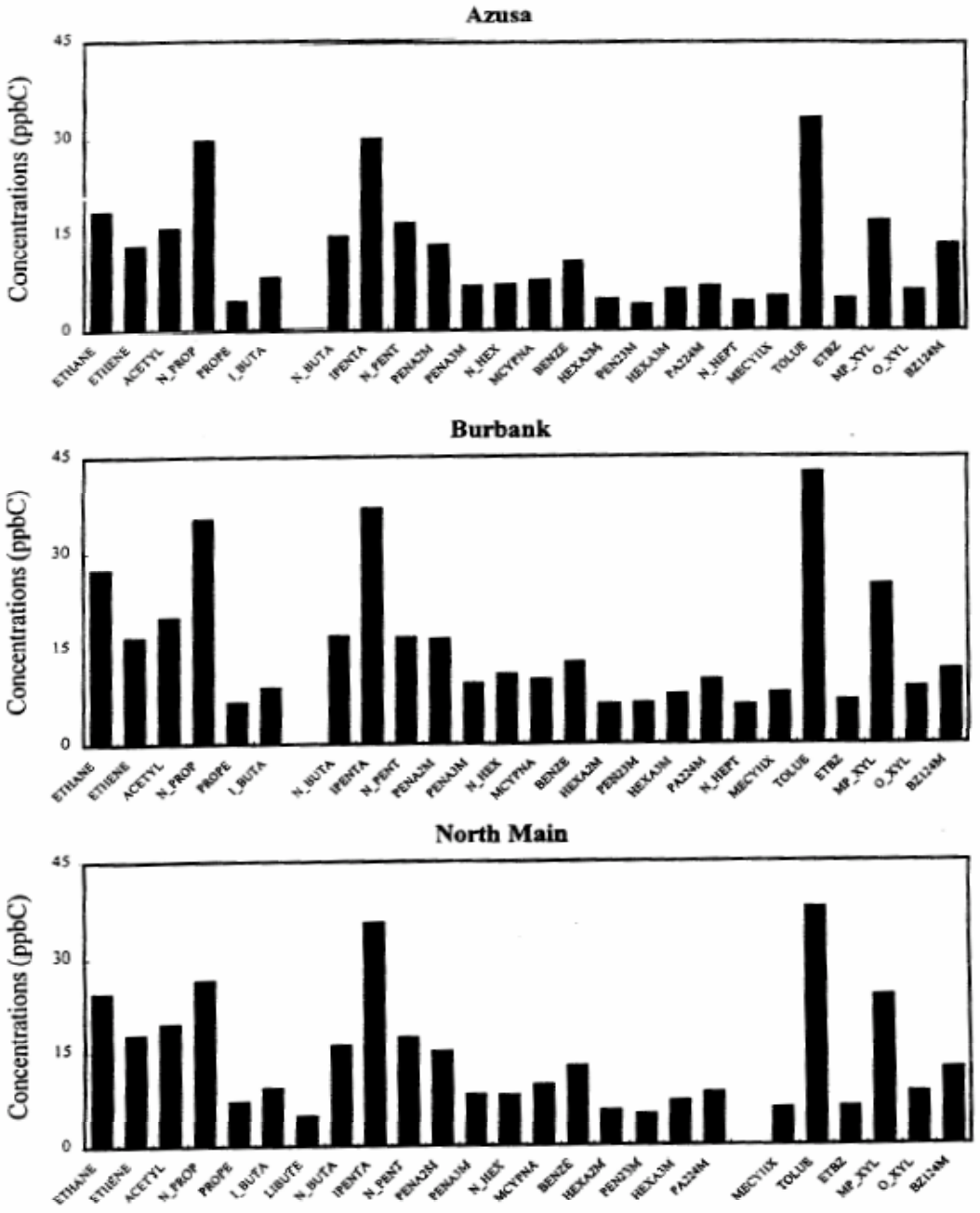
Summer 1987 SCAQS Ambient Normalized NMOG Speciation – 8 sites – One Common Source?



Ref: Fujita *et al.* 1992

Average concentrations for 25 most abundant species, 3 sites, averaged for all morning and afternoon samples; six 7-day periods, summer 1995.

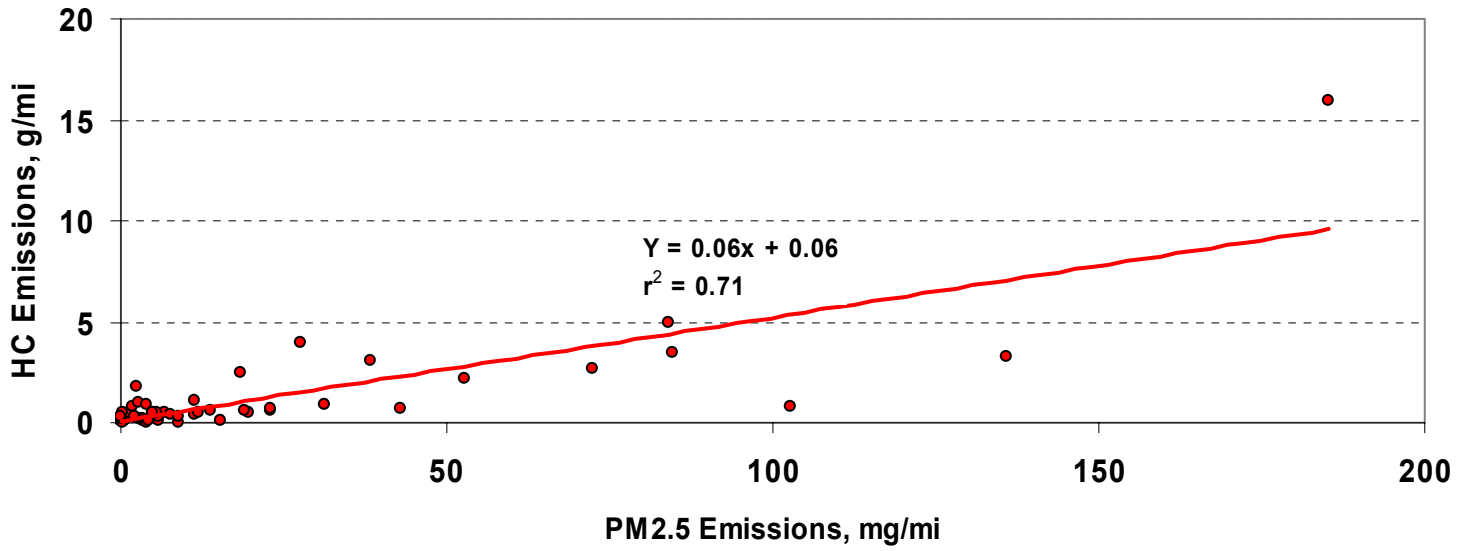
One common source?



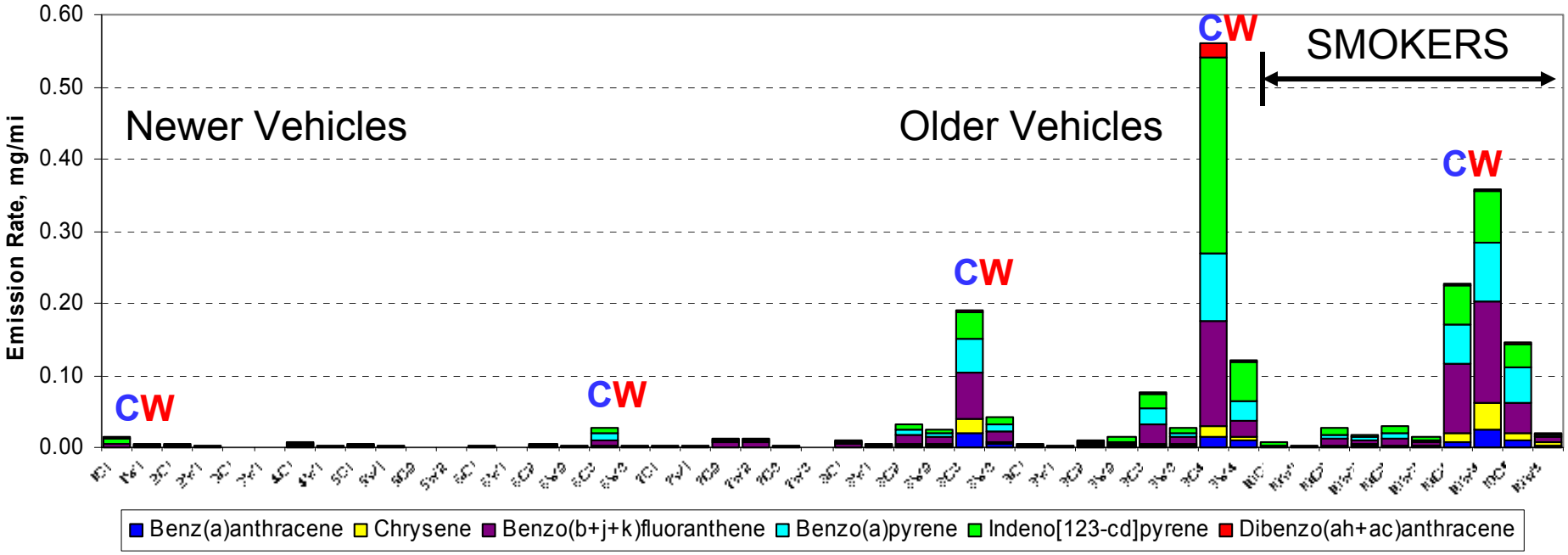
Ref: Zielinska et al., ARB contract no. 94-332.

DOE Gasoline/Diesel PM Split Study

57 LD Spark-Ignition Vehicles tested over the Unified Driving (LA-92) Cycle



DRI Spark Ignition Source Profiles for Apportionment by CMB for 7 PAH Listed as Animal Carcinogens by IARC

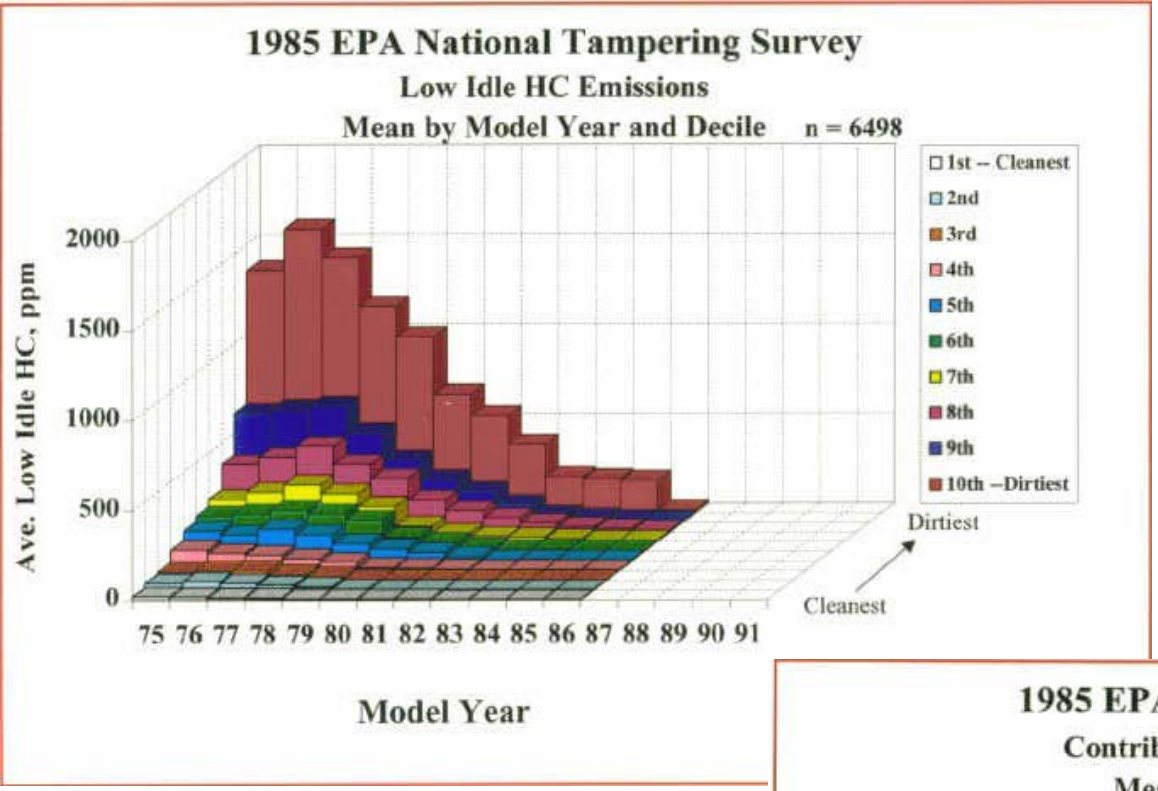


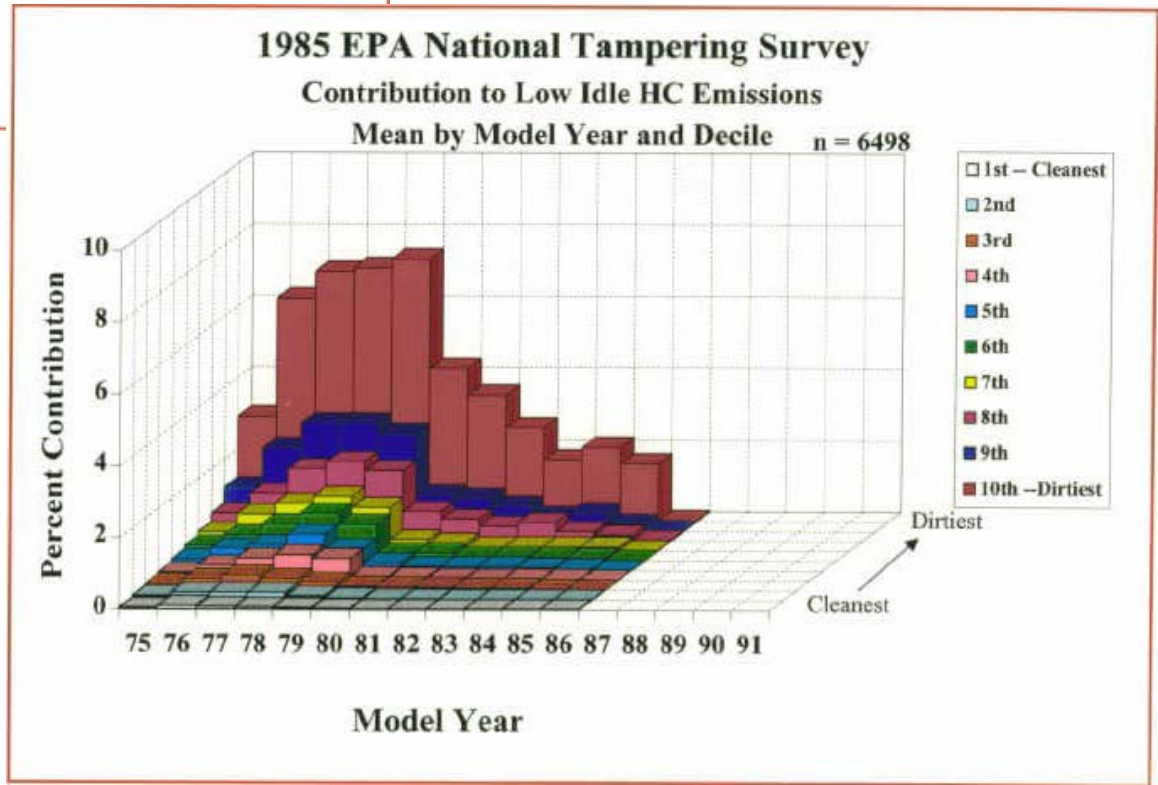
C = Cold phase of the UDC; W = Warm phase of the UDC

Nationwide On-Road Idle HC Emissions

EPA's 1985 National Tampering Survey

6498 vehicles





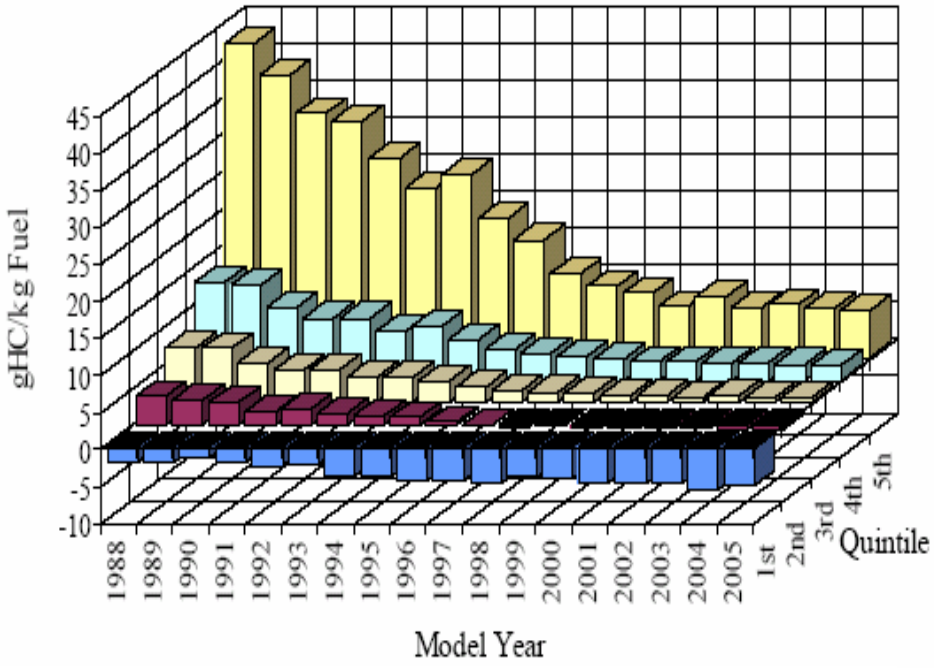
On average, fleet emissions increase as vehicles age; mean fleet emissions driven by high emitters

Most new cars are clean; a few new vehicles are dirty; new vehicles irrelevant to air quality

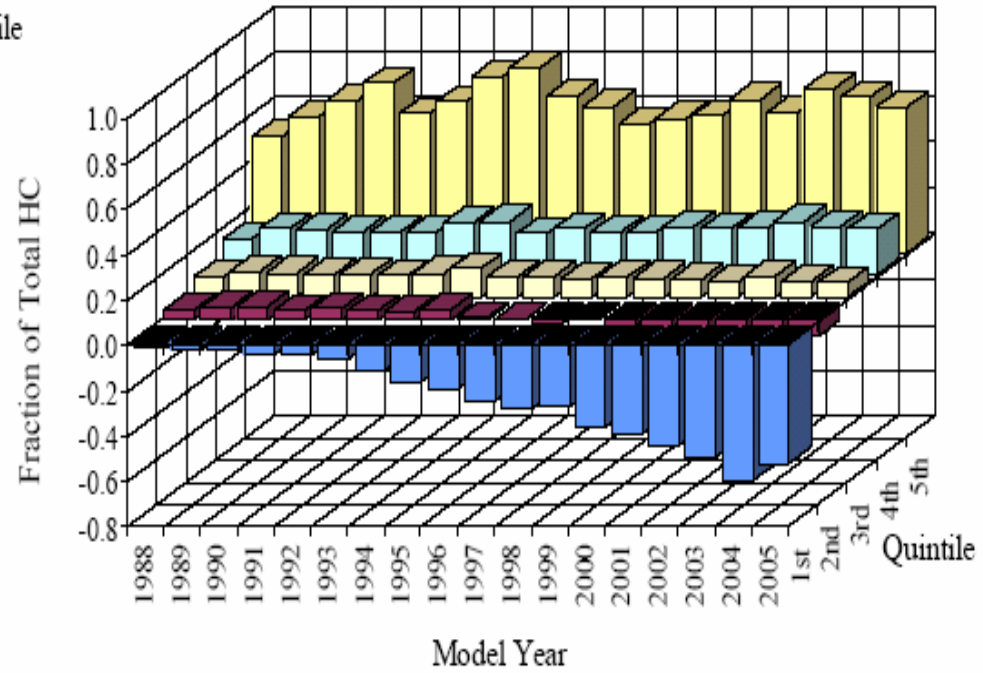
Most old cars are "clean"

Ref: Lawson *et al.* 1996

Remote Sensing HC Emissions by Quintile



19,500 measurements,
October 17-21, 2005



Ref: On-Road Remote Sensing of Automobile Emissions in West Los Angeles: Year 4, October 2005, CRC Contract E-23-9, April 2006 (http://crcao.com)

“We easily forget that smog is the price of freedom of our streets from manure, and from the flies and diseases it brought.” – Daniel J. Boorstin (1914-2004), Librarian of Congress from 1975-1987.