Comparison of On-Road Vehicle Profiles Collected in Seven Cities Worldwide

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Abstract

- This presentation provides a brief description of the activities and results of a cooperative on-road vehicle study carried out in seven international urban areas.
- The study is designed to efficiently collect important data about the current on-road fleet to support development of an accurate estimate of vehicular emissions for any urban area.
- The seven cities included in this report are:
  - Almaty, Kazakhstan (May 2003);
  - Lima, Peru (December 2003);
  - Los Angeles, USA (2001);
  - Mexico City, Mexico (January 2004);
  - Nairobi, Kenya (March 2002);
  - Pune, India (March 2003);
  - Santiago, Chile (December 2001, 2002).

- At the conclusion of a 2 week study per city, a comprehensive portrayal of the on-road driving patterns, vehicle technology distribution, vehicle flow and temporal distribution on representative streets, and vehicle start-up patterns is developed.
- Analysis of data collected to date provides some important and interesting comparisons of key transportation parameters for these cities.

Background

- These datasets have been formatted for application in the new International Vehicle Emission Model (IVE) and used to predict vehicle emission estimates (more information at *www.issrc.org*)
- The first stage of the IVE Model (Activity Study) has been developed specifically as a policy tool for developing nations for estimating the impacts of fleet technology improvements, traffic flow improvements, and fuel modifications on criteria pollutants, toxics, and global warming gases from on-road vehicles.
- Further activity studies are underway in Beijing, China; Bogotá, Colombia; São Paulo, Brazil; and Shanghai, China.
- The second stage of the IVE Model considers vehicle on-board emission measurements in Mexico City, São Paulo, Nairobi and Almaty.

Overview

Data collection methods

- Vehicle technology distribution
- Vehicle driving patterns
- Vehicle start patterns

Results

- Average annual vehicle use
- On-road distribution of vehicle types
- Age of Passenger Vehicle Fleet and Vehicle Use
- Vehicle Fuels and Technologies
- Passenger cars average daily driving speed
- Emissions analysis

Conclusions

Data collection methods

- Three representative sections of the city under analysis are normally selected for the IVE activity study. The areas selected should represent the fleet makeup and the general driving taking place in the city.
- To accomplish this objective, one of the study areas represents a generally lower income area of the city, another area represents a generally upper income area of the city, and the third one represents a commercial area of the city—normally the city center.
- Within each of the study areas, different types of streets were analyzed to gather data representative of all of urban streets. Streets were classified into highway, arterial and residential.


Surco
San Isidro
SAN ISIDRO
(COMERCIAL)
2.7 Km
6.0 Km
2.6 Km

Vehicle technology distribution

- The objective of this activity was to develop a representative distribution of vehicle types, sizes, and ages of the operating fleet in each city on various roadway types.
- In each city, nine roads were videotaped on weekdays between the hours of 07:00 and 21:00. The nine roads were selected from the three representative parts of the city of interest. These videotapes were reviewed to determine the numbers of passenger vehicles, taxis, buses, trucks, motorcycles, three-wheeled vehicles, and other vehicles observed on the nine city streets. The traffic volumes were also determined.
- At the same time as the videotaping, parking lots were visited by teams consisting of a local experienced automobile mechanic, an ISSRC/UCR team member, and an expert from the government agency or local university that was working as a study partner. Between 1000-1200 randomly selected vehicles were collected over the course of each study. The data collected in the parking lot studies consisted of vehicle manufacturer, model, fuel type, model year, license plate number, engine size and technology, odometer reading, add-on control technology, transmission type, air conditioning, and general condition.

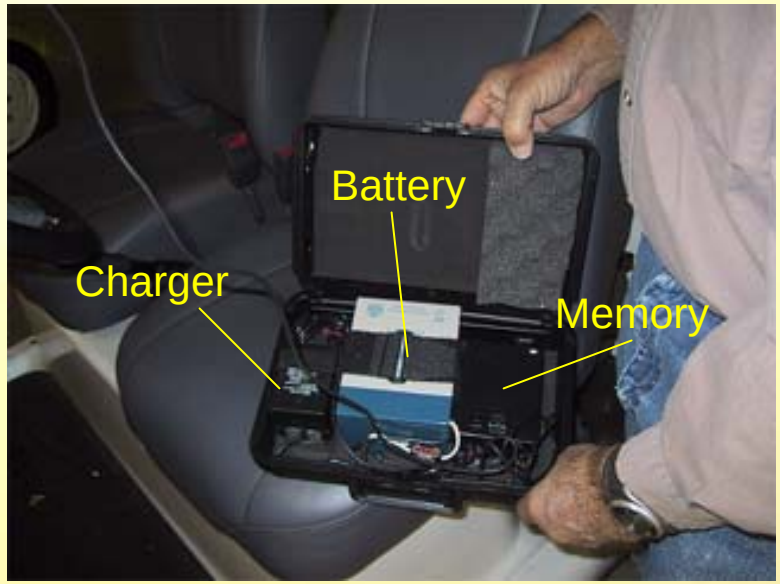

Camera 1
Camera 2

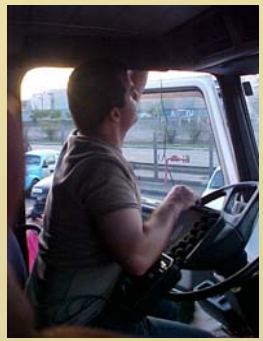

Indicates
Engine Size
KXO 695
Indicates
Registration
Year


INTERNET
PALACE
FUJIFILM

Vehicle driving patterns

- The objective of this activity is to collect second-by-second information on the speed and acceleration of the main types of vehicles operating in each city on a representative set of roadways throughout the day.
- The driving patterns for the various classes of vehicles were measured using Combined Global Positioning Satellite (CGPS) modules with microprocessors developed by CE-CERT and GSSR. This technology allows for the second by second continuous measurements of vehicle 3D position, velocity, time, and satellite status.
- At the same time as the videotaping and parking lot surveys, three vehicles were operated on the nine selected streets to measure passenger vehicle driving patterns, including motorcycles in Pune. Data was collected from 07:00 to 19:00 to provide driving pattern information for different times of the day. During this same time period, students were dispatched to ride various buses, trucks and three-wheelers to estimate their driving patterns.

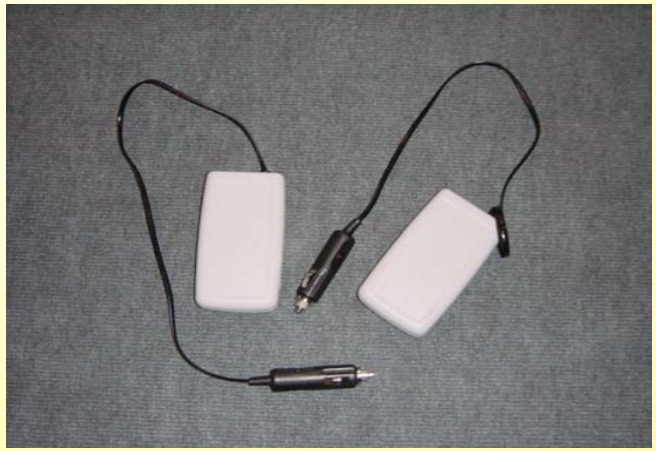


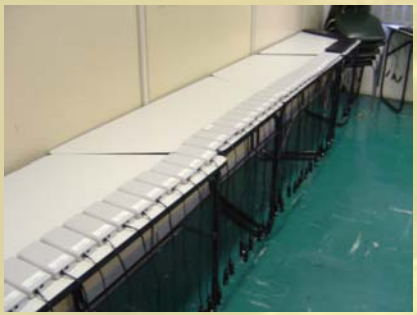


Different examples of GPS mounting techniques (passenger car, motorcycle, bus, truck)

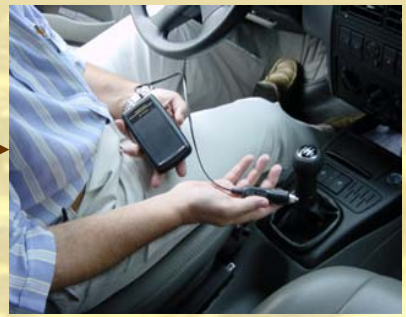
Vehicle start patterns

- Between 10% and 30% of vehicle emissions come from vehicle starts in the United States. This is a significant amount of emissions. Thus, it is important to understand vehicle start patterns in an urban area to fully evaluate vehicle emissions.
- To measure start patterns, a small device that plugs into the cigarette lighter or otherwise hooks into a vehicle electrical system has been developed. This system, denoted VOCE, senses vehicle system voltage fluctuations. VOCE data can be used to determine when vehicles start, how long they operate, and how long they sit idle between starts. This information is essential to establish vehicle start emissions. The VOCE units were placed in 60-80 passenger vehicles and left there for a period of six to ten days.





Set-up procedure

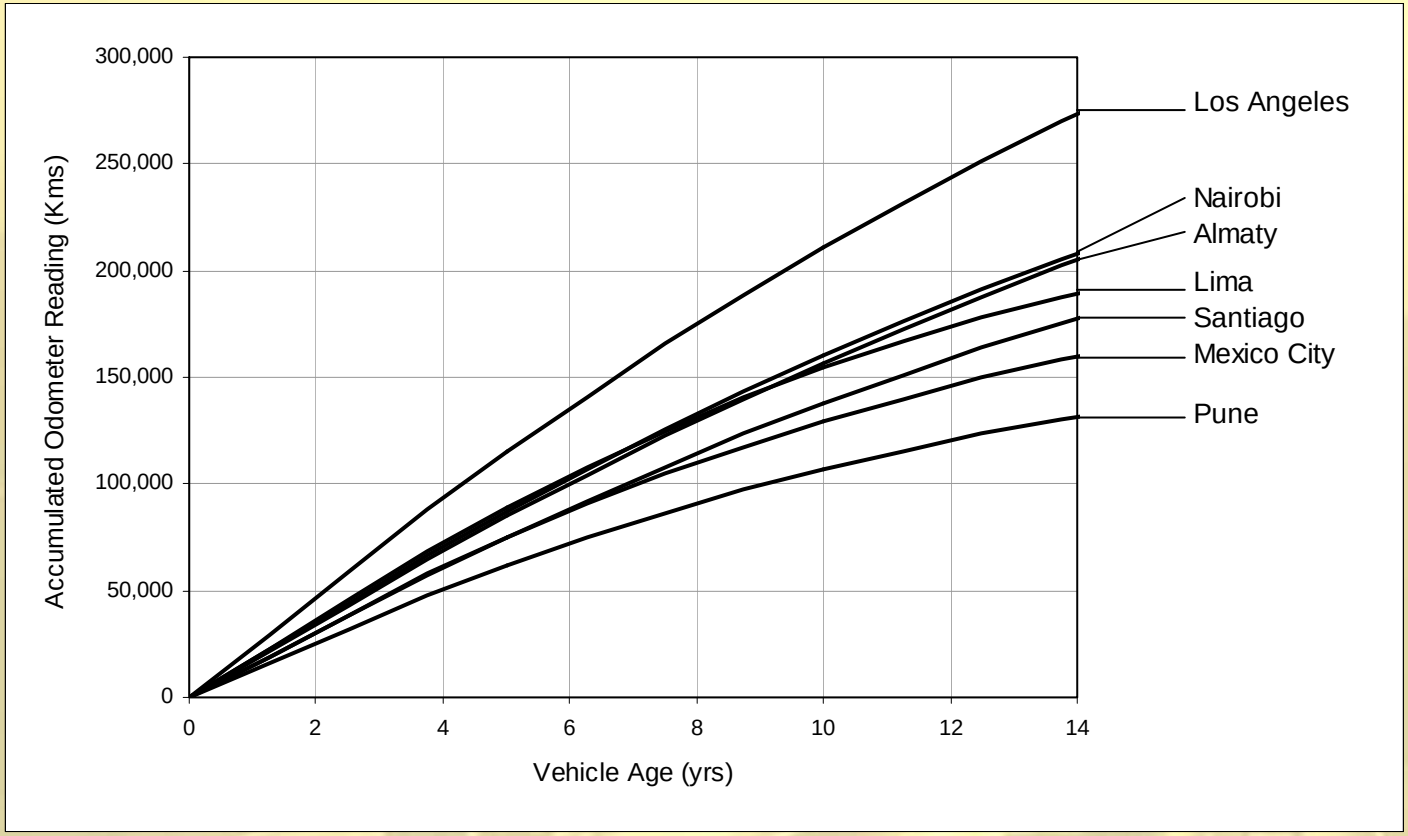


Measurement process

Downloading data

Results

Average annual vehicle use



On-road distributions of vehicle types

City	Pass. Vehicles	Motor Cycles	Taxi	3-Wheel Carriers	Buses	Trucks	Non-Moto-rized
Almaty	82.9%	0.1%	n/d	0.0%	11.6%	4.7%	0.7%
Lima	52.0%	1.0%	3.0%	0.0%	18.0%	6.0%	0.0%
LA	95.4%	0.1%	0.0%	0.0%	0.6%	3.9%	0.0%
Mexico City	79.0%	1.6%	11.0%	0.0%	3.5%	5.1%	0.0%
Nairobi	87.8%	1.7%	0.5%	0.0%	3.8%	5.4%	0.8%
Pune	12.0%	55.0%	0.3%	13.3%	1.5%	1.4%	16.5%
Santiago	78.9%	1.2%	7.9%	0.0%	6.7%	5.3%	0.0%

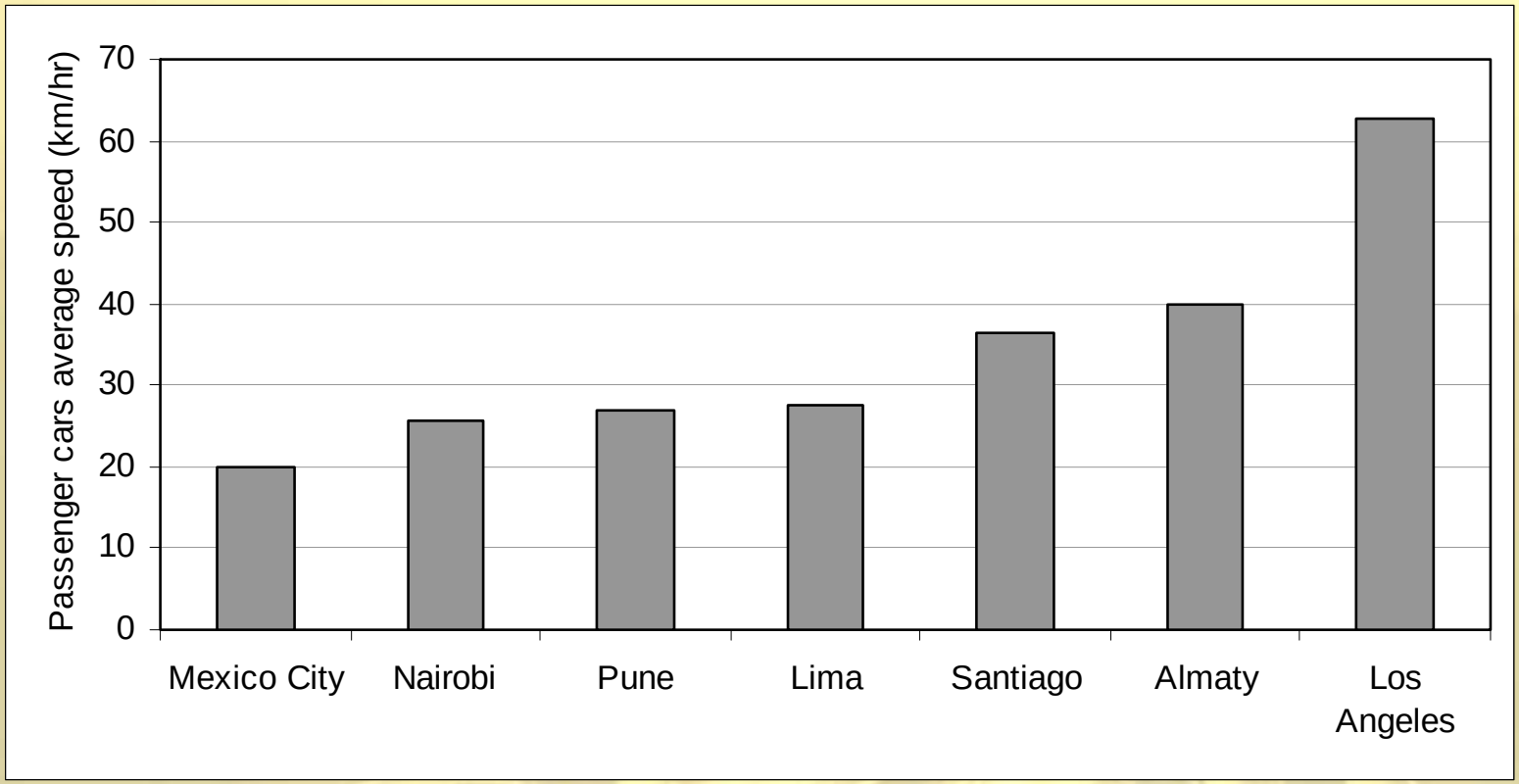
Age of Passenger Vehicle Fleet and Vehicle Use

Location	Average Age (years)	Average daily use (km/day)
Pune, India	4.7	29.8
Mexico City, Mexico	6.4	32.5
Santiago, Chile	6.5	35.5
Los Angeles, USA	6.6	54.3
Lima, Peru	11.0	26.6
Almaty, Kazakhstan	11.3	33.8
Nairobi, Kenya	13.2	30.7

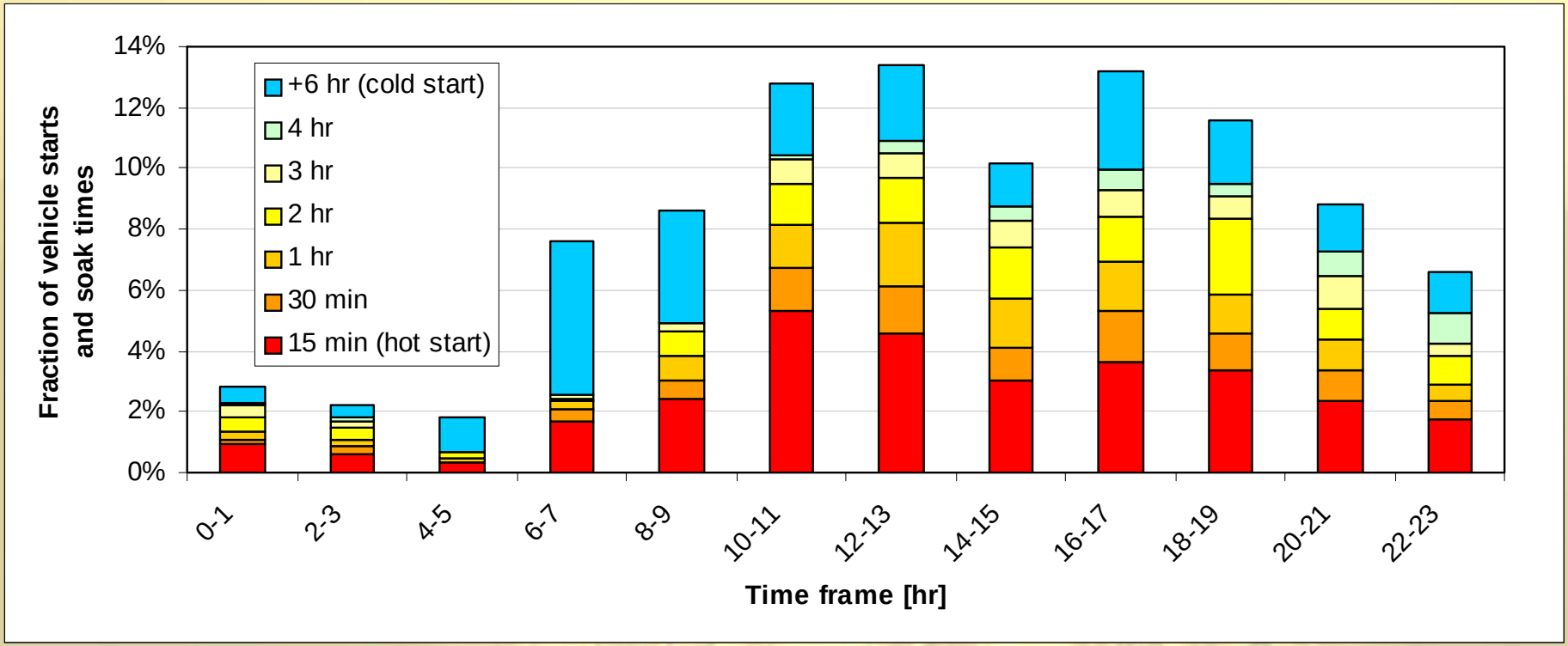
Vehicle Fuels and Technologies

Location	Diesel	Air/Fuel Control		Catalyst		
	Passenger cars	Carburetor	Fuel Injection	None	2-Way Catalyst	3-Way Catalyst
Almaty	5.8%	45%	51%	89%	0%	7%
Lima	25.0%	44%	56%	53%	6%	40%
Los Angeles	0.2%	6%	94%	1%	3%	96%
Mexico City	0.6%	18%	82%	20%	0%	80%
Nairobi	8.0%	60%	32%	100%	0%	0%
Pune	25.4%	42%	32%	29%	35%	11%
Santiago	3.1%	17%	80%	17%	3%	77%

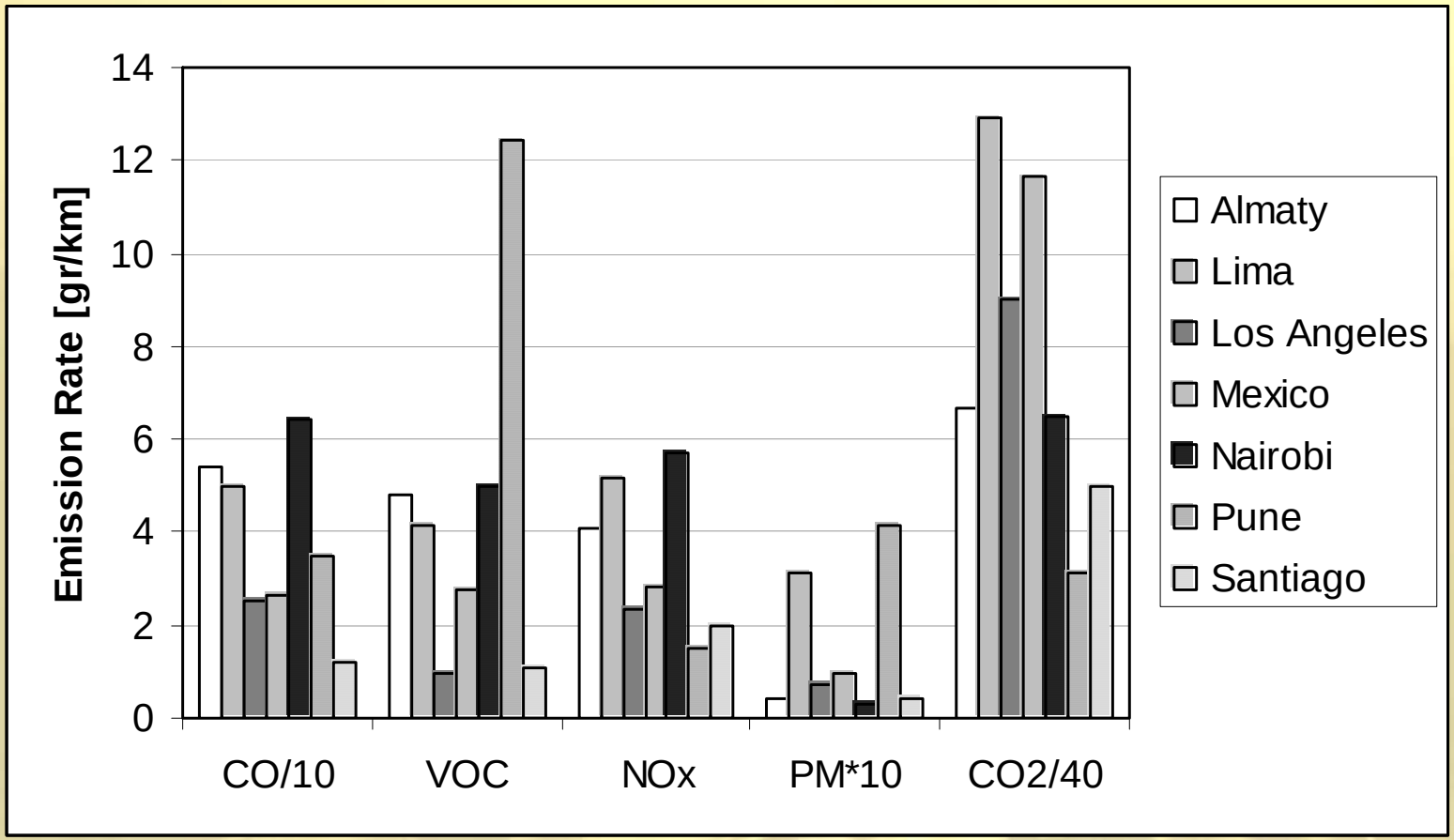
Passenger cars average daily driving speed



Fraction of vehicle starts and soak time



Emissions analysis



Conclusions (1/2)

- A vehicle emission model has been developed and put into use in several countries to understand the impact of mobile sources and to improve policy making, allowing analysis of the impacts of fleet technology improvements, traffic management, and fuel modifications on criteria pollutants, toxics, and global warming gases.
- The data collection described above defines a low-cost and easy to use methodology for developing key motor vehicle related data, especially in cities from developing countries. These datasets have been formatted for application in the IVE Model, which is flexible and easy to use, adaptable to multiple international locations, useful for analyzing policy decisions and vehicle growth impacts, and provides a broad range of criteria, toxic, and global warming pollutant data.

Conclusions (2/2)

- The International Vehicle Emissions (IVE) model is used to make emission estimates based on driving patterns and technology distributions measured in the various cities, considering dynamic behavior of the vehicle fleet instead of static existing databases.
- It is recommendable to improve emission factors for in-use vehicles. More emission studies are needed to verify the operating emissions of passenger vehicles, buses and trucks to insure that the best emission factors are being used.
- In conclusion, this study has developed basic data to allow for improved estimates of emissions from the fleets at different cities. Additional studies are needed to further improve emission estimates in these cities, but significant planning activities can occur using the available data.

Acknowledgments

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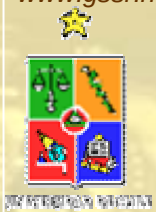

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