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

Sajal S. Pokharel

Gary A. Bishop

Donald H. Stedman

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

Sajal S. Pokharel, Gary A. Bishop and Donald H. Stedman

Department of Chemistry and Biochemistry

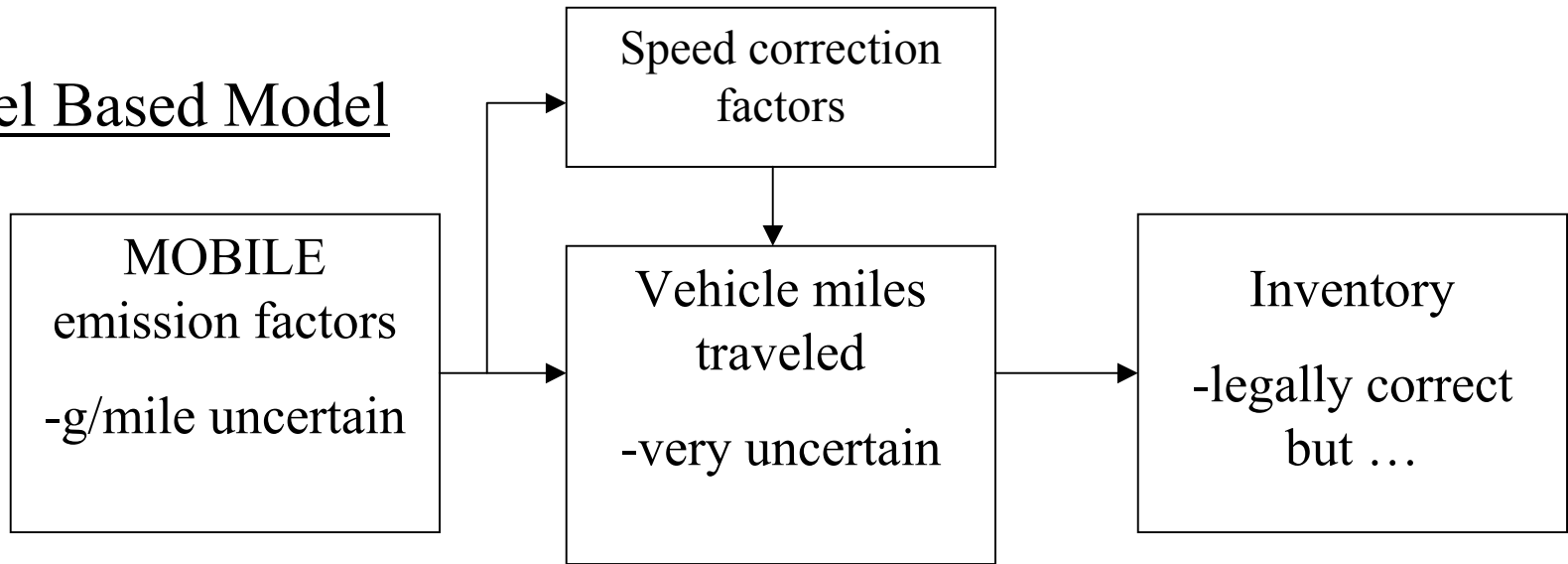
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2101 E. Wesley Ave.

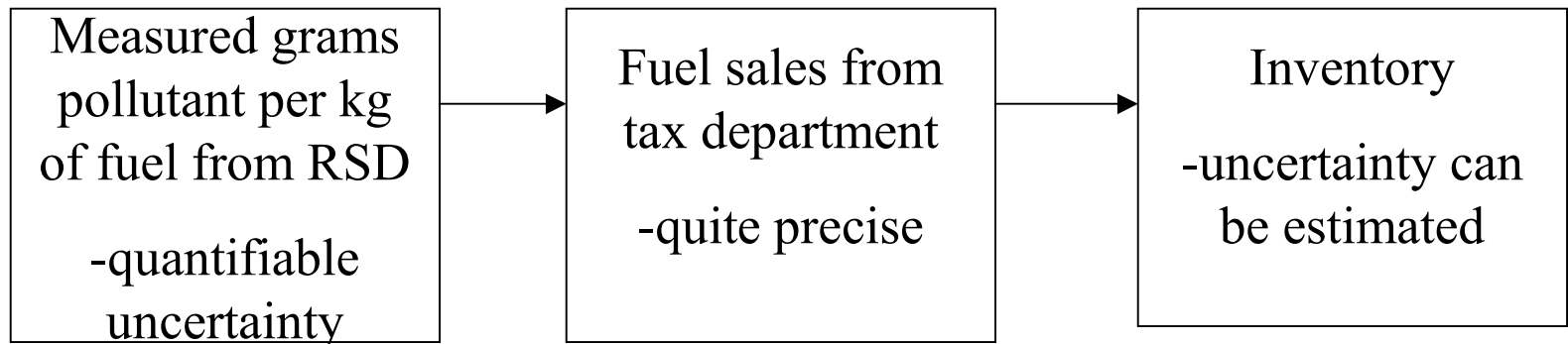
Denver, CO 80208

Mobile Source Emissions Inventory Methods

Travel Based Model

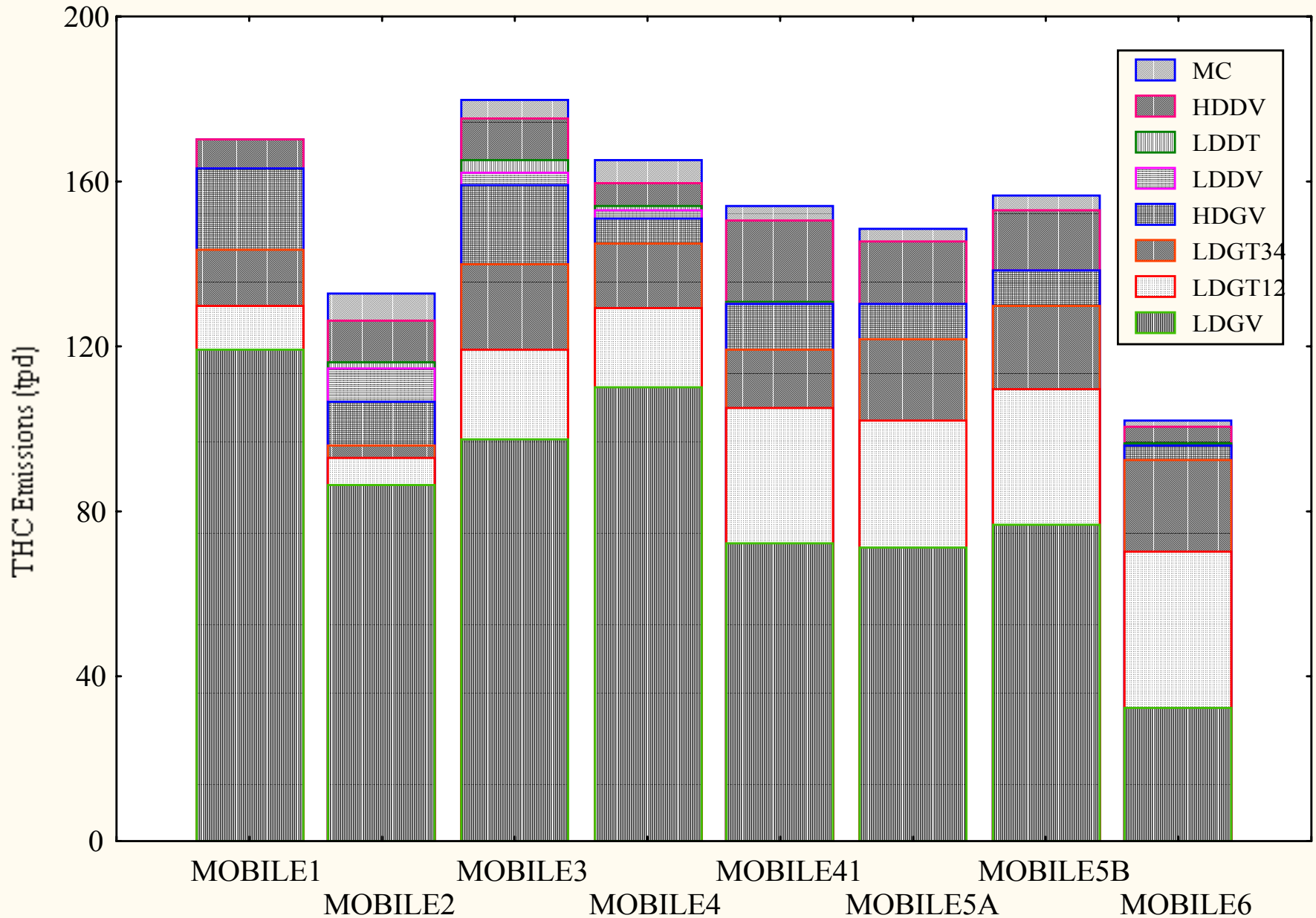


Fuel Based Data

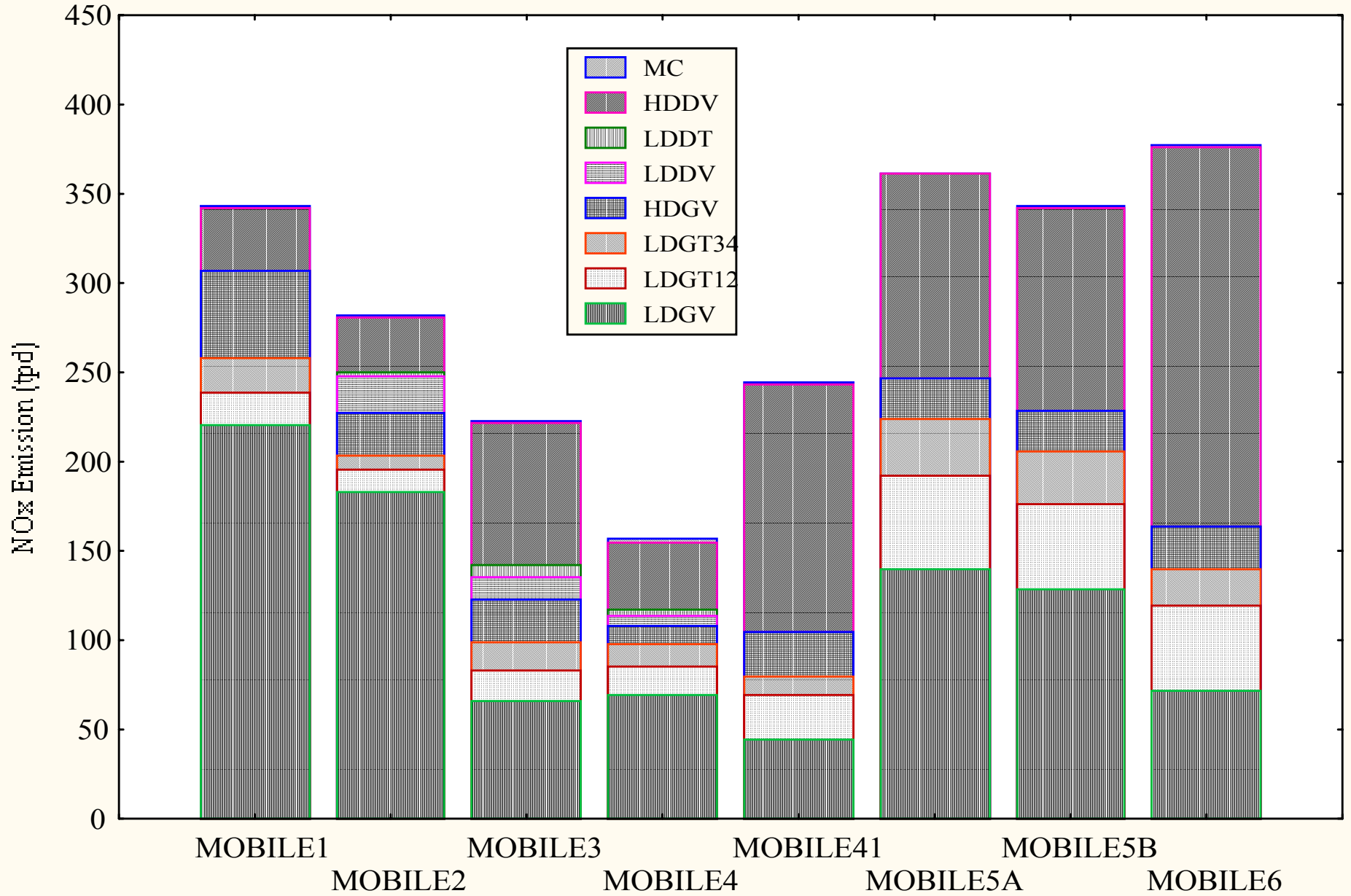


2010 THC Emissions by Vehicle Class for a Metropolitan Area

(default VMTmix and applicable standards)



(default VMT mix and applicable standards)

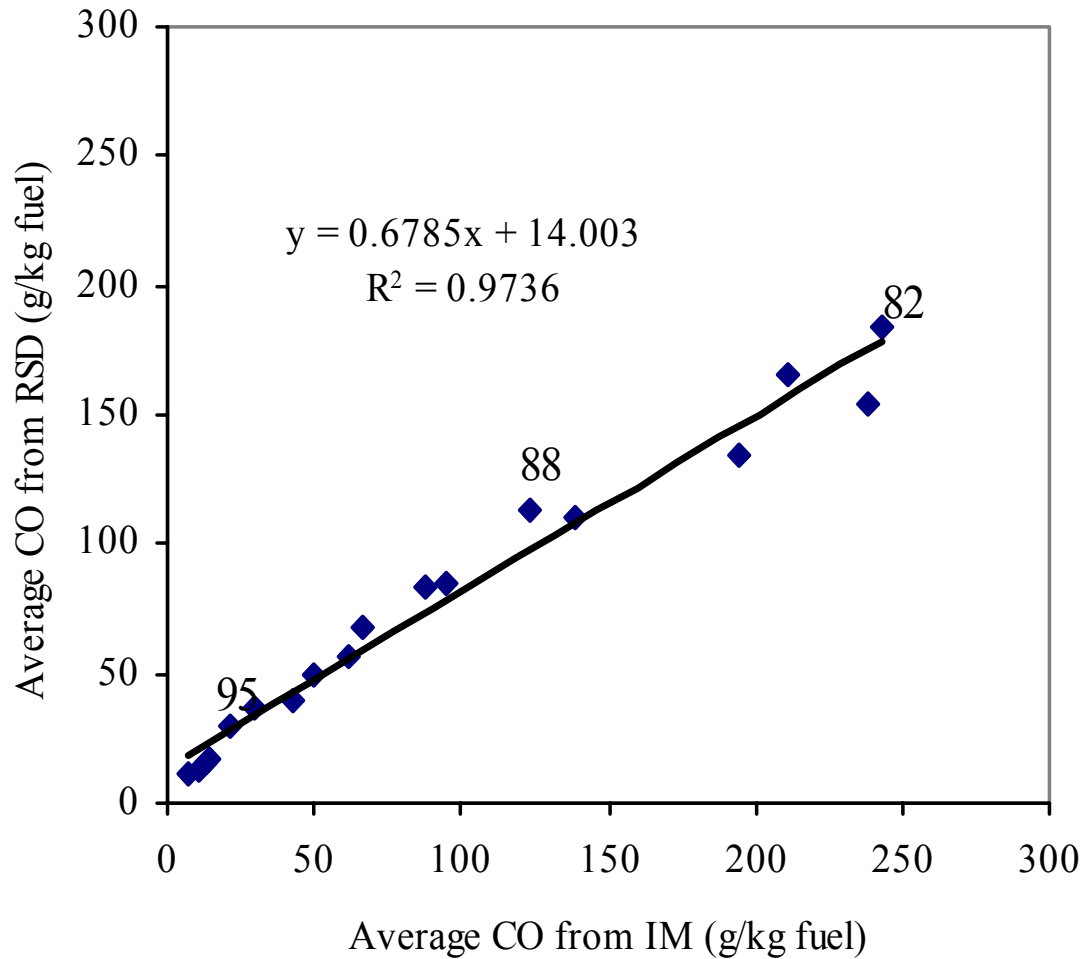


Remote Sensing versus IM240

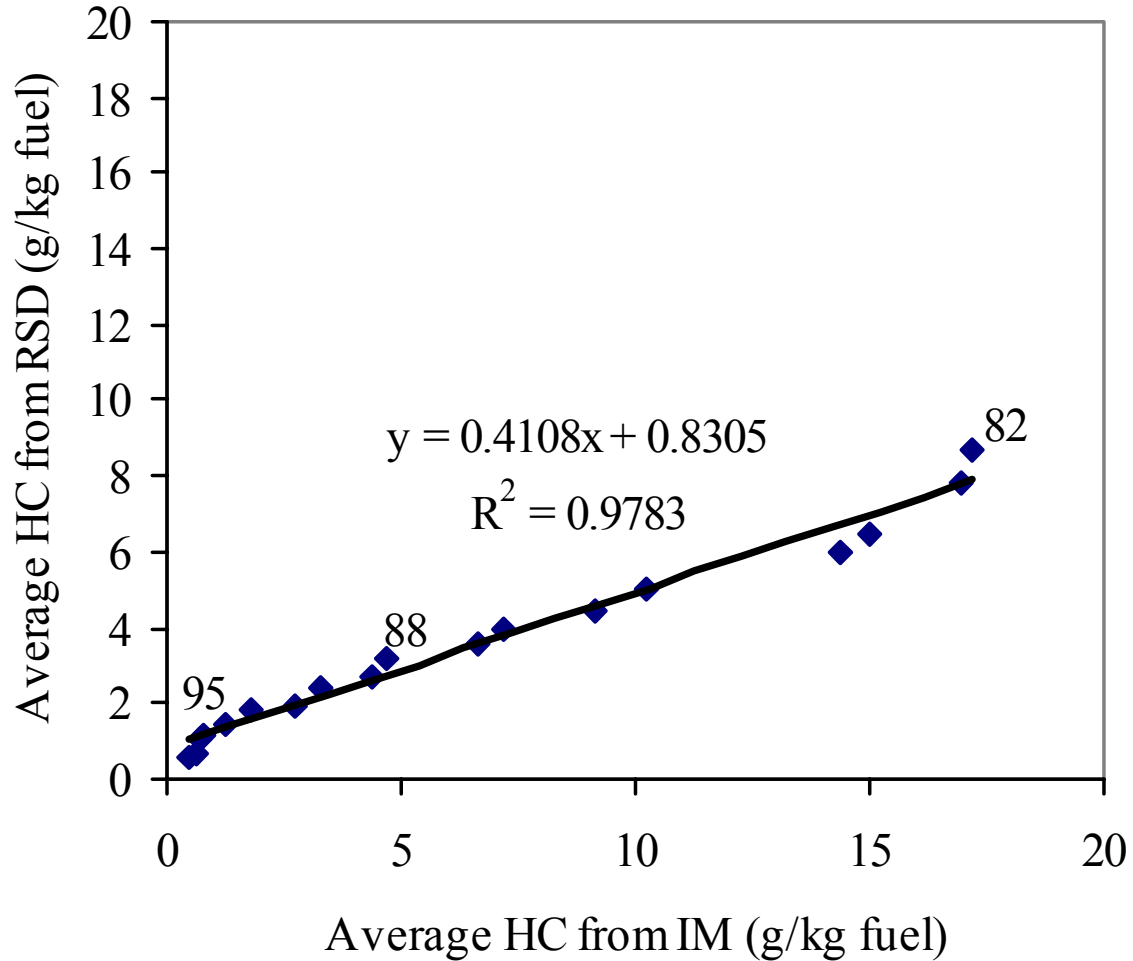
Correlation in grams/kg

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

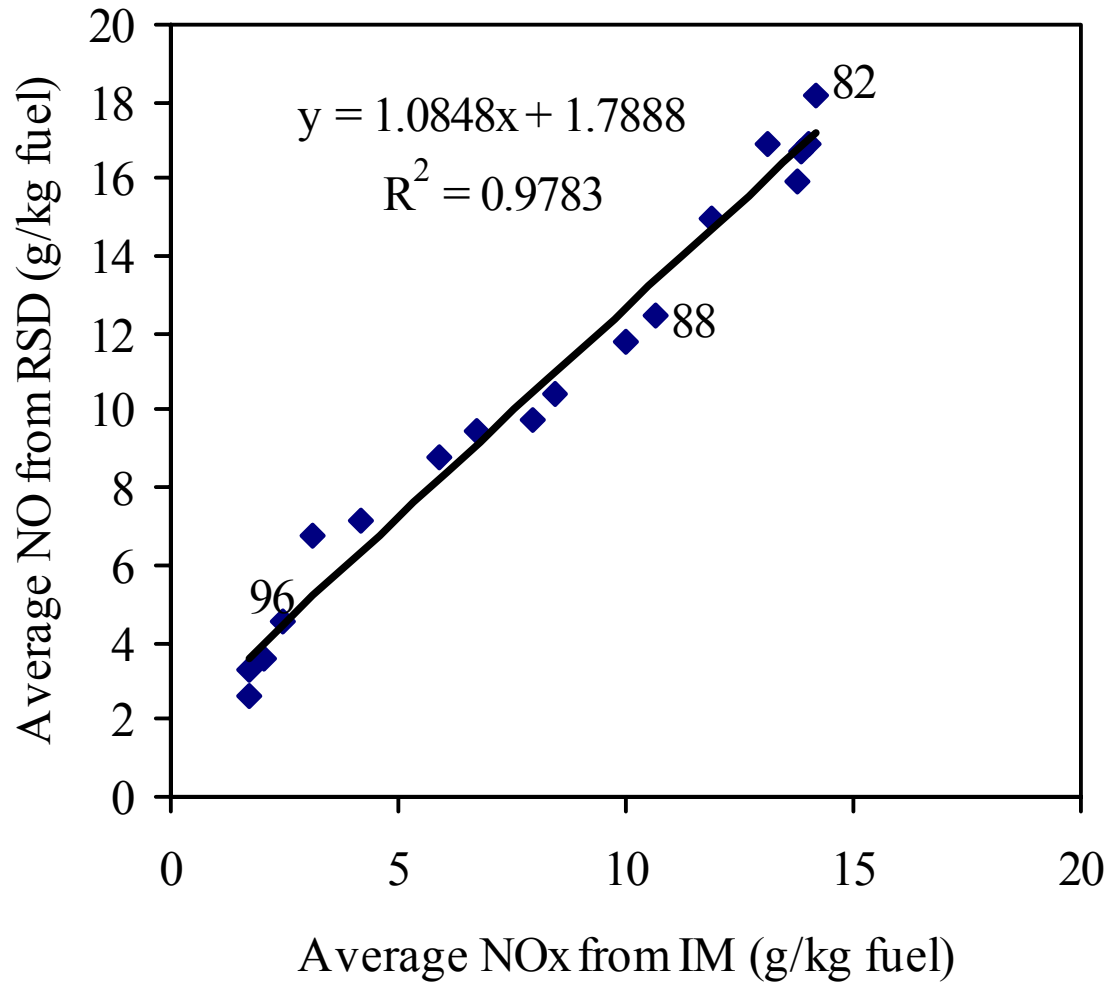
Denver 1999 CO



Denver 1999 HC



Denver 1999 NO



Calculations for Fuel-Based Approach

$$\frac{gCO}{kgFUEL} = \frac{28 \times \frac{\%CO}{\%CO_2}}{\frac{\%CO}{\%CO_2} + 1 + \left(3 \times \frac{2.2 \times \%HC}{\%CO_2}\right)} \times \left(\frac{1}{0.014}\right)$$

$$\frac{gHC}{kgFUEL} = \frac{44 \times \frac{2.2 \times \%HC}{\%CO_2}}{\frac{\%CO}{\%CO_2} + 1 + \left(3 \times \frac{2.2 \times \%HC}{\%CO_2}\right)} \times \left(\frac{1}{0.014}\right)$$

$$\frac{gNO}{kgFUEL} = \frac{30 \times \frac{\%NO}{\%CO_2}}{\frac{\%CO}{\%CO_2} + 1 + \left(3 \times \frac{2.2 \times \%HC}{\%CO_2}\right)} \times \left(\frac{1}{0.014}\right)$$

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

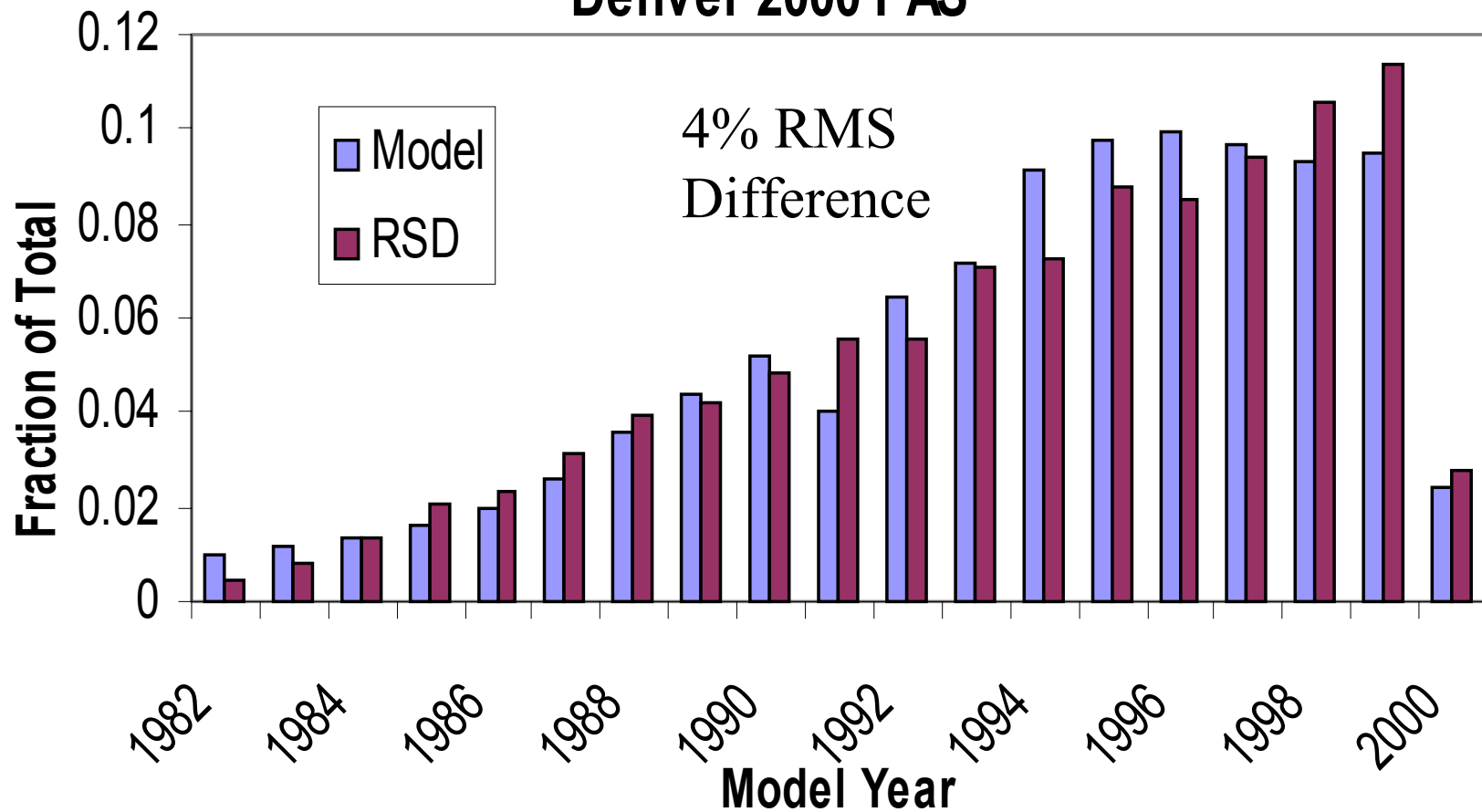
$$M = \sum_{v=V_1}^{V_n} \sum_{y=Y_1}^{Y_n} f_{yv} E_{yv}$$

M = Emission factor of fleet

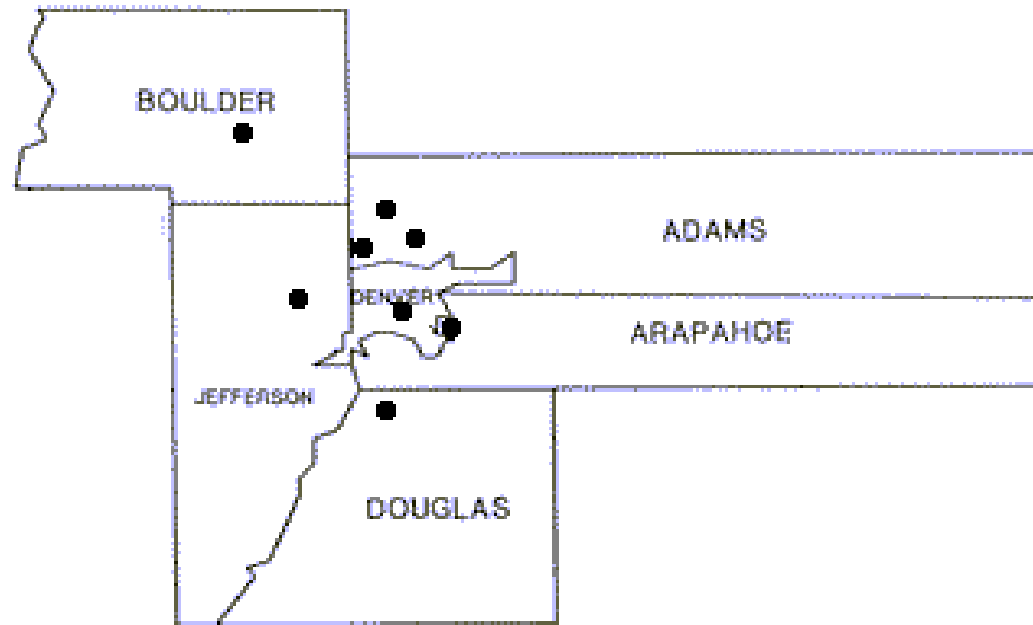
Statistics of Using RSD for Inventory

- 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



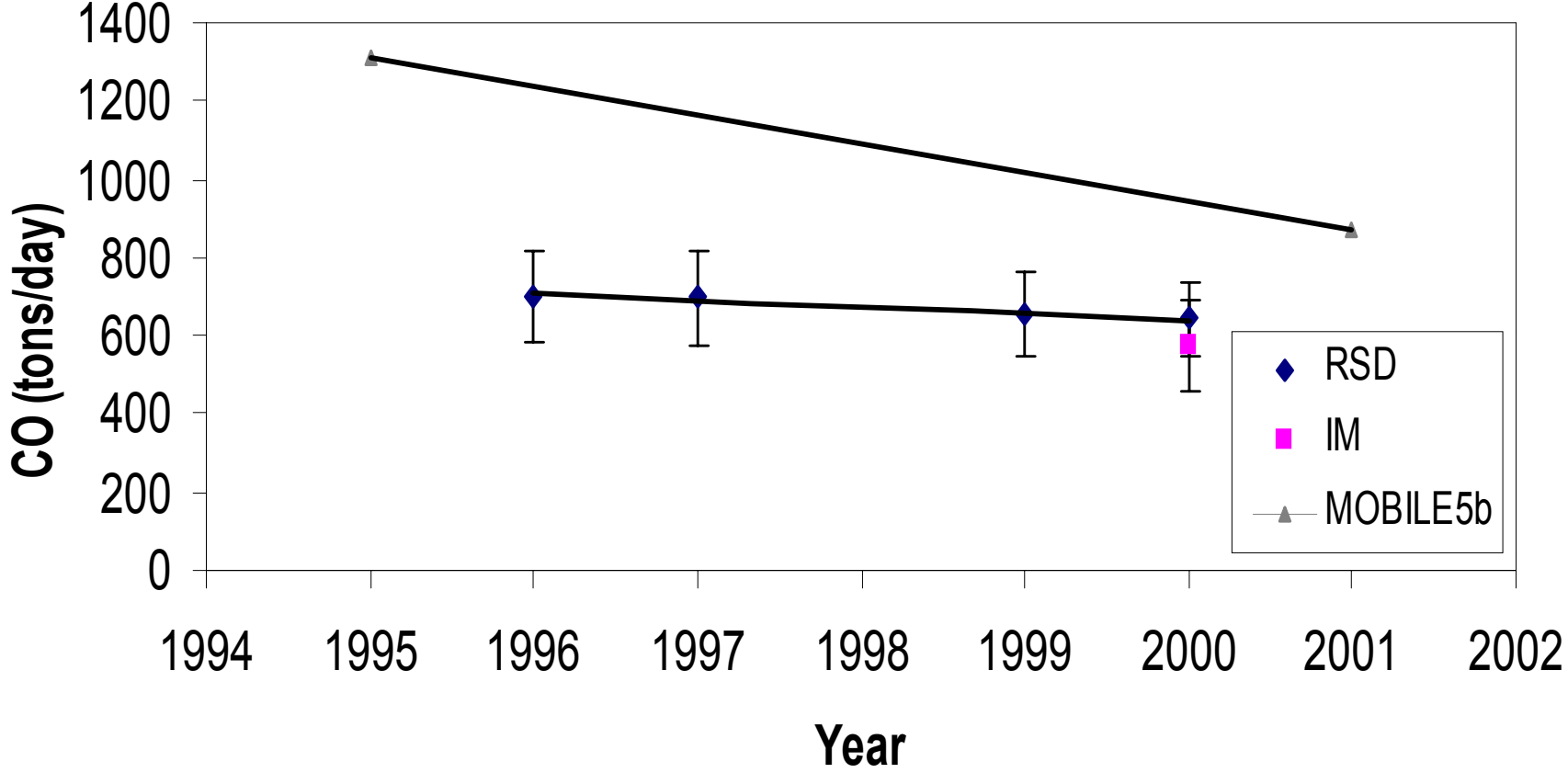
Map of Study Area with Measurement Locations



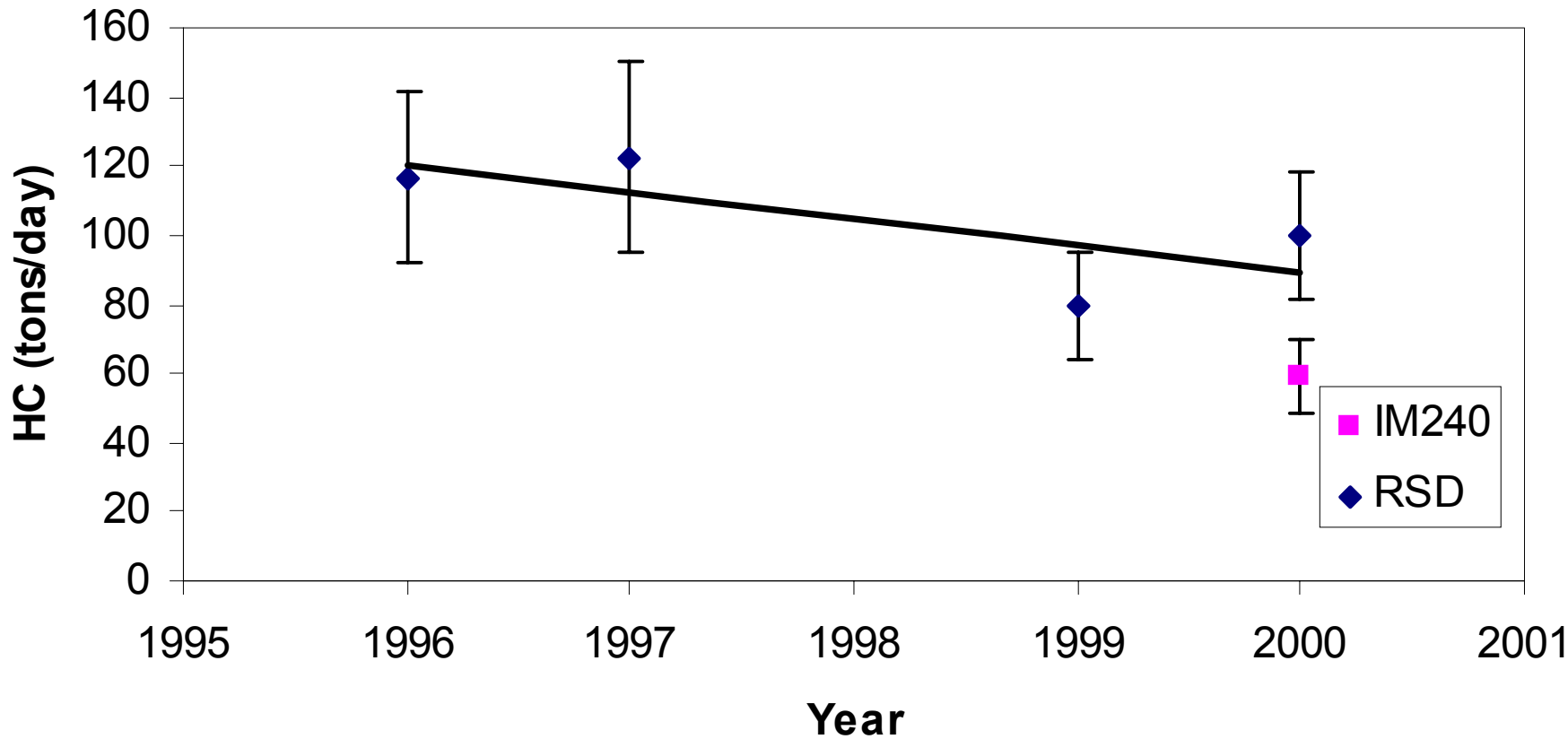
Emission Factors and Inventories for Denver 2000

	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

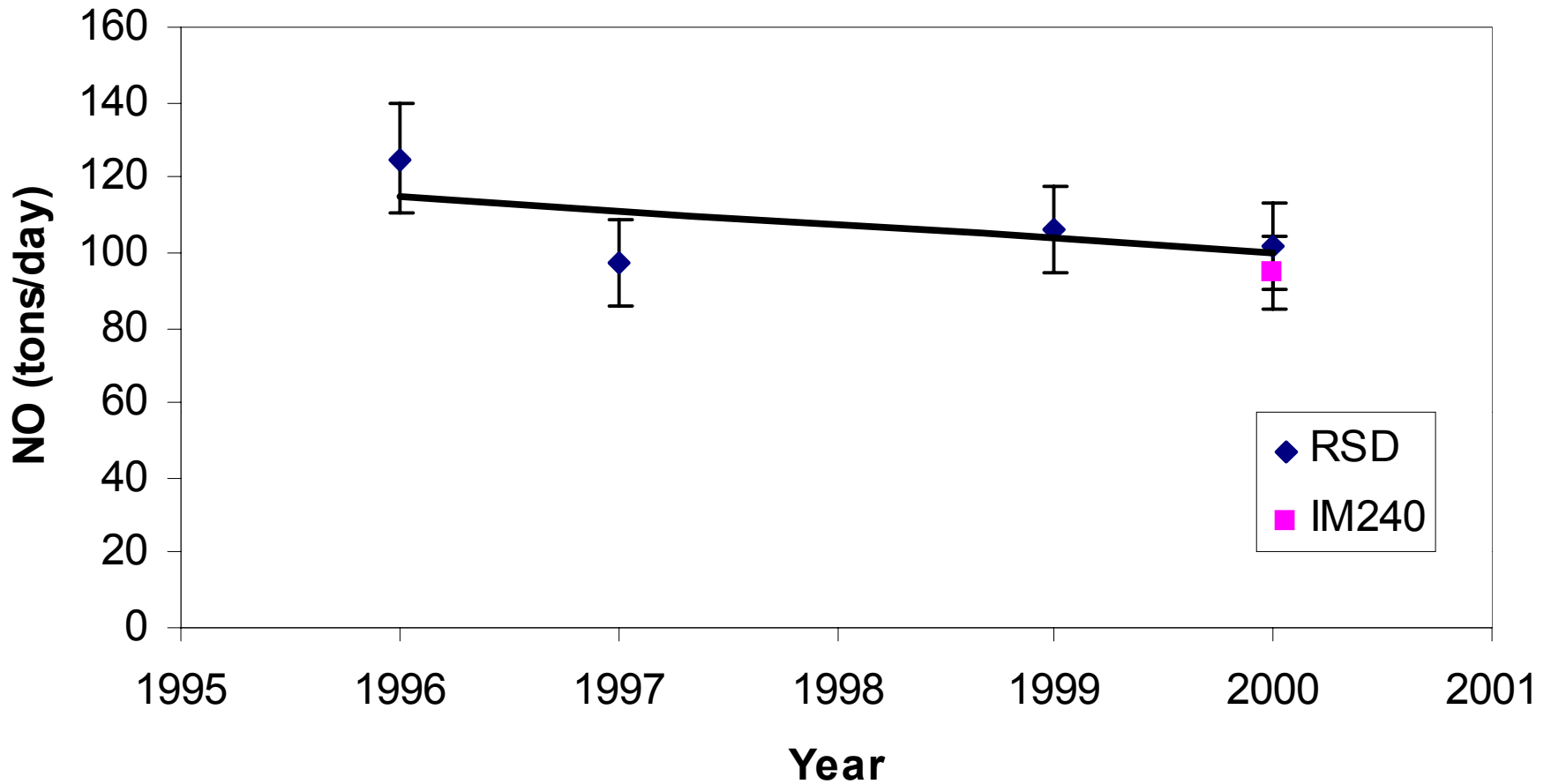
CO Inventories in Denver for Several Years



HC Inventories in Denver for Several Years



NO Inventories in Denver for Several Years



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