Fuel-Based On-Road Motor Vehicle Emissions Inventory for the Denver Metropolitan Area

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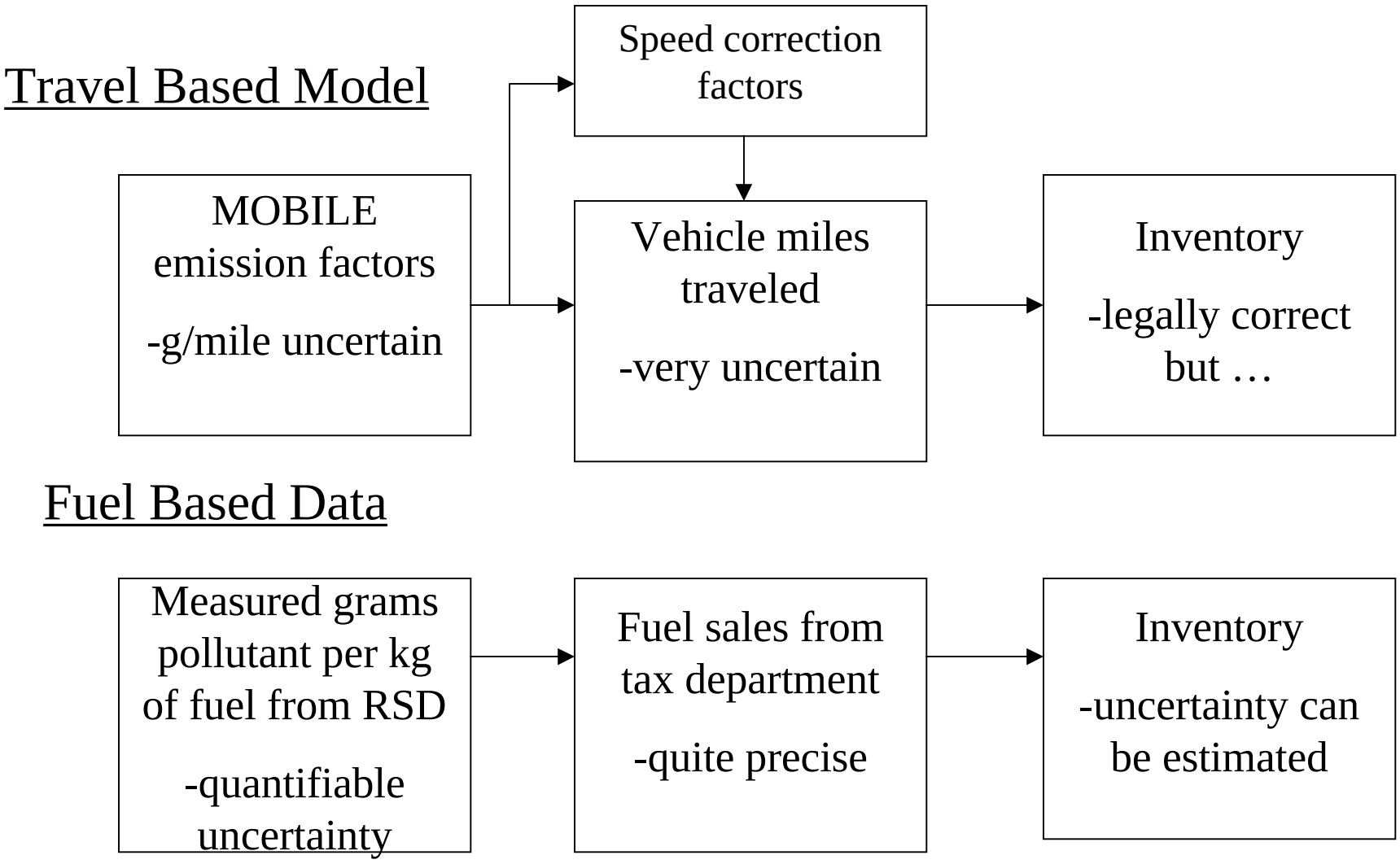
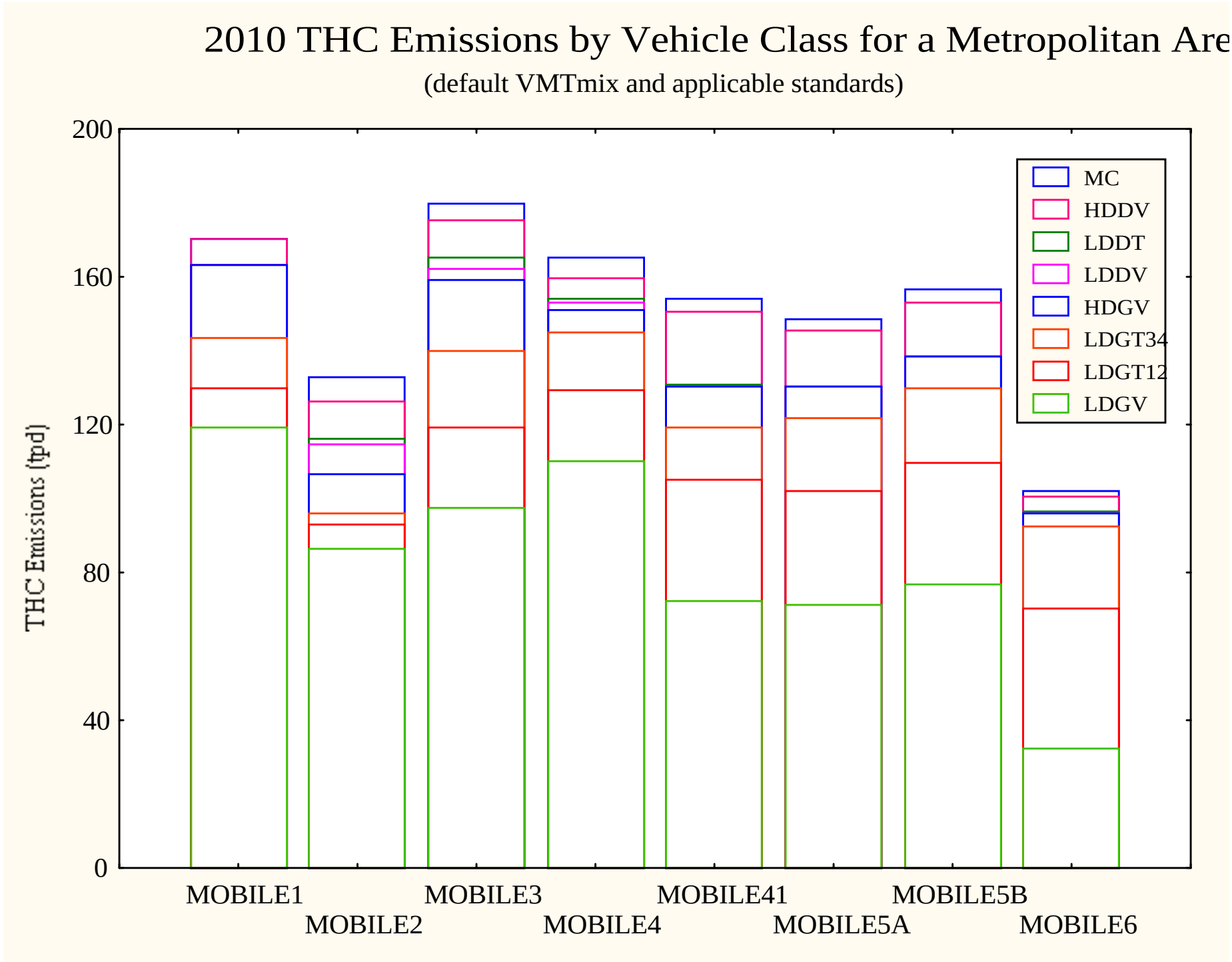
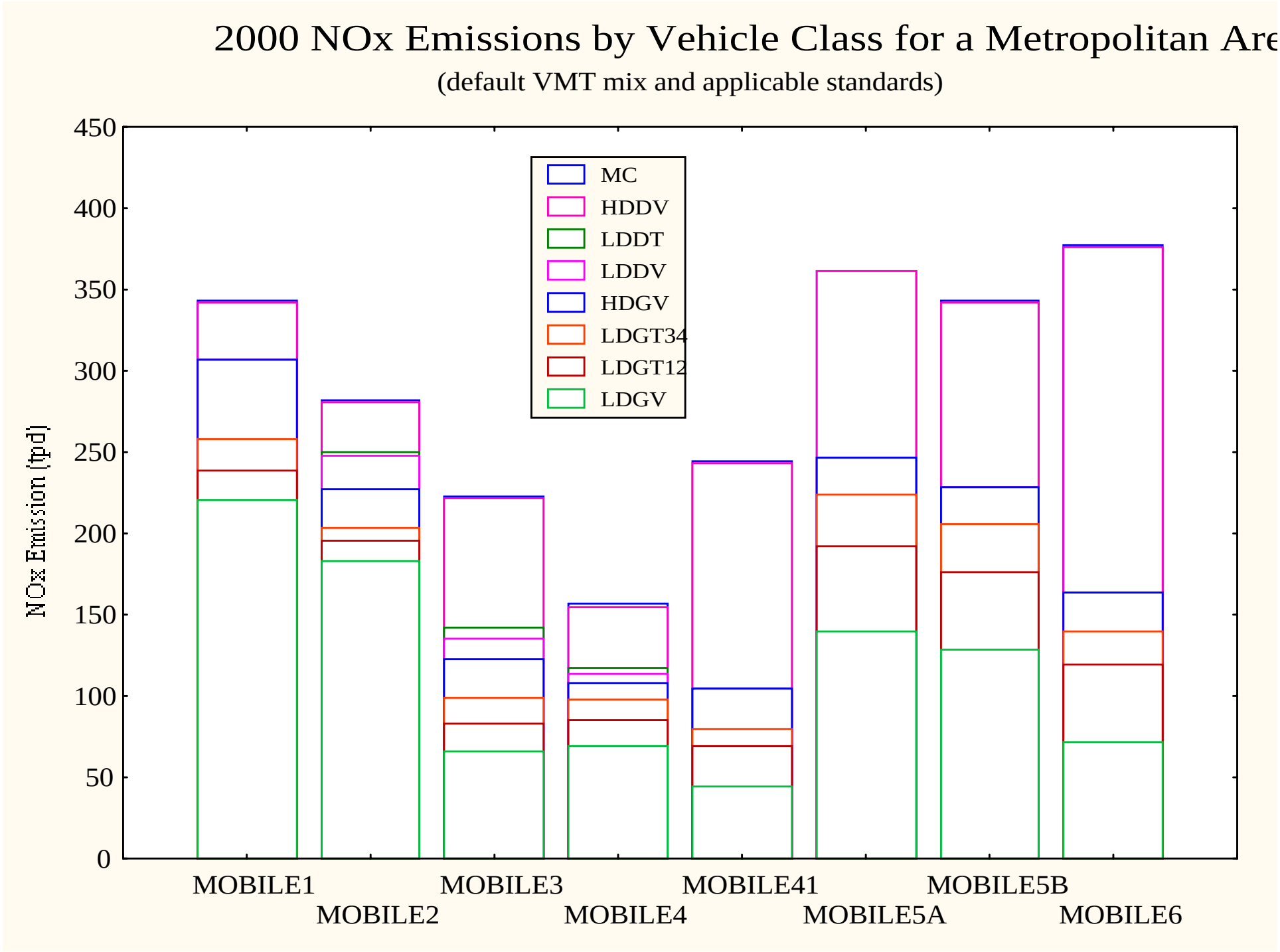
Mobile Source Emissions Inventory Methods



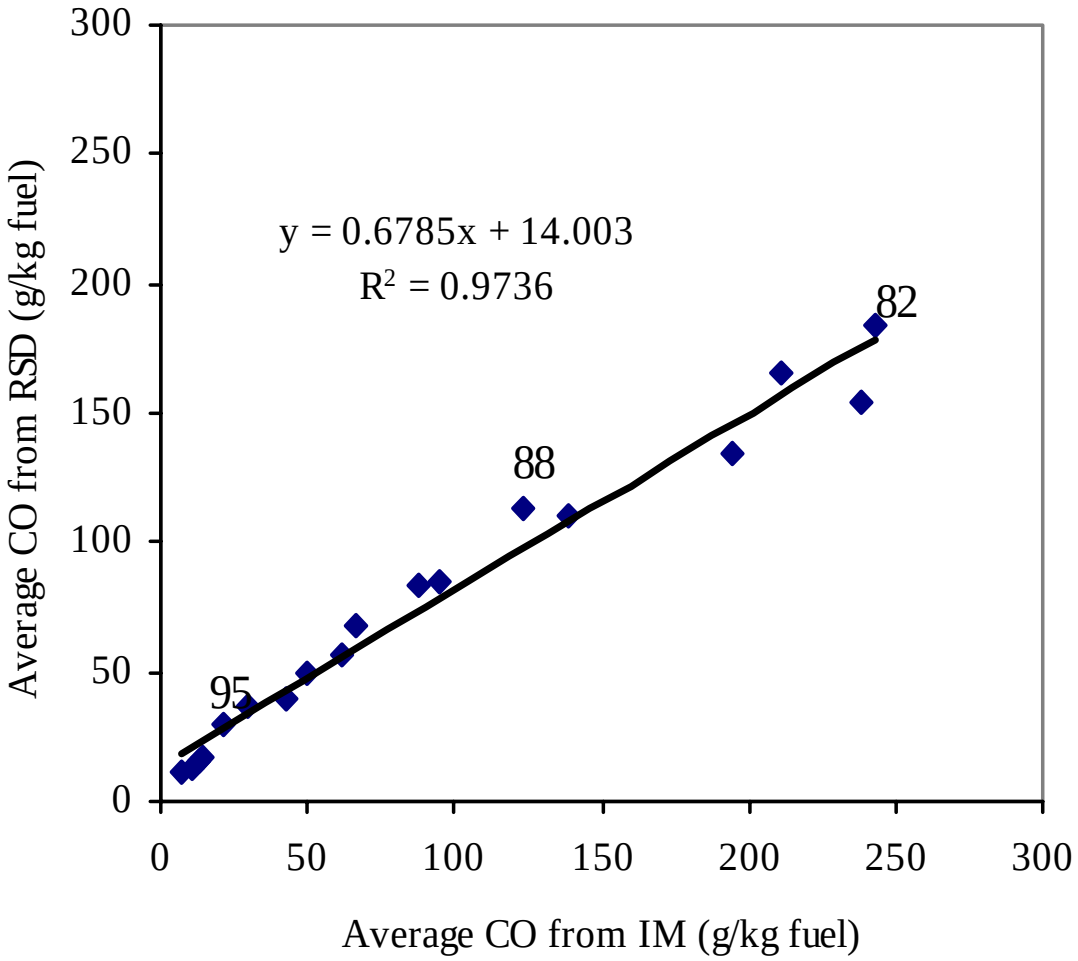

2010 THC Emissions by Vehicle Class for a Metropolitan Are
(default VMTmix and applicable standards)
THC Emissions (tpd)
200
160
120
80
40
0
MC
HDDV
LDDT
LDDV
HDGV
LDGT34
LDGT12
LDGV
MOBILE1
MOBILE2
MOBILE3
MOBILE4
MOBILE41
MOBILE5A
MOBILE5B
MOBILE6


2000 NOx Emissions by Vehicle Class for a Metropolitan Are
(default VMT mix and applicable standards)
NOx Emission (tpd)
450
400
350
300
250
200
150
100
50
0
MC
HDDV
LDDT
LDDV
HDGV
LDGT34
LDGT12
LDGV
MOBILE1
MOBILE2
MOBILE3
MOBILE4
MOBILE41
MOBILE5A
MOBILE5B
MOBILE6

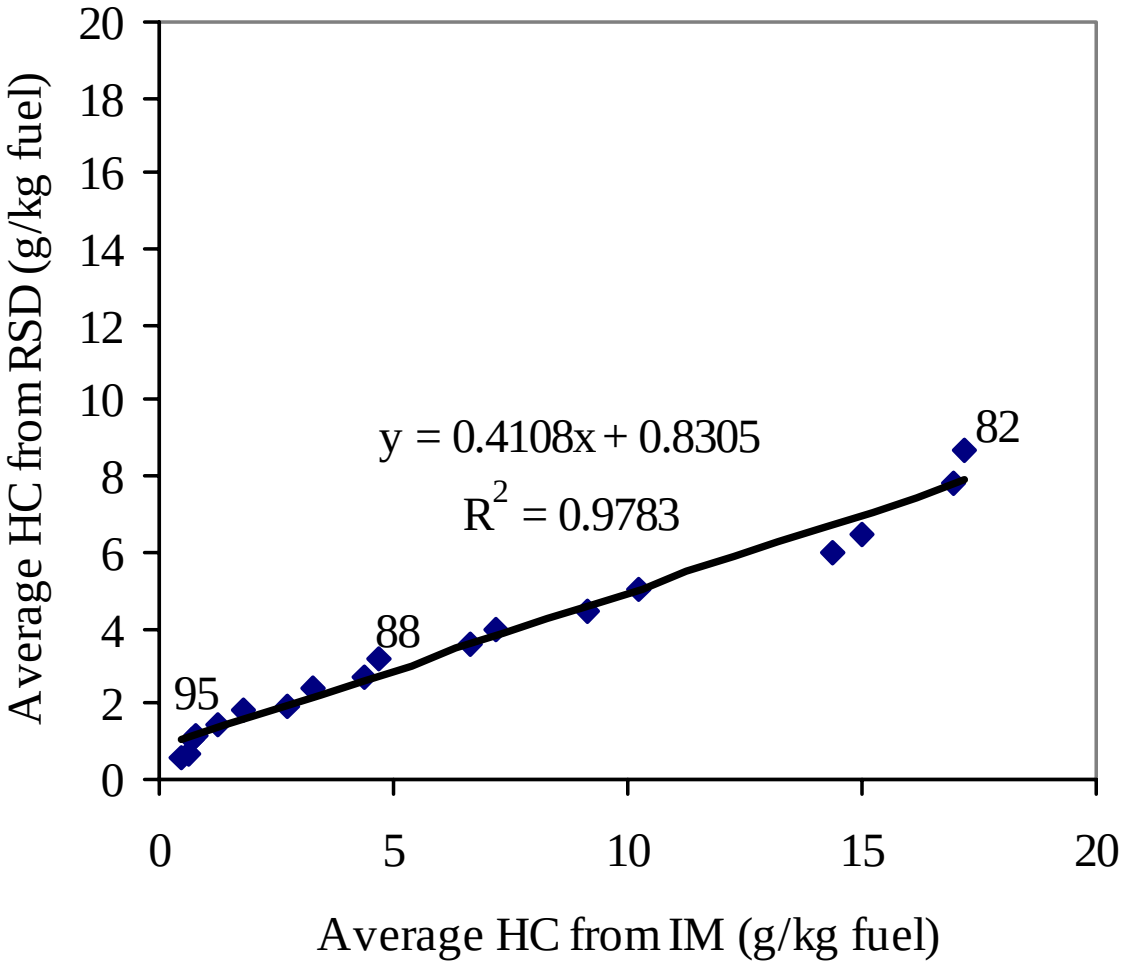
Remote Sensing versus IM240 Correlation in grams/kg

- Data averaged by model year correlate very well
- Cost of RSD: $25,000
- Cost of IM240: $25,000,000

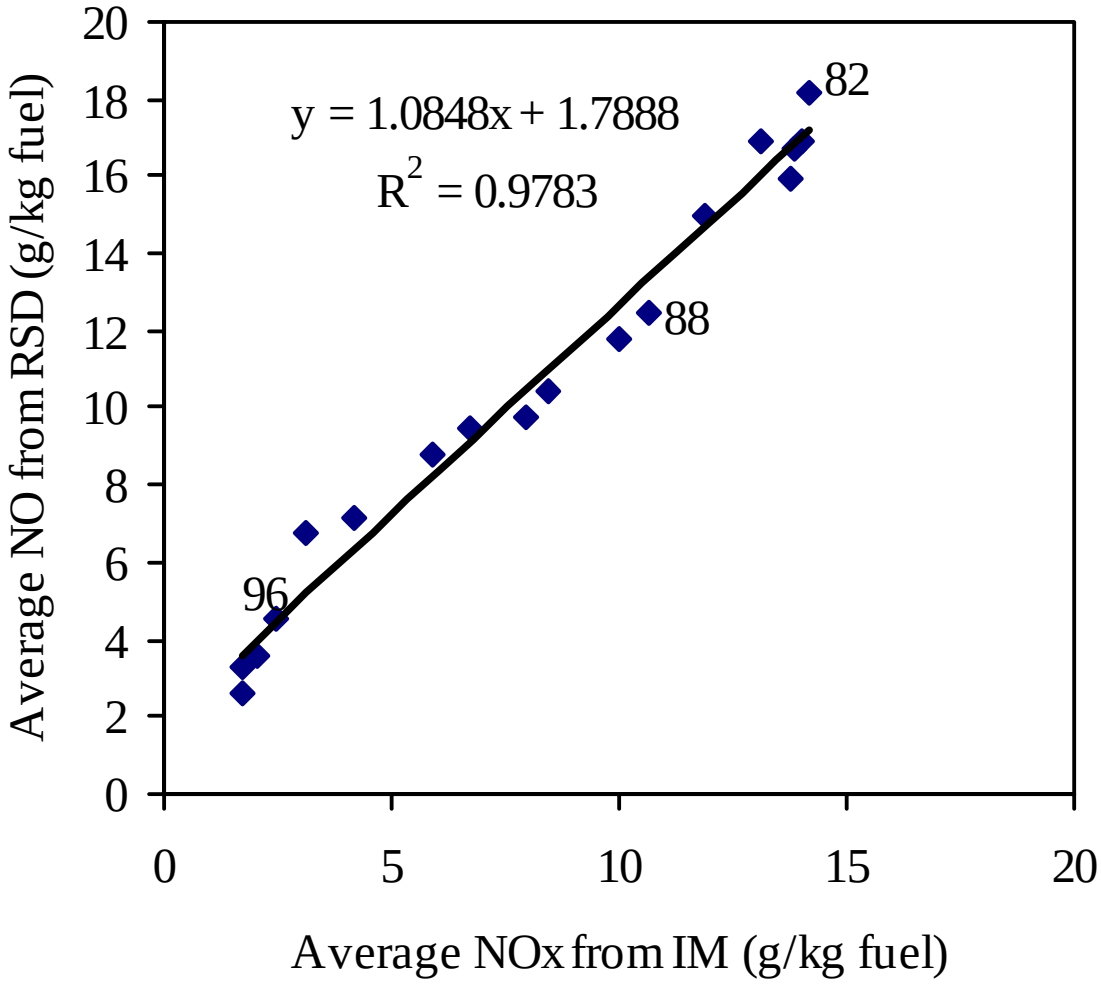
Denver 1999 CO



Denver 1999 HC



Denver 1999 NO



Calculations for Fuel-Based Approach

$$\frac{gCO}{kgFUEL} = \frac{28 \times \frac{\%CO}{\%CO_2}}{\frac{\%CO}{\%CO_2} + 1 + (3 \times \frac{\%HC}{\%CO_2})} \times (\frac{1}{0.014})$$

$$\frac{gHC}{kgFUEL} = \frac{44 \times \frac{\%HC}{\%CO_2}}{\frac{\%CO}{\%CO_2} + 1 + (3 \times \frac{\%HC}{\%CO_2})} \times (\frac{1}{0.014})$$

$$\frac{gNO}{kgFUEL} = \frac{30 \times \frac{\%NO}{\%CO_2}}{\frac{\%CO}{\%CO_2} + 1 + (3 \times \frac{\%HC}{\%CO_2})} \times (\frac{1}{0.014})$$

Calculations of Emission Factors in Fuel-Based Approach

$$t_{yv} = \frac{n_{yv}}{N}$$

y = model year subgroup
v = vehicle type subgroup (car or truck)
t = fraction of travel of subgroup
n = number of measurements of subgroup
N = total number of measurements

$$f_{yv} = \frac{(t_{yv} / F_{yv})}{\sum_{v=V_1}^{V_n} \sum_{y=Y_1}^{Y_n} (t_{yv} / F_{yv})}$$

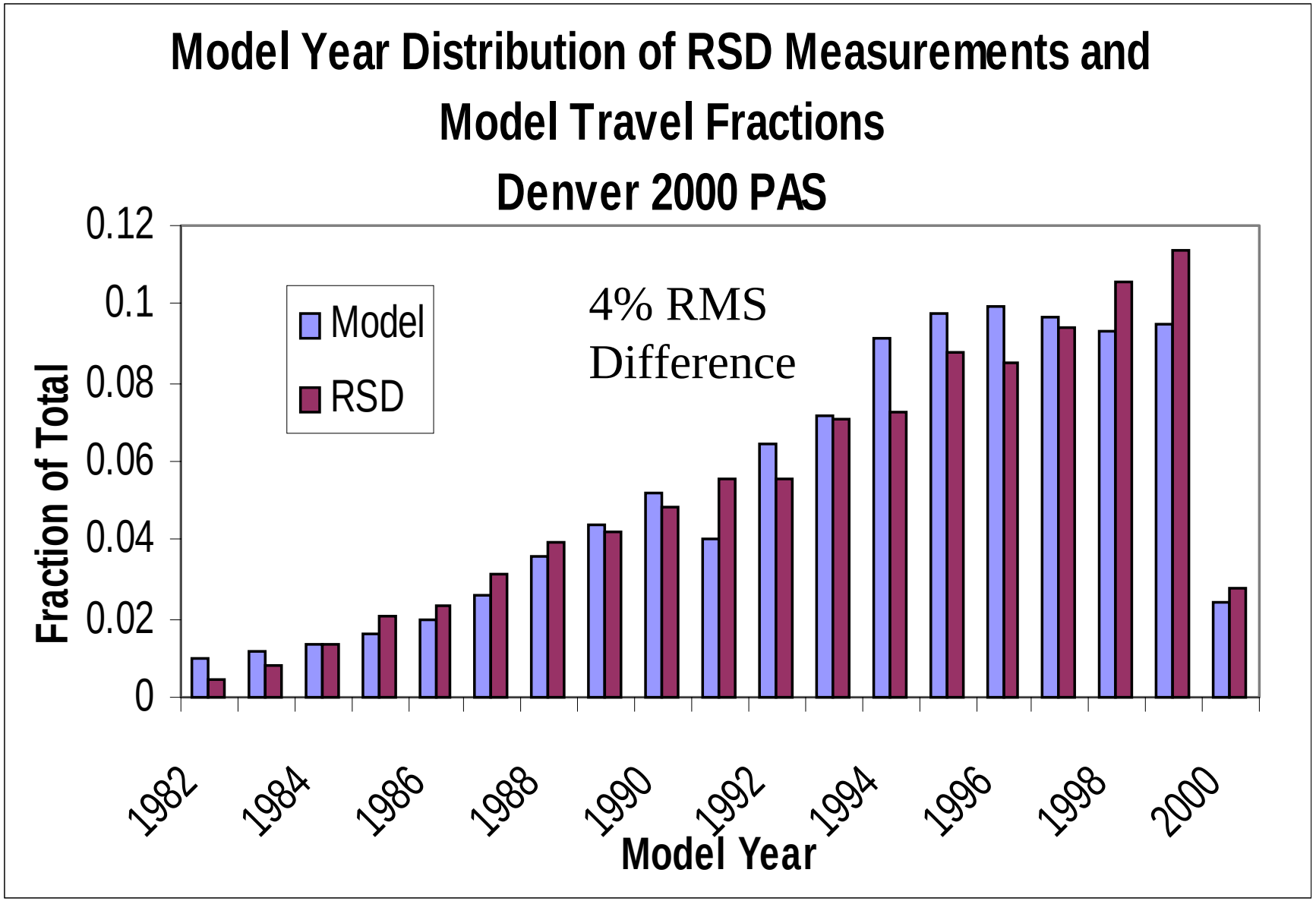
F_{yv} = fuel economy of MY subgroup y and vehicle type v
$Y_1 \ldots Y_n$ = various model years measured
$V_1 \ldots V_n$ = vehicle types measured
f_{yv} = relative fuel economy of subgroup y and v

$$M = \sum_{v=V_1}^{V_n} \sum_{y=Y_1}^{Y_n} f_{yv} E_{yv}$$

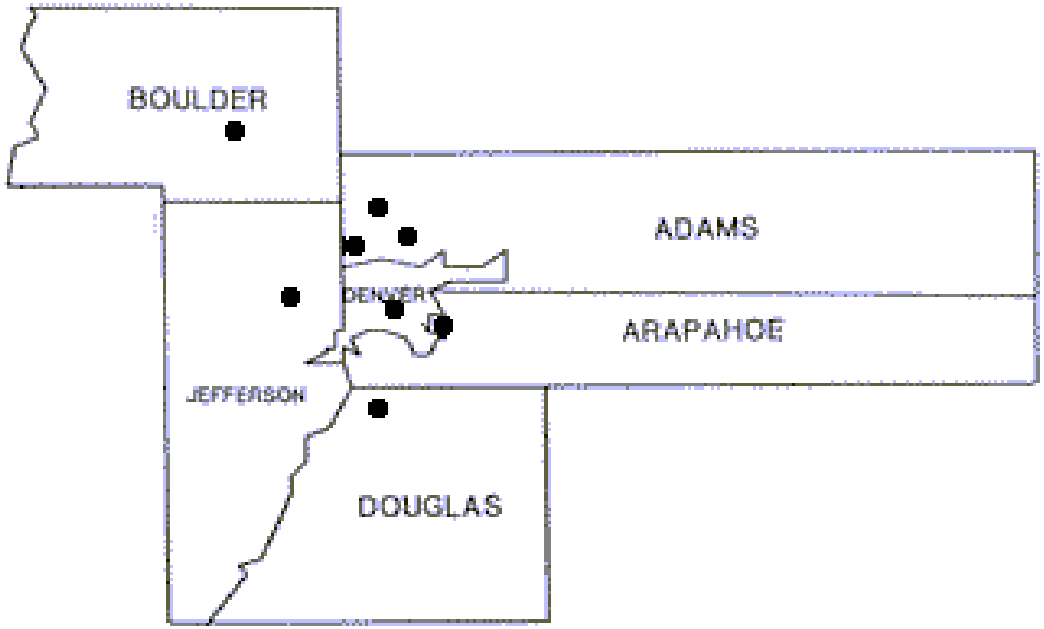
M = Emission factor of fleet

Statistics of Using RSD for Inventory

- One week's work
- 25,000 vehicles
- Approximately 5% variability in day to day average emissions
- Adding uncertainty in fuel economy and fuel sales in area: 10% overall uncertainty

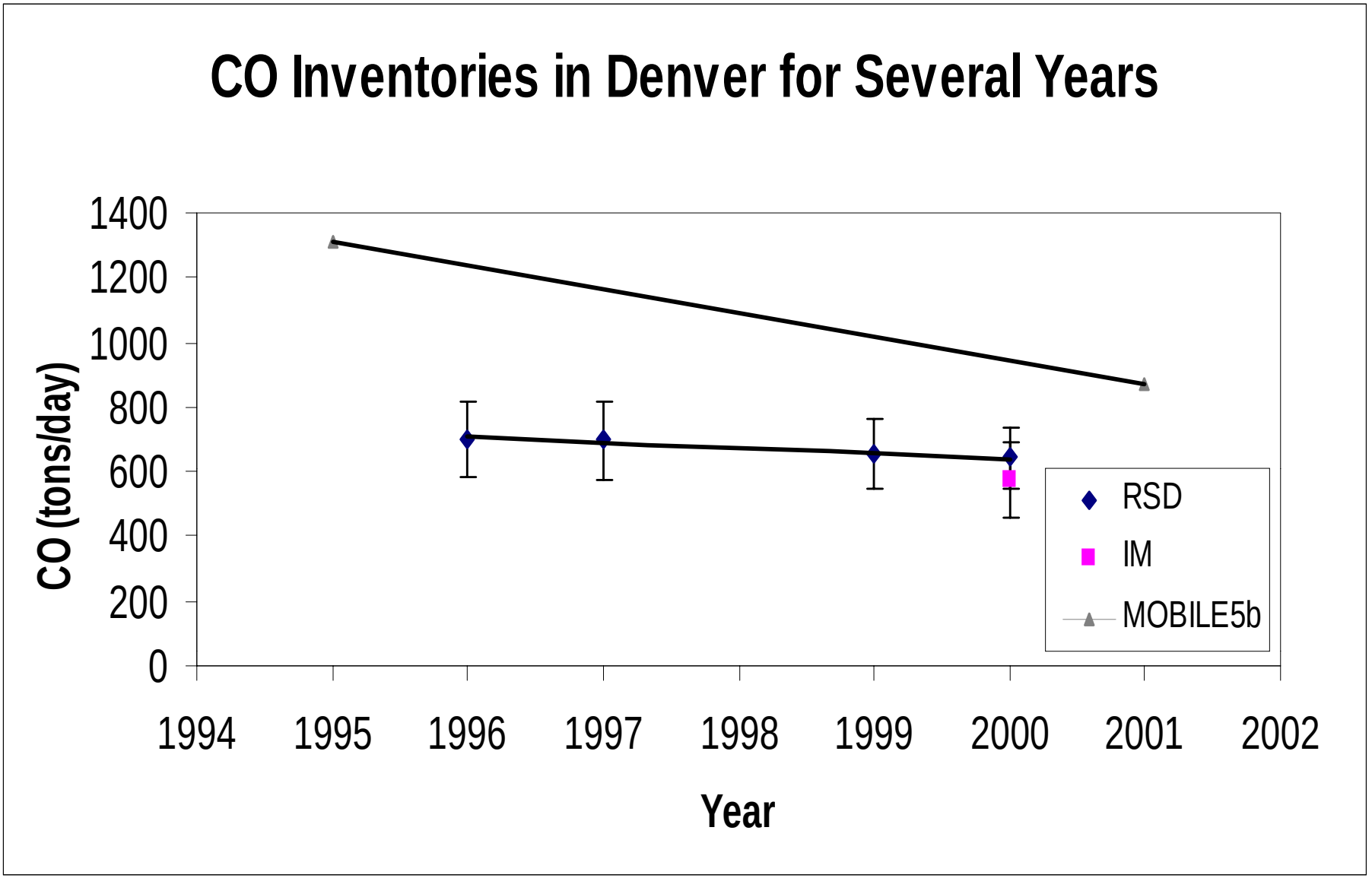

Model Year Distribution of RSD Measurements and
Model Travel Fractions
Denver 2000 PAS
Fraction of Total
0.12
0.1
0.08
0.06
0.04
0.02
0
Model
RSD
4% RMS
Difference
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Model Year

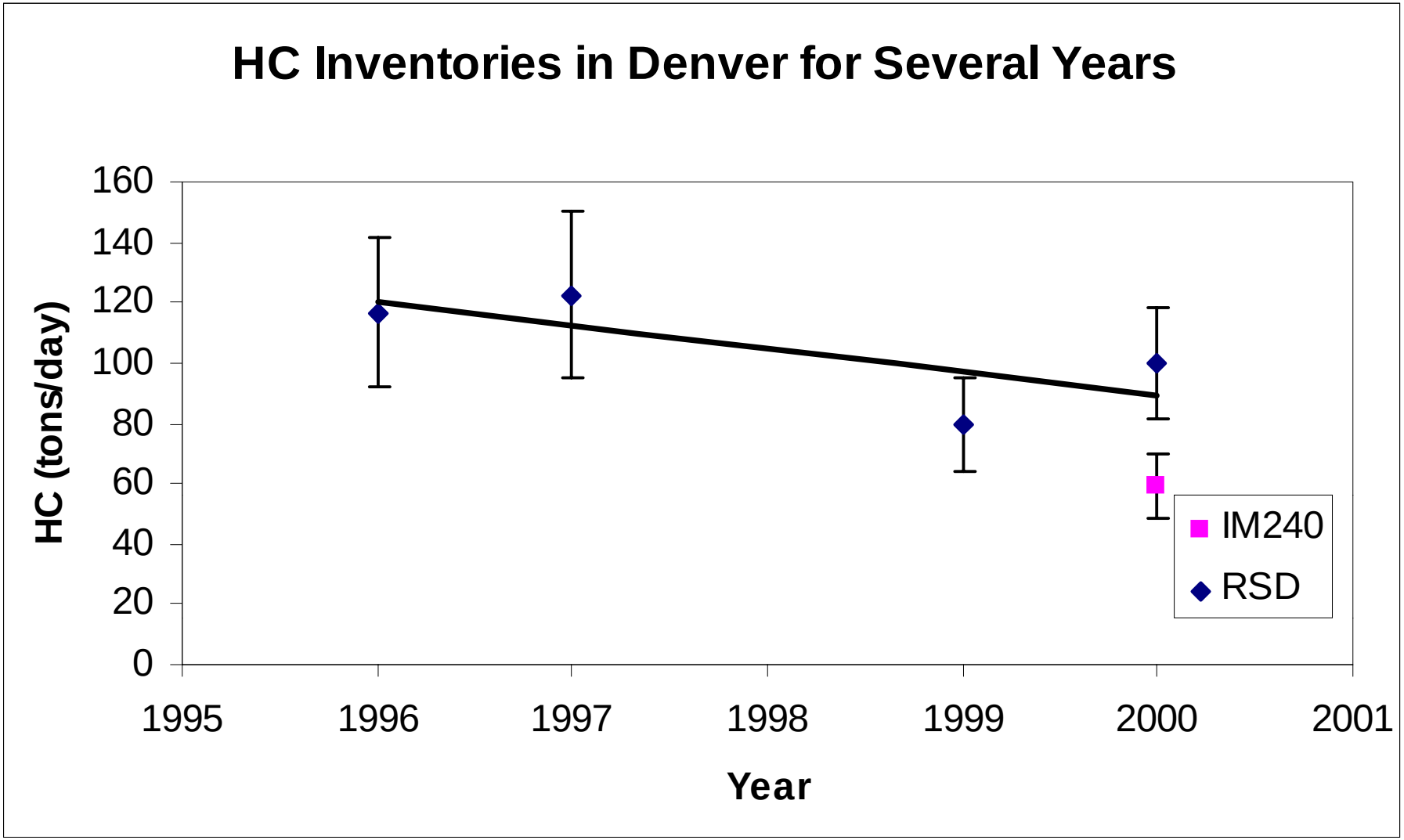
Map of Study Area with Measurement Locations

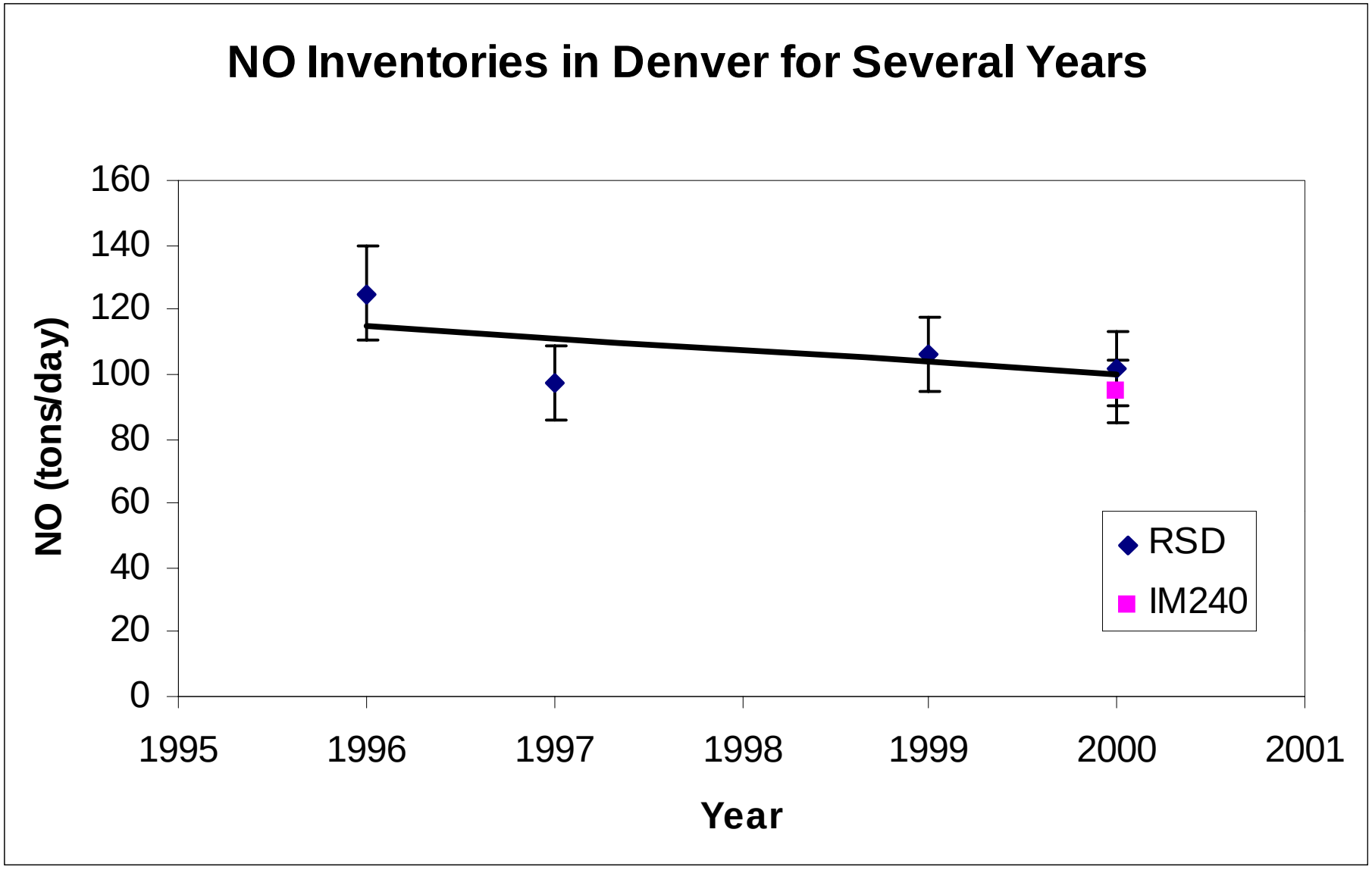


Emission Factors and Inventories for Denver 2000

	CO	HC	NO	Units
Gasoline (LTK, PAS)	66	9	7	g per kg of fuel
Gasohol (LTK, PAS)	59	8	7	g per kg of fuel
Diesel trucks	32	14	24	g per kg of fuel
Gasoline (LTK, PAS)	369	48	37	Tons/day
Gasohol (LTK, PAS)	220	30	27	Tons/day
Diesel trucks	52	22	38	Tons/day
Total	642	100	102	Tons/day


CO Inventories in Denver for Several Years
CO (tons/day)
1400
1200
1000
800
600
400
200
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year
RSD
IM
MOBILE5b


HC Inventories in Denver for Several Years
HC (tons/day)
160
140
120
100
80
60
40
20
0
1995
1996
1997
1998
1999
2000
2001
Year
IM240
RSD


NO Inventories in Denver for Several Years
160
140
120
100
80
60
40
20
0
NO (tons/day)
1995
1996
1997
1998
1999
2000
2001
Year
RSD
IM240

Implications

- RSD method ideal for mobile source emissions inventories
- Especially where IM240 does not exist
- Only need one week of work and fuel sales to get fuel based emissions inventories