On-Road Remote Sensing of Vehicle Exhaust Emissions in Auckland, New Zealand

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ABSTRACT

In order to inform policy and increase understanding of air pollution effects, there is a requirement for more information on the emissions of New Zealand's vehicle fleet. The remote sensing campaign was implemented to establish the emissions profile for the on-road vehicle fleet. The data have been used to investigate the important factors that determine the fleet emission profiles. A total of 42,011 valid emissions measurements and 34,497 registration records of unique vehicles were obtained over a month-long campaign in April 2003. The fleet average emissions of carbon monoxide (CO), hydrocarbons (HC) and nitric oxide (NO) were 0.71%, 330ppm and 796ppm respectively. The emissions distributions of the total fleet were skewed, with the highest 10% of measurements responsible for 53%, 51% and 39% of the total CO, HC and NO emissions respectively. The findings suggest that policy targeting high emitters may be more effective than simply getting old vehicles off the road, or of testing and regulating all vehicles equally.

INTRODUCTION

As in many other cities in the world, New Zealand's largest city, Auckland, with a population of 1.3 million, suffers poor air quality at times in the central city region, despite its overall generally good air quality (Fisher 2000). Air quality monitoring shows carbon monoxide (CO) and nitrogen dioxide (NO_2) exceedences of the national environmental standards for ambient air quality (MfE 2004). Most of the standard exceedences occur at peak traffic monitoring sites, and are caused by vehicle emissions. The 1998 Auckland air emissions inventory estimated that vehicles produce 81% of the CO, 67% of the nitrogen oxides (NOx), and 46% of the volatile organic compounds (VOCs) through exhaust and evaporative emissions (Joynt *et al.*, 2002). NZ's vehicle fleet has unique features, unlike those in even closely related countries. A large proportion (approximately 50%) of vehicles are imported used vehicles. In addition, New Zealand's transport fuel has historically been of low quality (high benzene and sulphur content) and vehicle emissions in New Zealand are completely unregulated, except for one little-used regulation which allows ticketing of excessively smoky vehicles. Although the central government has recently implemented some emissions requirements for new vehicles and is developing in-use emissions requirements, one consequence of the historical lack of regulation is limited information surrounding the emissions performance of the fleet in New Zealand. This lack of information has made it difficult to develop targeted policies to reduce emissions and to monitor the subsequent effectiveness of any policy once it is implemented (Irving and Moncrieff, 2004). One of the main purposes of this remote sensing campaign was to redress this knowledge gap, improve understanding of the emissions performance, and provide more effective policy and management tools.

Remote sensing provides an efficient method to measure exhaust emissions from a large number of in-use vehicles (Cadle *et al.* 1994) and has been used to assess the emissions performance of on-road vehicle fleets in several countries, mainly the United States and Europe where stringent emissions regulations are imposed (Pokharel *et al.* 2003; Sjodin and Andreasson 2000). There is insufficient information, however, about the emissions characteristics for unregulated fleets (Zhang *et al.* 1995). A simple remote sensing system has been tested in several New Zealand cities in recent years to measure CO and hydrocarbon (HC) emissions (Gong 2002). In these trials, measurements were undertaken for a small number of vehicles, but their type was not identified. Consequently, the study reported in this paper is the first time that a significant remote sensing campaign has been implemented to establish the emission profiles for on-road vehicles anywhere in New Zealand. The findings on the emissions characteristics for the New Zealand fleet also have substantial implications for emissions reduction policy and public information in many countries where there are a large proportion of diesel vehicles and imported used cars, and few emissions regulations and/or weak enforcement.

MEASUREMENTS

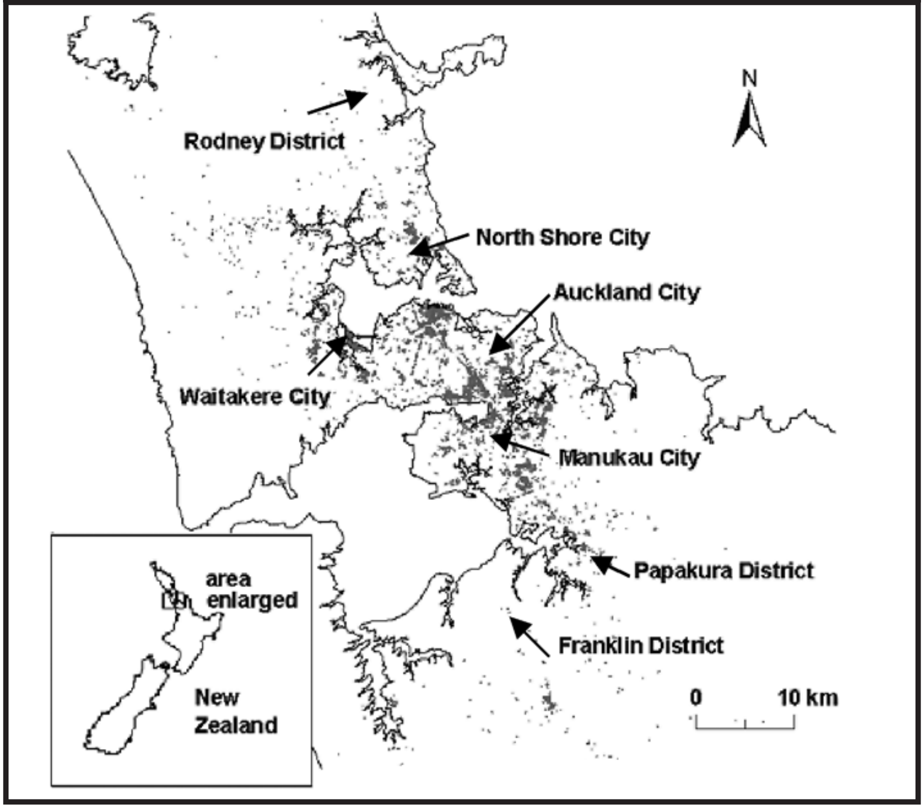
The sampling campaign was carried out at 15 sites in the Auckland region across the seven territorial local authorities (TLAs) that comprise the greater Auckland urban area: Auckland City, Manukau City, Waitakere City, North Shore City, Franklin District, Rodney District, and Papakura District (Figure 1), in April 2003 for over 16 days. The sampling sites were selected to represent typical traffic composition and conditions encountered across the entire region, as well as to test for possible variations within the region (Fisher *et al.* 2003). Measurements at the bus lane site have not been included in this study due to the relatively small number of "non-typical" vehicles (i.e. buses only) measured at this site.

The remote sensor and the measurement technique used in this study were developed at the University of Denver, and have previously been described in detail in the literature (Bishop and Stedman 1996; Popp *et al.* 1999). Briefly, the instrument consists of an infrared (IR) component for detecting carbon monoxide (CO), carbon dioxide (CO_2) and hydrocarbons (HC), and an ultraviolet (UV) spectrometer for measuring nitric oxide (NO). The measured emission ratios of CO/CO_2, HC/CO_2, and NO/CO_2 can be converted to %CO, %HC and %NO in the exhaust gas, corrected for water and excess oxygen not used in combustion. The ratios can also be converted into mass emissions per kilogram of fuel used (Pokharel *et al.* 2002a). Quality assurance calibrations are performed and account for hour-to-hour variations in instrument sensitivity and variations in ambient CO_2 levels caused by accumulation of the gases discharged by passing vehicles, atmospheric pressure, and instrument path length. Propane is used to calibrate the hydrocarbon measurements and these are given as propane equivalents. NOx (NO and NO_2) emissions from vehicles largely consist of NO, with a small proportion of NO_2. The proportion of NO_x as NO_2 from diesel engines is generally higher than from petrol vehicles (Jenkin 2004). The remote sensing equipment used in this study is capable of only measuring NO. A total of 52,255 vehicles were sampled which yielded 42,011 valid emissions readings.

The focus of many vehicle emissions assessments is on PM10, and the new ambient air quality standards introduced in 2005 will require very strict controls on PM10 emissions. The remote sensor employed for this study does not measure PM10. It has an opacity measurement capability, but this is not as accurate or as robust as the CO, HC and NO measurements. An upgraded instrument is now available, and future work will include more detailed assessments of particulate emissions.

The remote sensor was accompanied by a video system to record the licence plate of the vehicles measured. Licence plate data were used to extract the registration records, including the manufacture year, fuel type, gross vehicle weight, vehicle type, and vehicle usage, from Land Transport New Zealand's (LTNZ) vehicle database (Motochek, http://www.motorchek.co.nz).

Figure 1. The general locations of the sampling sites used in the remote sensing vehicle emissions campaign.



Registration records on 34,497 unique vehicles were obtained from 38,000 enquiries. The setup of the remote sensor, with a sensing beam height of 30 cm, only allows measuring emissions from vehicles with low level exhaust pipes. Therefore, heavy duty vehicles were under-represented in the sample, as these often have exhausts located above the cab beyond the range of the roadside sensor. A follow-up study is currently underway to address this aspect.

RESULTS AND DISCUSSION

Profile of fleet emissions

Table 1 summarises the CO, HC, and NO measurement results for the “valid readings” dataset. The average CO, HC, and NO emissions are 0.71% or 90 g/kg fuel, 330ppm or 13 g/kg fuel, and 791ppm or 11 g/kg fuel, respectively (the fuel based emissions in grams of pollutant per kilogram of fuel used, are calculated by considering the stoichiometry of fuel combustion, see Pokharel *et al.*, 2002a). The medians, 0.23%, 190ppm, and 394ppm, for CO, HC, and NO emissions respectively, are lower than the averages. The dirtiest 10% of the measurements contribute to 53%, 51%, and 39% of the total CO, HC, and NO emissions respectively. This demonstrates the skewed characteristics of the fleet emissions.

The CO, HC, and NO measurement results for the matched plate dataset (sampled vehicles with both valid emissions readings and valid registration records, not shown) are very similar to those for the valid readings dataset (sampled vehicles with valid emissions readings). This suggests that the matched plate dataset is a good representation of the valid readings dataset. The large sample size (Table 1) enables a disaggregation of the total fleet into petrol vehicles, light duty diesel vehicles, and heavy duty diesel vehicles for more detailed analysis. Of the 34,497 unique vehicles sampled, 84.5% were petrol-fueled, and 15.3% were diesel-fueled. The remaining 0.2% were fuelled either by LPG, CNG, or had no fuel type information in their licence records. The proportions of petrol and diesel vehicles are approximately the same as those reported for the NZ national fleet (MED, 2001). The diesel fleet was grouped into light duty diesel vehicles and heavy duty diesel vehicles. To be consistent with other studies (Yanowitz *et al.*, 2000), diesel vehicles with a gross vehicle weight of greater than 3,856 kg (8,500 lb) were categorised as heavy duty diesel vehicles. The proportion of heavy duty diesel vehicles in the sampled diesel fleet (14.0%) is lower than that of heavy commercial vehicles (gross vehicle weight more than 3,500kg) in the national diesel fleet (23.6%) (MoT, 1998). This is because heavy duty diesel vehicles with elevated exhaust pipes are excluded from the sampled data set.

Figure 2 shows the profiles of the model year distribution for the total fleet (average 1994), petrol vehicles (average 1994), light duty diesel vehicles (average 1994), and heavy duty diesel vehicles (average 1993). The model year profile displays a bi-modal pattern with a peak around 1994 and another around 2002. This is due to the influence of relatively large numbers of older imported used vehicles and an increasing number of new vehicles into the fleet. The bi-modal pattern for the model year profile is less obvious for heavy duty diesel vehicles. Compared to the national fleet (MED 2001), the sample fleet has a slightly higher proportion of new vehicles (less than five years old), approximately the same proportion of medium age vehicles (5 to 9 years old), a higher proportion of moderately older age vehicles (10 to 14 years), but a significantly lower proportion of the oldest vehicles (15 years old or greater). The younger age of the sample fleet may be due to newer vehicles being more frequently driven than older ones, and/or to a newer vehicle fleet in Auckland due to greater affluence of the Auckland population on average compared to the rest of the country.

Emissions of petrol and diesel vehicles

Table 1 shows that average CO and HC emissions from petrol vehicles are higher than from light duty diesel vehicles and heavy duty diesel vehicles, and average CO and HC emissions from light duty diesel vehicles and heavy duty diesel vehicles are similar. Average NO emissions from heavy duty diesel vehicles (998ppm) are higher than from petrol vehicles (841ppm) and from light duty diesel vehicles (440ppm). In general, diesel engines emit lower amounts of CO and HC, but larger amounts of NO_x

Table 1. Emissions from the total fleet, petrol vehicles, light duty diesel vehicles (LDDVs) and heavy duty diesel vehicles (HDDVs).

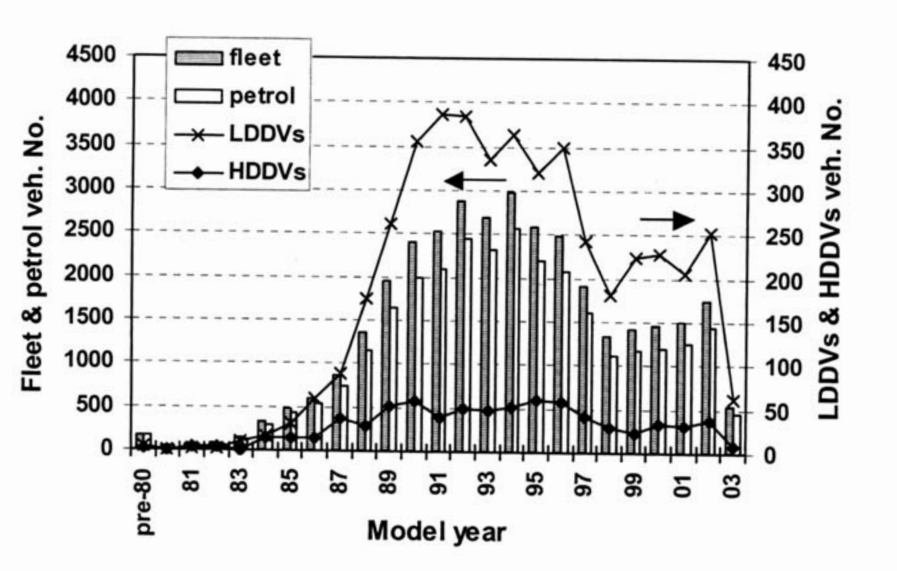
	Total fleet valid readings, *Petrol vehicles*, LDDVs, **HDDVs**		
	CO (%)	HC (ppm)	NO (ppm)
Number of valid measurements	42,011, *31,602*, 5,013, **834**	41,647, *31,363*, 4,961, **817**	36,430, *27,326*, 4,408, **731**
Average	0.71, *0.83*, 0.11, **0.12**	330, *366*, 133, **211**	796, *841*, 440, **998**
Median	0.23, *0.33*, 0.06, **0.09**	190, *220*, 80, **130**	394, *357*, 377, **907**
Standard deviation	1.22, *1.28*, 0.37, **0.17**	781, *809*, 448, **493**	986, *1062*, 321, **566**
% of emissions from the 10% dirtiest measurements	53, *48*, 61, **39**	51, *49*, 69, **51**	39, *39*, 25, **22**

and PM, while being relatively fuel-efficient, due to the design of the compression-ignition engine. The data show much higher average NO emissions from petrol vehicles than from light duty diesel vehicles. Table 1 reveals that median NO emissions from petrol vehicles are lower than from light duty diesel vehicles. This indicates that the higher average NO emissions from petrol vehicles are due to the contributions of the petrol gross emitters.

The emission contributions to the total fleet are compared for petrol and diesel vehicles, by the product of the average emissions and the number of vehicles (Jimenez *et al.*, 1999). The results show that petrol vehicles are the dominant contributor for CO, HC and NO with 97.6% for CO, 93.2% for HC, and 89.6% for NO, while light duty diesel vehicles and heavy duty diesel vehicles only contribute to 2.1% and 0.4% (CO), 5.4% and 1.4% (HC), and 7.6% and 2.8% (NO) of total emissions. However, the contributions from heavy duty diesel vehicles are likely to be under-estimated since they are under represented in the sample fleet.

Table 1 demonstrates the skewed distributions of CO, HC, and NO emissions for petrol vehicles, of CO and HC emissions for diesel vehicles, but nearly normal NO distributions for diesel vehicles (similar average and median values, and relatively low proportions of emissions from the 10% dirtiest measurements). This is supported by the histogram of the CO, HC and NO emissions (not shown). Remote sensing measurements have previously been used to show that CO, HC, and NO emissions from fleets consisting of only petrol vehicles (Sjodin and Andreasson 2000) or a mix of petrol and diesel vehicles (Zhang *et al.* 1995) demonstrate skewed distributions, caused by the small proportion of high emitters. Regulatory policies targeting poorly maintained gross polluters are expected to be more cost-effective than non-targeted testing or fuel specification change programmes (Beaton *et al.* 1995). For heavy duty diesel vehicles, the distributions of CO and HC emissions are also skewed toward high emissions from a small number of gross emitters, while the distributions of NO emissions are close to a normal distribution (Yanowitz *et al.* 2000). The distributions of CO, HC, and NO emissions from Auckland's heavy duty diesel vehicles are in qualitative agreement with those reported by Yanowitz *et al.* (2000). The emissions distributions from light duty diesel vehicles are not well reported in the literature. Strategies that deal with the whole fleet such as stricter emissions standards and reformulated diesel fuel, are necessary for reducing NO emissions from heavy duty diesel vehicles and light duty diesel vehicles, due to the nearly normal distributions (Jimenez *et al.* 2000). The findings here of nearly normal distributions of NO emissions for light duty diesel vehicles provide clear evidence that different strategies should be used for cost-effective emissions reduction for light duty diesel vehicles and for their petrol counterparts. These findings are significant due to lack of information on light duty diesel vehicles emissions and their increasing use in many countries (NEPC 1999).

Figure 2. The distribution of vehicle numbers by model year for the total fleet, petrol vehicles, light duty diesel vehicles (LDDVs) and heavy duty diesel vehicles (HDDVs).



Identifying high emitters

From the matched plate dataset, a profile was developed of the type of vehicles that are likely to be high emitters. The analysis considered the fractions of the highest 1, 5, 10 and 20% emissions of CO, HC, and NO for the total fleet. The factors considered in the profiling include model year, cumulative mileage, current warrant of fitness or certificate of roadworthiness, fuel type, country of origin, ownership profile, vehicle type and usage, and location where the measurement was made. The results for the high emitters were then compared to those for the total fleet. The profiling results showed that high emitters can come from any category of vehicle, however, they tend to be more commonly associated with particular factors. The analysis suggests that, among the factors discussed above, model year and fuel type may be the most important. The average model year for the high emissions fractions ranges between 1989 and 1992, compared to the average model year of 1994 for the total fleet. Therefore, older vehicles are more likely to be high emitters than newer ones. The high emissions fractions consist of 93 ~ 99% petrol and 1 ~ 6% diesel vehicles, compared to 84.5% petrol and 15.3% diesel vehicles for the total fleet. This shows that nearly all the high CO, HC, and NO emitters are petrol vehicles. This analysis provides a good "target" for potential inspection and maintenance programs for the three contaminants measured.

Emissions variations with model year

The average CO, HC, and NO emissions by model year are shown in Figure 3. Vehicles of model year 1985 and older were grouped together because of the small sample of older vehicles. For the total fleet, a steady decrease of average CO and HC emissions with increasing model year is observed. Average NO emissions also demonstrate a general downward trend but show relatively large decreases around model year 1991 and 1998. The decrease in emissions as the vehicle age decreases has been reported from other remote sensing data. Sharp decrements in CO, HC, and NO emissions have been observed in some fleets to coincide with those model years when new emission control technologies were introduced (Schifter *et al.* 2003). Zhang *et al.* (1995) also reported the gradual reduction of CO and HC emissions with model year in the Los Angeles fleet, which could be mainly attributed to improved maintenance, a reduction in emission system tampering with newer vehicles, improved emissions control technology, and less aging. Little information is available about the emission control equipment in the NZ fleet, and there is no requirement for their maintenance (MED 2001). Therefore, it is difficult to assess how effectively emission control technologies could reduce emissions from the NZ fleet.

Petrol vehicles show the same pattern of emissions variations with model year as the total fleet, but diesel vehicles do not demonstrate significant changes in emissions with model year (Figure 3). For older vehicles, the average emissions of CO, HC and NO from the petrol fleet are higher than from the diesel fleet. For newer vehicles, the average emissions from petrol vehicles are still higher than but approach those of diesel vehicles for CO, are comparable for HC (model year 2000-2003 for light duty diesel vehicles, and model year 1997-2003 for heavy duty diesel vehicles) and are lower for NO (model year 1998-2003 for light duty diesel vehicles, and model year 1995-2003 for heavy duty diesel vehicles). In their review of emissions trends in heavy duty diesel vehicles as measured on a chassis dynamometer, Yanowitz *et al.* (2000) showed steady decrease in CO and HC

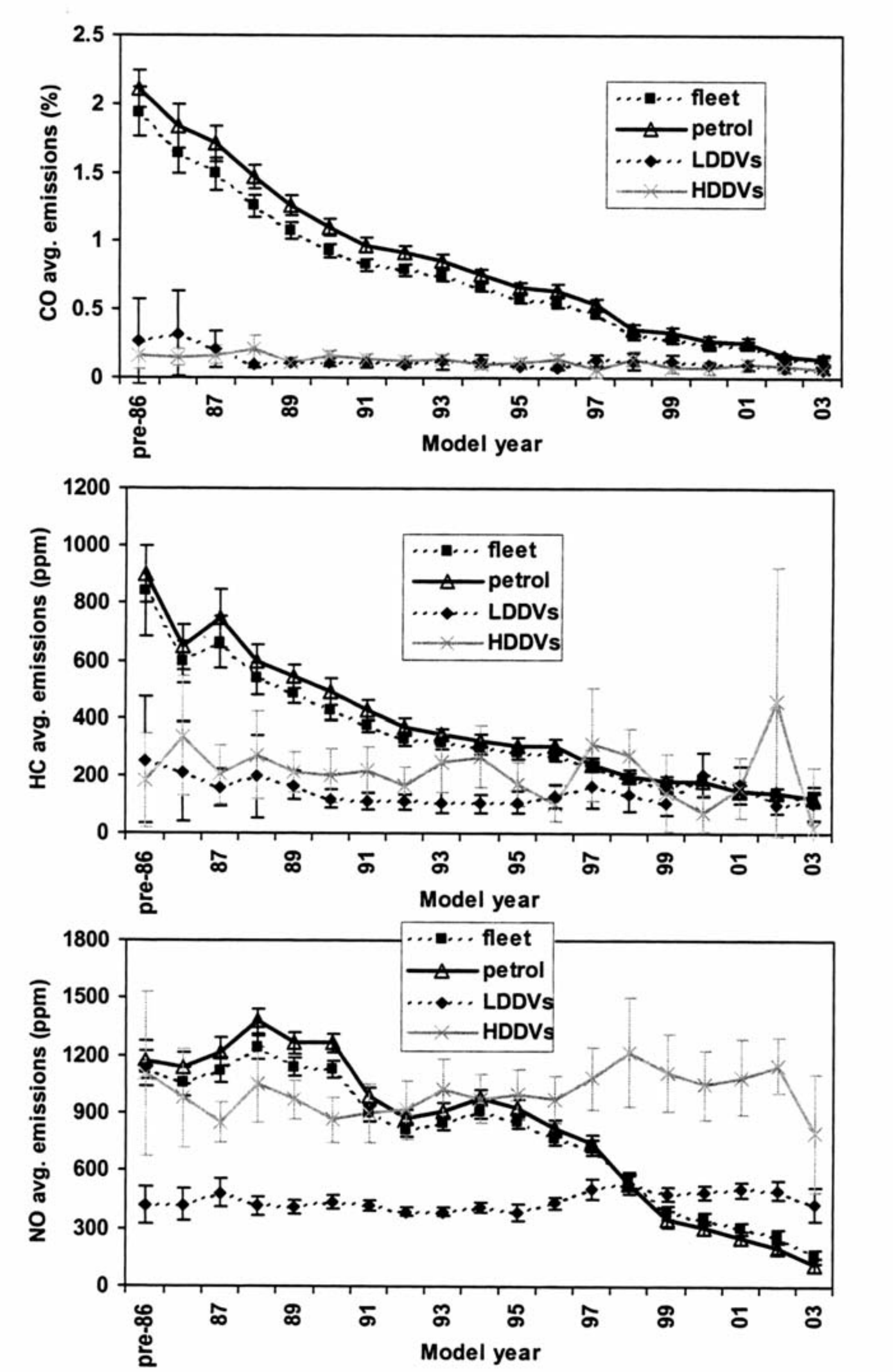


Figure 3. Variations of average CO (top), HC (middle) and NO (bottom) emissions with vehicle model year for the total fleet, petrol vehicles, light duty diesel vehicles (LDDVs) and heavy duty diesel vehicles (HDDVs). Error bars represent the 95% confidence intervals for the average values.

emissions for US vehicles in the last ten years, but very little change in NOx emissions over the last twenty five years. However, there is little information about emissions trends by model year for heavy duty diesel vehicles or for other diesel vehicles from remote sensing data (Bishop *et al.* 2001). Results for the Auckland on-road sensing programme suggest that both heavy duty diesel vehicles and light duty diesel vehicles emissions do not change significantly with vehicle age. The fleet age is widely believed to be the most important parameter in determining fleet emission levels for light duty vehicles (Bishop *et al.* 2001). However, for the sampled light duty diesel vehicles, age is not a significant factor for the fleet emissions. Although, NO emissions from light duty diesel vehicles are generally lower than from pre-1997 petrol vehicles, new light duty diesel vehicles emit about twice NO as new petrol vehicles (Figure 3). This finding is highly policy-relevant and will need to be addressed if NO_2 exceedences in Auckland are to be mitigated. This issue is especially relevant considering the significantly higher NO_2 fraction of NO_x from diesel vehicles and the increasing popularity of diesel vehicles.

The dependence of average emissions on vehicle age may be due to deterioration, old technology, and poorer maintenance of older vehicles (Beaton *et al.* 1995). Quintile analysis has been carried out to illustrate the effect of vehicle maintenance on emissions. The sample fleet was broken down by model year and into five equal groups (quintiles, or 20% categories) according to their emissions. The analysis results show that average CO emissions from the dirtiest 20% of the new vehicles are higher than those from the cleanest 20% of the old vehicles (Figure 4). The same results are also observed in the HC and NO data. These results are consistent with other studies (Zhang *et al.* 1995). This observation is likely to be the result from the effect of vehicle maintenance on emissions.

Emissions of NZ new and imported used vehicles.

The NZ vehicle fleet consists of approximately 50% NZ new vehicles (NZNVs, vehicles first registered and only driven in NZ) and 50% of imported used vehicles. The vast majority (97%) of used vehicles are imported from Japan. To assess the influence of the emissions of imported used vehicles, the sampled fleet was disaggregated according to country of origin: NZNVs and Japanese imported used vehicles (JIUVs). Their model year profiles were very different. There is an increasing number of new NZNVs registrations each year, with an average age of 7 years (model year 1996). JIUVs begin entering the fleet several years after their model year, with an average age of 11 years (model year 1992). As a result, the model year profile of the total fleet displays a bi-modal pattern (Figure 2).

Emissions from NZNVs and JIUVs, disaggregated into petrol and diesel vehicles, are listed in Table 2. Due to small numbers of measurements for pre-1986 NZNVs and JIUVs, and for post-1999 JIUVs, this calculation is based on the subset of model year 1986-1999 for both petrol and diesel vehicles. Table 2 shows that, on average, petrol NZNVs emit higher amounts of CO, HC, and NO than petrol JIUVs. For diesel vehicles, NZNVs generally have higher emissions of NO than JIUVs, but have similar emissions of CO and HC. This is an unexpected result, as anecdotal evidence suggests that people believe that JIUVs are more polluting than NZNVs. There is a difference between the average model year of diesel NZNVs (model year 1996) and that of diesel JIUVs (model year 1992). However, this difference is not a significant factor for their relative emissions, due to relatively stable emissions of CO, HC, and NO with model year for diesel vehicles (Figure 3). Raine *et al.* (1999) have also reported lower CO and HC emissions for JIUVs than for NZNVs from a study of idle emissions undertaken at two other locations in New Zealand, and suggested that the difference was principally due to a higher technology level (such as fuel injection and catalysts) being required for vehicles to meet Japanese emissions regulations. As New Zealand has few emission regulations, NZNVs were traditionally fitted with a lower level of emission control equipment or even none in some cases, but this situation has changed markedly in recent years. Comparison of CO, HC, and NO emissions variations with model year (1986-1999) shows that emissions from the latest model year (1998-1999) NZNVs fleet are comparable to those from the total JIUVs fleet. However, the emissions from older NZNVs are higher than comparably aged JIUVs.

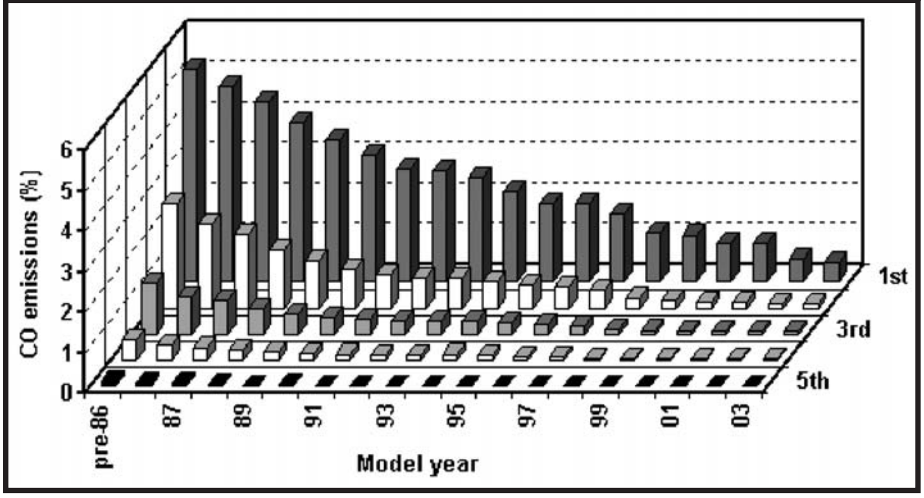
Comparison with measurements in other cities

The average emissions of the Auckland fleet were compared with similar recent measurements made in other cities, to provide an indication of the Auckland fleet performance relative to other countries. No attempt has been made to adjust the effects of model year or vehicle age on emissions. On average the Auckland fleet emits a higher level of CO, HC and NO than the vehicles measured in any of the four US cities used in the comparison: Denver (Burgard *et al.* 2003), Chicago (Bishop *et al.* 2003a), Phoenix (Bishop *et al.* 2003b) and Los Angeles (Williams *et al.* 2003, Pokharel *et al.* 2002b). Relative to their US counterparts, the Auckland vehicles emit approximately double the amount of CO and NO, and three times the amount of HC. This result is not surprising because of NZ's relatively older vehicle fleet, lack of emission controls, and lower fuel quality. By comparison, the emissions of the Auckland fleet are lower than those in Mexico City (Schifter *et al.* 2003).

Policy implications

This study suggests that there is scope and opportunity to reduce emissions from the Auckland vehicle fleet and that the potential benefit of emissions reduction is significant. The NZ government has undertaken a number of new policy initiatives to improve air quality through reductions in emissions from vehicles. One of these, promulgated in 2003, has been the introduction of fuel standards that will see sulphur contents progressively reduced and come into line with EU standards by 2007. Another is the introduction of vehicle emissions controls on visible emissions at the time of regular inspections (in New Zealand the "Warrant of Fitness"). The study carried out with remote sensing has provided information relevant to such policies. In particular, it has shown that resource efficient reductions can be achieved by targeting particular portions of the fleet - the high emitters. The study results clearly show that these high emitters are not necessarily confined to the old vehicles in the fleet, but can include new vehicles. Other results from the study have also provided valuable information, such as data on types of vehicles that might be high emitters. The study has clearly demonstrated the value of remote sensing information for effective emissions reduction policy development, and further studies are planned to assess the effectiveness of new policies once they are enacted.

Figure 4. Average CO emissions disaggregated into quintiles by model year for the total fleet. The first quintile represents the highest 20% emitters of the vehicles for the model year, the fifth the lowest. Note that the 1st and even 2nd quintiles for late model years (e.g., 2002 - 2003) have higher CO emissions than the 5th quintile for even the oldest vehicles in the fleet (e.g. 1989 - pre-86).



CONCLUSIONS

Auckland's total fleet and petrol vehicles demonstrated the skewed distributions for CO, HC, and NO emissions. For light duty diesel vehicles and heavy duty diesel vehicles the emissions distributions were skewed for CO and HC, but close to normal for NO. The high emitters tended to be more commonly associated with older petrol vehicles, although they could come from any category of vehicle. The total fleet and petrol vehicles showed a general decrease of average CO, HC, and NO emissions with increasing model year, but diesel vehicles demonstrated little changes in emissions with model year. Average CO, HC, and NO emissions from the cleanest old vehicles were lower than those from the dirtiest new vehicles. Petrol NZNVs emitted higher amounts of CO, HC, and NO than petrol JIUVs. For diesel vehicles, NZNVs generally had higher emissions of NO than JIUVs, but had similar emissions of CO and HC. This study has provided valuable information for effective emissions reduction policy development.

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Table 2. Emissions of New Zealand new vehicles (NZNVs) and Japanese imported used vehicles (JIUVs) from model year 1986-1999.

	Petrol vehicles NZNVs (mean model year 1993), **JIUVs (mean model year 1993)**			**Diesel vehicles** NZNVs (mean model year 1996), **JIUVs (mean model year 1992)**		
	CO (%)	**HC (ppm)**	**NO (ppm)**	**CO (%)**	**HC (ppm)**	**NO (ppm)**
Number of valid measurements	11,272, **13,874**	11,189, **13,764**	9,897, **11,693**	1,352, **3,370**	1,335, **3,331**	1,184, **2,964**
Average	1.04, **0.76**	483, **297**	1320, **631**	0.13, **0.11**	148, **134**	683, **435**
Median	0.58, **0.30**	330, **180**	1047, **301**	0.06, **0.06**	80, **80**	542, **364**
Standard deviation	1.32, **1.22**	861, **669**	1238, **819**	0.41, **0.31**	388, **447**	507, **331**

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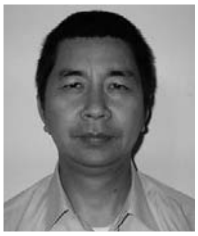

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