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On-Road Emissions in Asia Measured by Remote Sensing

Donald H. Stedman

Gary A. Bishop

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- **Donald H. Stedman, Gary A. Bishop, University of Denver, Department of Chemistry and Biochemistry, Denver CO 80208**

- **www.feat.biochem.du.edu**
- **www.sign.du.edu**

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Data Analysis

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5. USAID: SHELL ASIA
6. Chan et al Atmos. Envt. *38*, 2055, 2004.
7. Nick Tan – Singapore NEA

Web sites

- www.feat.biochem.du.edu DU reports, publications and downloadable data.
- www.sign.du.edu SMART SIGN 24/7 RSD operation and live web camera.
- www.rsdaccuscan.com ESP Accuscan web site.

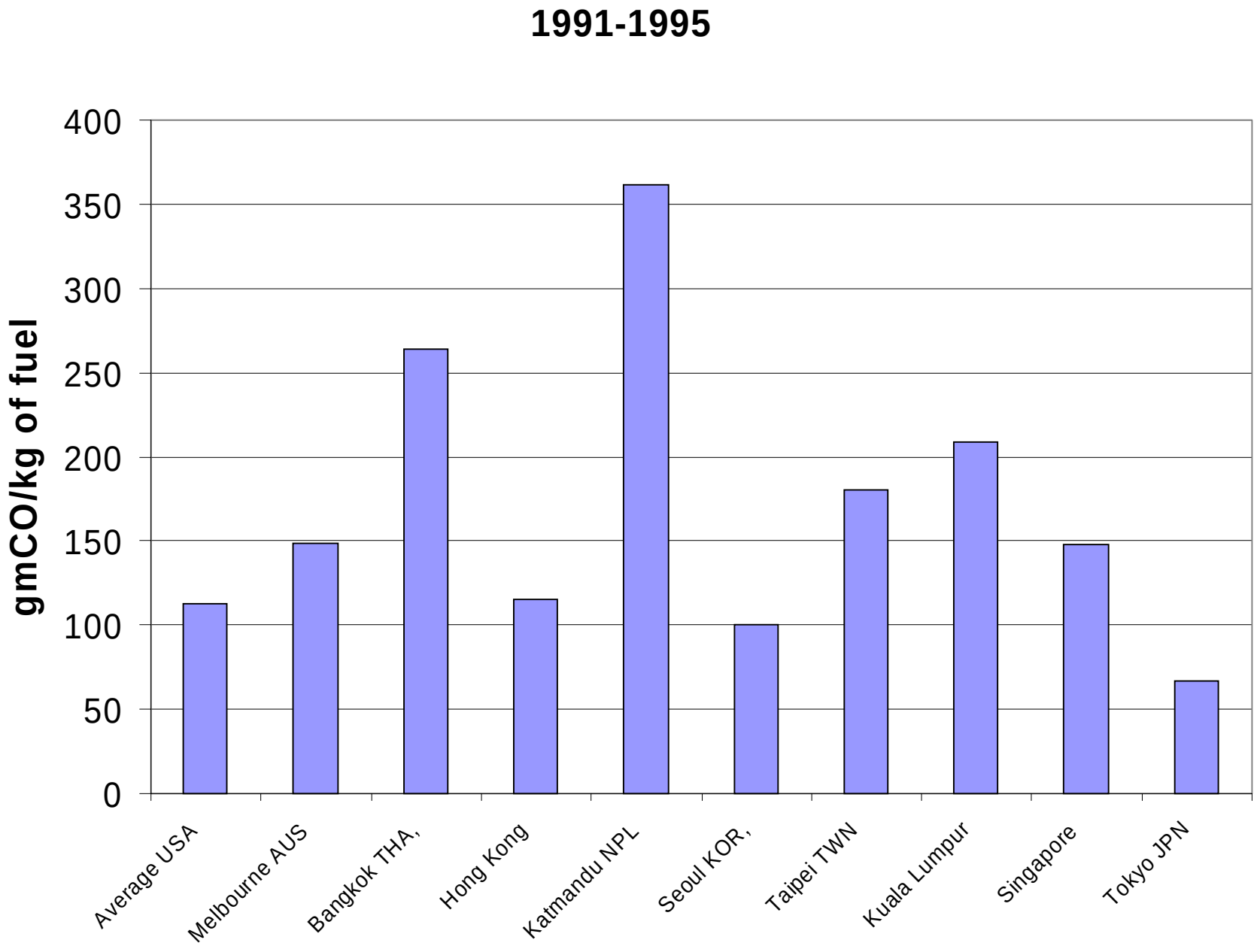
The on-road advantage

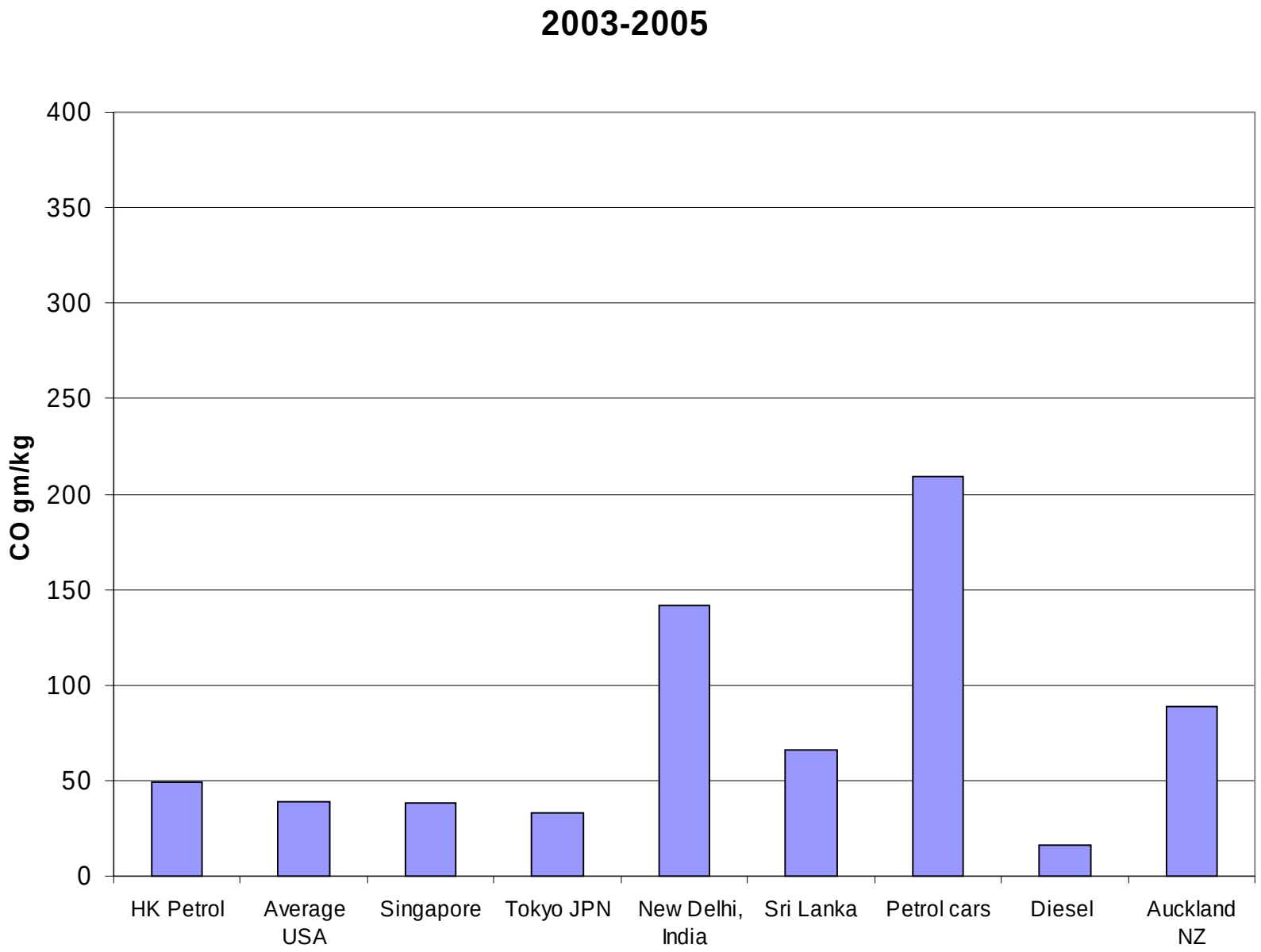
- Large on-road emissions cause poor air quality.
- Remote sensing measures on-road emissions.
- Mass emission per unit of fuel consumed.

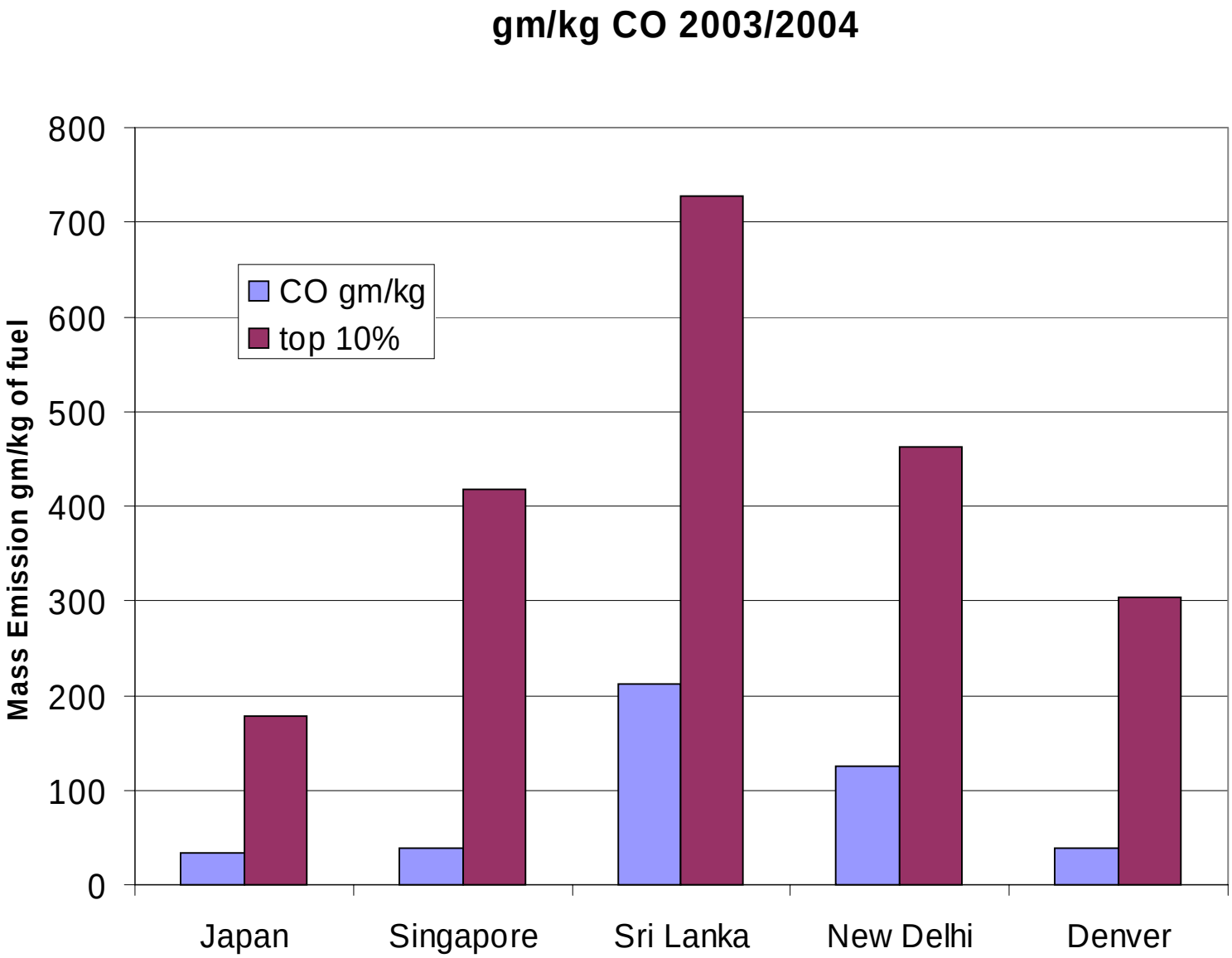
Asia results

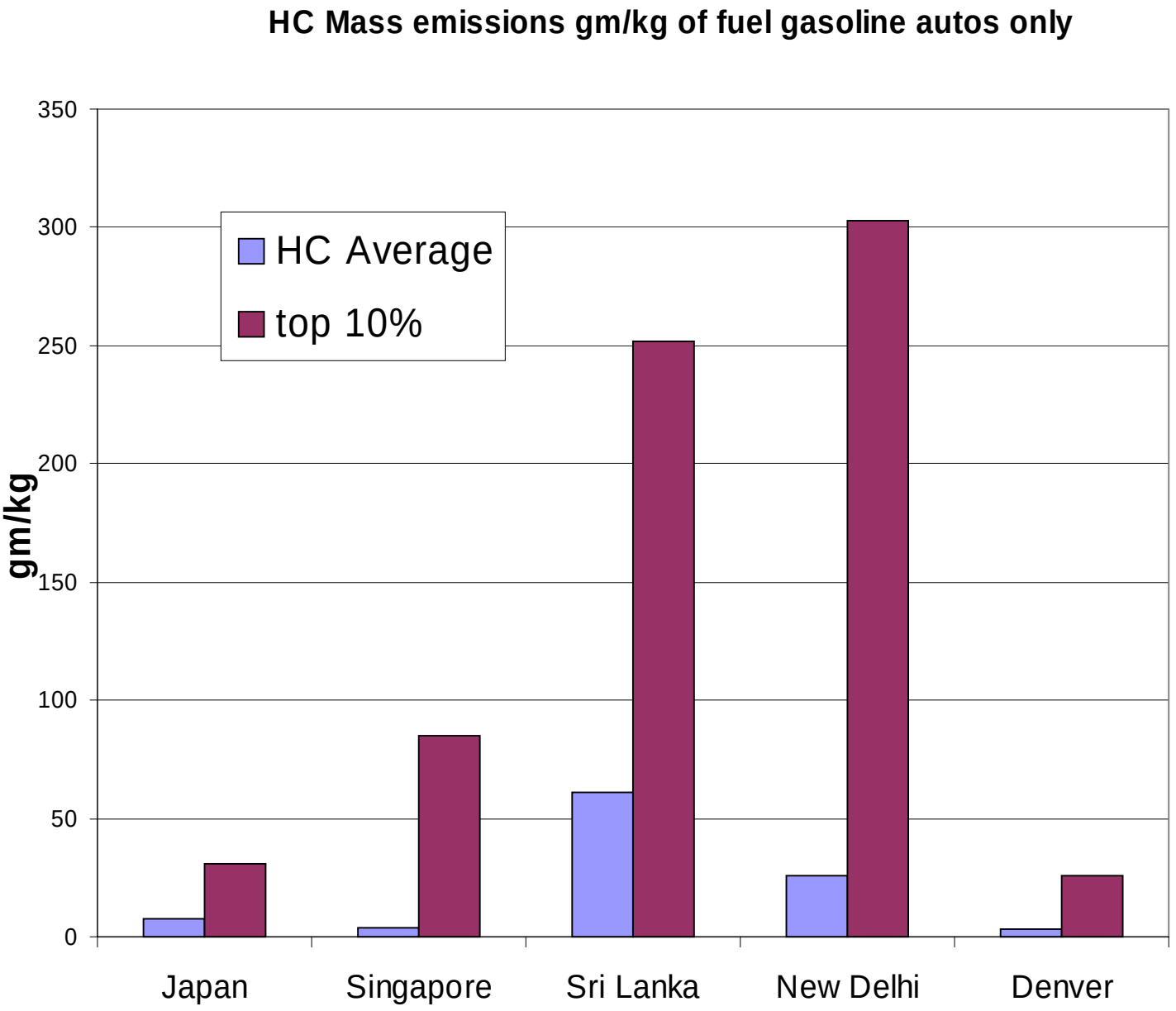
- On road emissions measured in Asia show large geographic variability and that a few vehicles are responsible for most of the on-road emissions.
- Emission benefits from new technology are everywhere apparent.
- Emission benefits from I/M programs are difficult to discern.

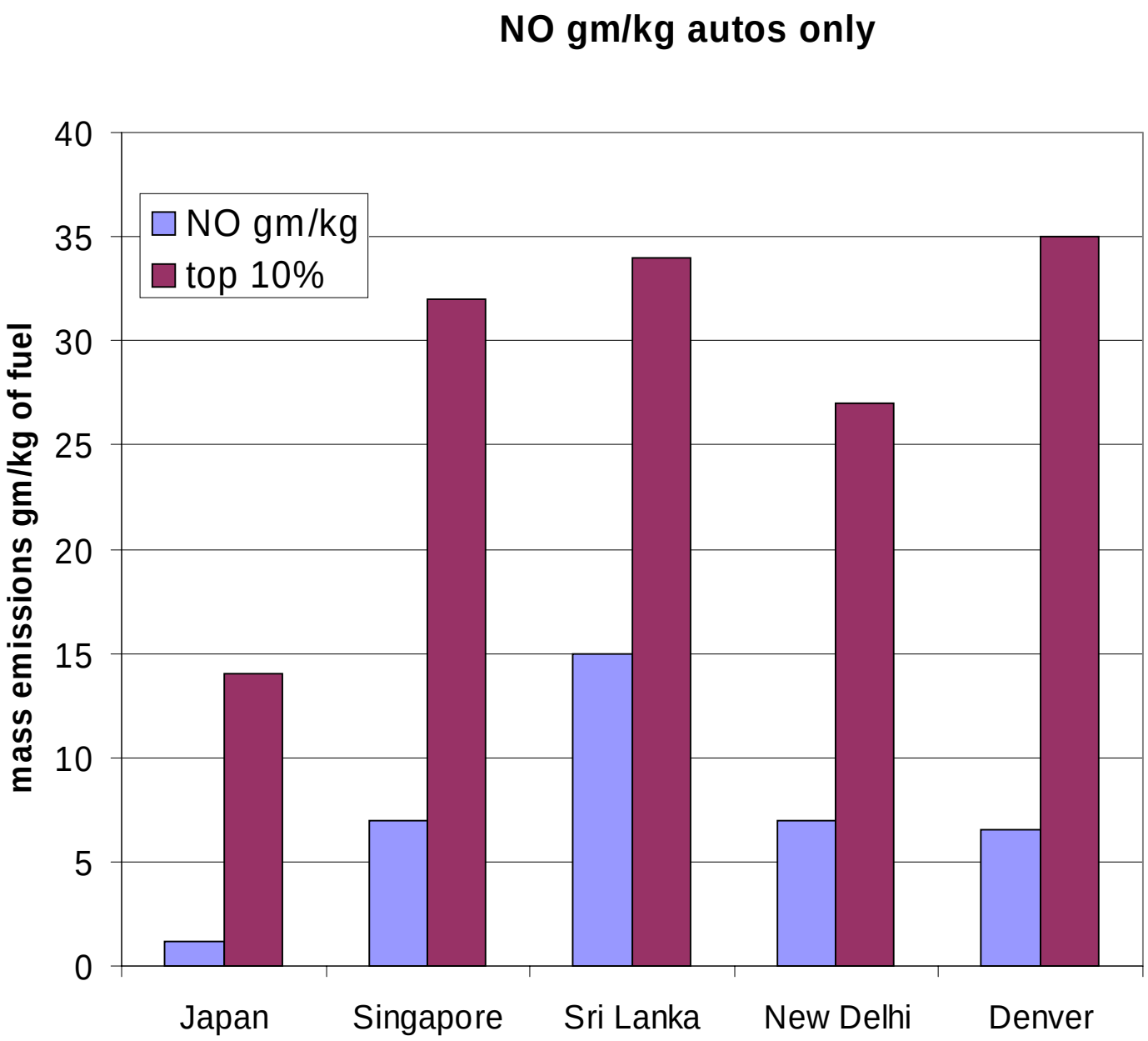
Locations & Year	Measurements	Mean gCO/kg	Mean gHC/kg	Mean gNO/kg
Bangkok THA, 1993	5,260	264	220	*
Hong Kong, 1993 Petrol 2003	5,891 8544	115 49	20 7	* 5
Katmandu NPL, 1993	11,227	362	189	*
Kuala Lumpur MAL, 1995	9,478	209	22	31
Seoul KOR, 1993	3,104	100	14.7	*
Taipei TWN, 1993	12,062	180	23.4	*
Singapore 1995 2004	1,681 55,000	148 38	7 4	24 7
Tokyo JPN, 1995 2004	3,881 5,917	67 33	15 8	* 1.2
Melbourne AUS, 1992	5,260	149	6.8	24
New Delhi, India, 2004	10,208	142	48	12
Sri Lanka, 2004 Petrol cars Diesel DP	35,000 6,659 14,944	66 209 16	50 61 17	11 15 7
Auckland NZ, 2004	34,400	89	13	10
Average USA 1989-92	*34,000*	*113*	*26*	*
Average USA 2003	*63,000*	*39*	*3.5*	*4.9*


1991-1995
gmCO/kg of fuel
400
350
300
250
200
150
100
50
0
Average USA
Melbourne AUS
Bangkok THA,
Hong Kong
Katmandu NPL
Seoul KOR,
Taipei TWN
Kuala Lumpur
Singapore
Tokyo JPN


2003-2005
CO gm/kg
400
350
300
250
200
150
100
50
0
HK Petrol
Average USA
Singapore
Tokyo JPN
New Delhi, India
Sri Lanka
Petrol cars
Diesel
Auckland NZ


gm/kg CO 2003/2004
Mass Emission gm/kg of fuel
800
700
600
500
400
300
200
100
0
CO gm/kg
top 10%
Japan
Singapore
Sri Lanka
New Delhi
Denver

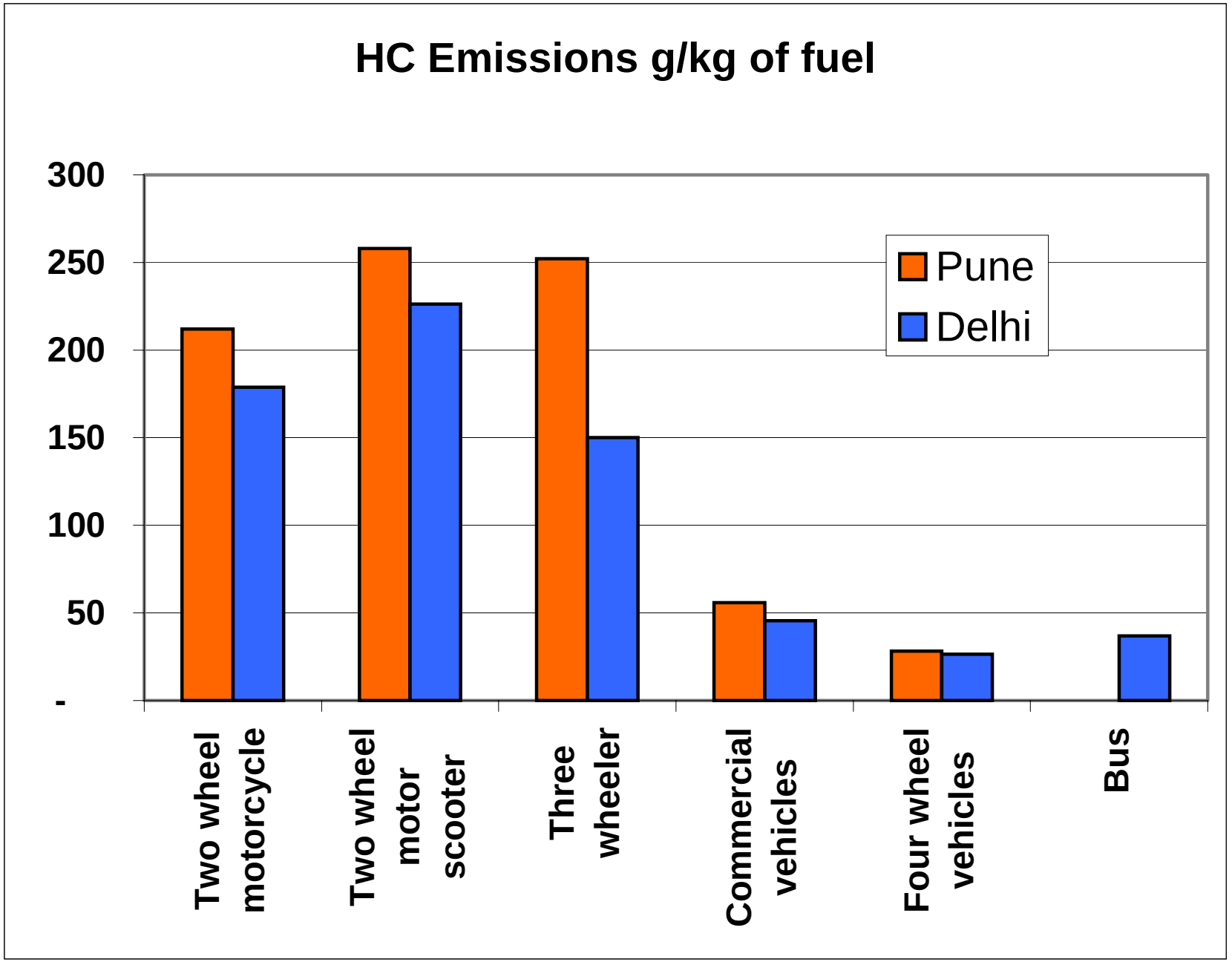

HC Mass emissions gm/kg of fuel gasoline autos only
HC Average
top 10%
gm/kg
350
300
250
200
150
100
50
0
Japan
Singapore
Sri Lanka
New Delhi
Denver

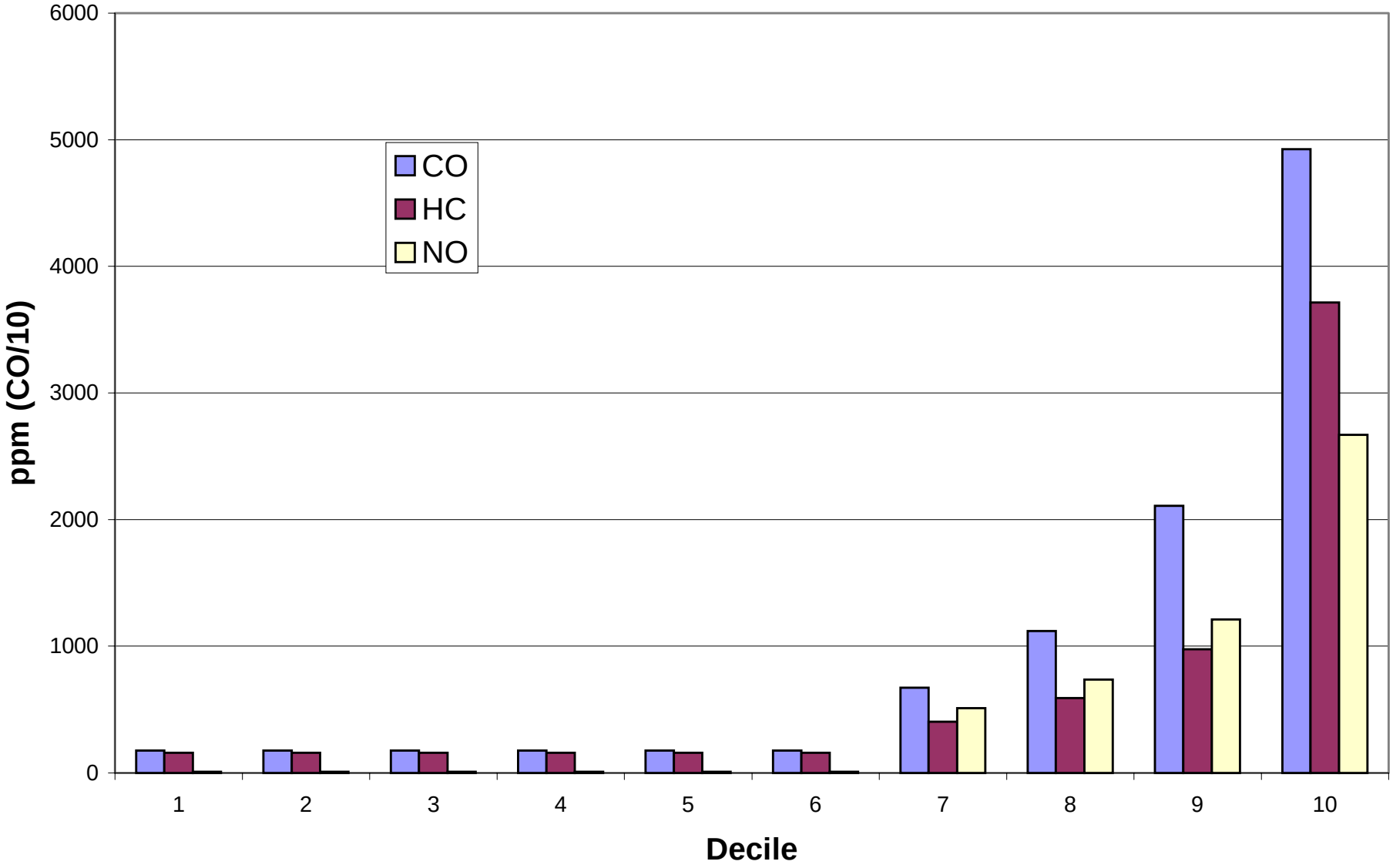

NO gm/kg autos only
mass emissions gm/kg of fuel
40
35
30
25
20
15
10
5
0
NO gm/kg
top 10%
Japan
Singapore
Sri Lanka
New Delhi
Denver

Asia comparison

- Some locations in Asia, Singapore, Hong Kong and Tokyo in particular, demonstrate on-road emissions comparable to current U.S. on-road fleet averages.

- Most of the emissions come from a few on-road vehicles
- The gross emitters
- Two-stroke vehicles are inevitably in this category


HC Emissions g/kg of fuel
300
250
200
150
100
50
-
Pune
Delhi
Two wheel motorcycle
Two wheel motor scooter
Three wheeler
Commercial vehicles
Four wheel vehicles
Bus


Auto emissions by decile. New Delhi, 2004
6000
5000
4000
3000
2000
1000
0
ppm (CO/10)
CO
HC
NO
1
2
3
4
5
6
7
8
9
10
Decile

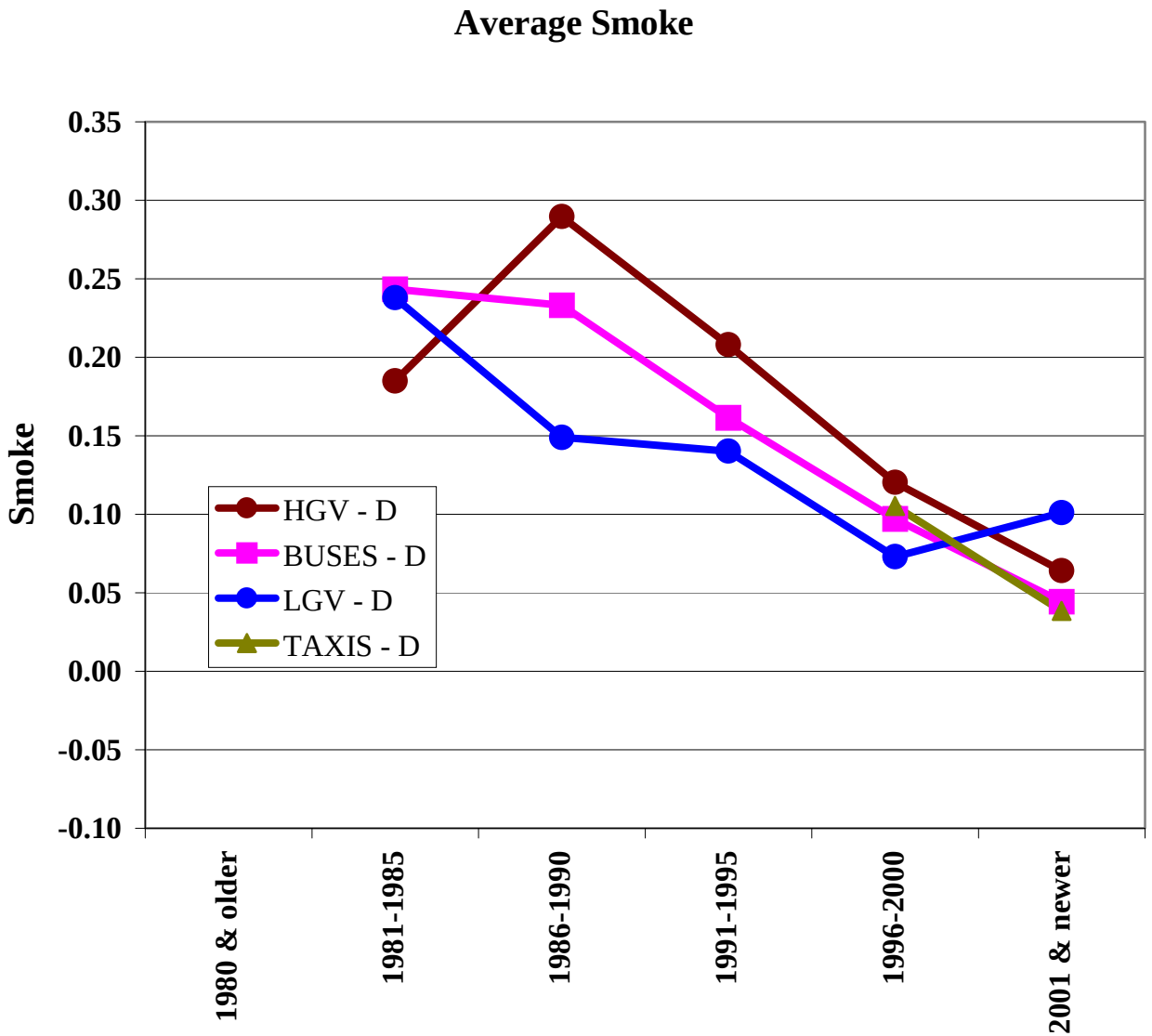
A few gross emitters

- It is apparent from this diagram that there is a majority of cars with negligible emissions, while the average is dominated by a very small fraction of the fleet.

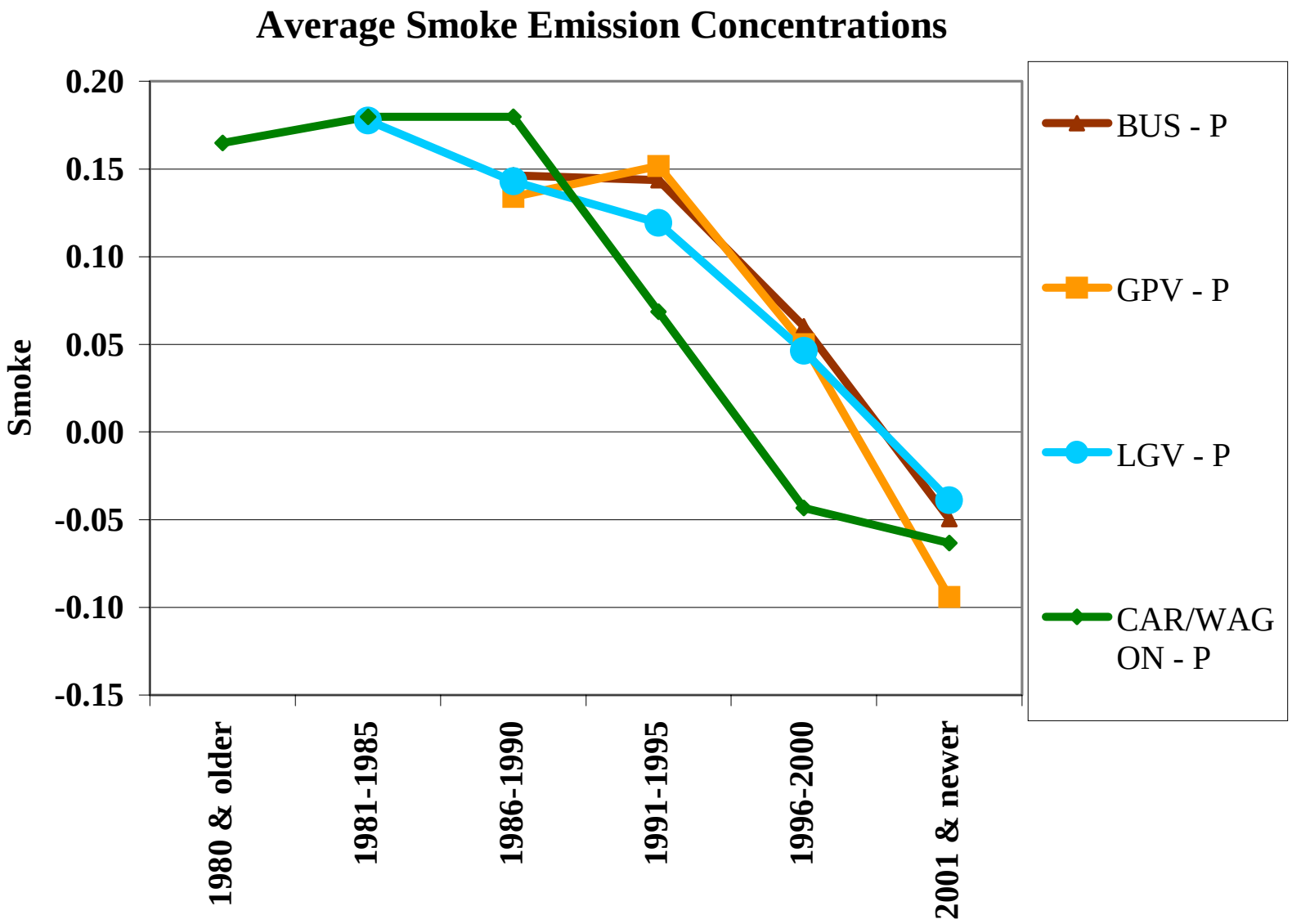
Singapore RSD -SMOKE

- Diesel vehicle smoke increases steadily with age
- Petrol vehicles have less smoke but smoke also increases with age
- A smoke reading of 1.0 corresponds to approximately 10 gm of smoke/kg of fuel. BAD!

Singapore RSD - Smoke - Diesel



Singapore RSD - Smoke - Petrol



- On-road emissions are not the same as readings from scheduled emission tests.
- On average the two correlate very well. CO, HC, NO and smoke versus IM240 r2 > 0.95 Pokharel et al 2000. CRC poster available at www.feat.biochem.du.edu and Vancouver report.

- On-road gross emitters pulled over by a policeman have more than an 85% chance of failing a California emissions test.

- *“REMOTE SENSING DEVICE HIGH EMITTER IDENTIFICATION WITH CONFIRMATORY ROADSIDE INSPECTION”* California BAR Final Report 2001 – 06 August 30, 2001. copy available on www.feat.biochem.du.edu.