Characteristics of Vehicle Emissions in China Based on Portable Emission Measurement System

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Contents

- Background
- Experimental section
- Results and discussion
- Conclusions

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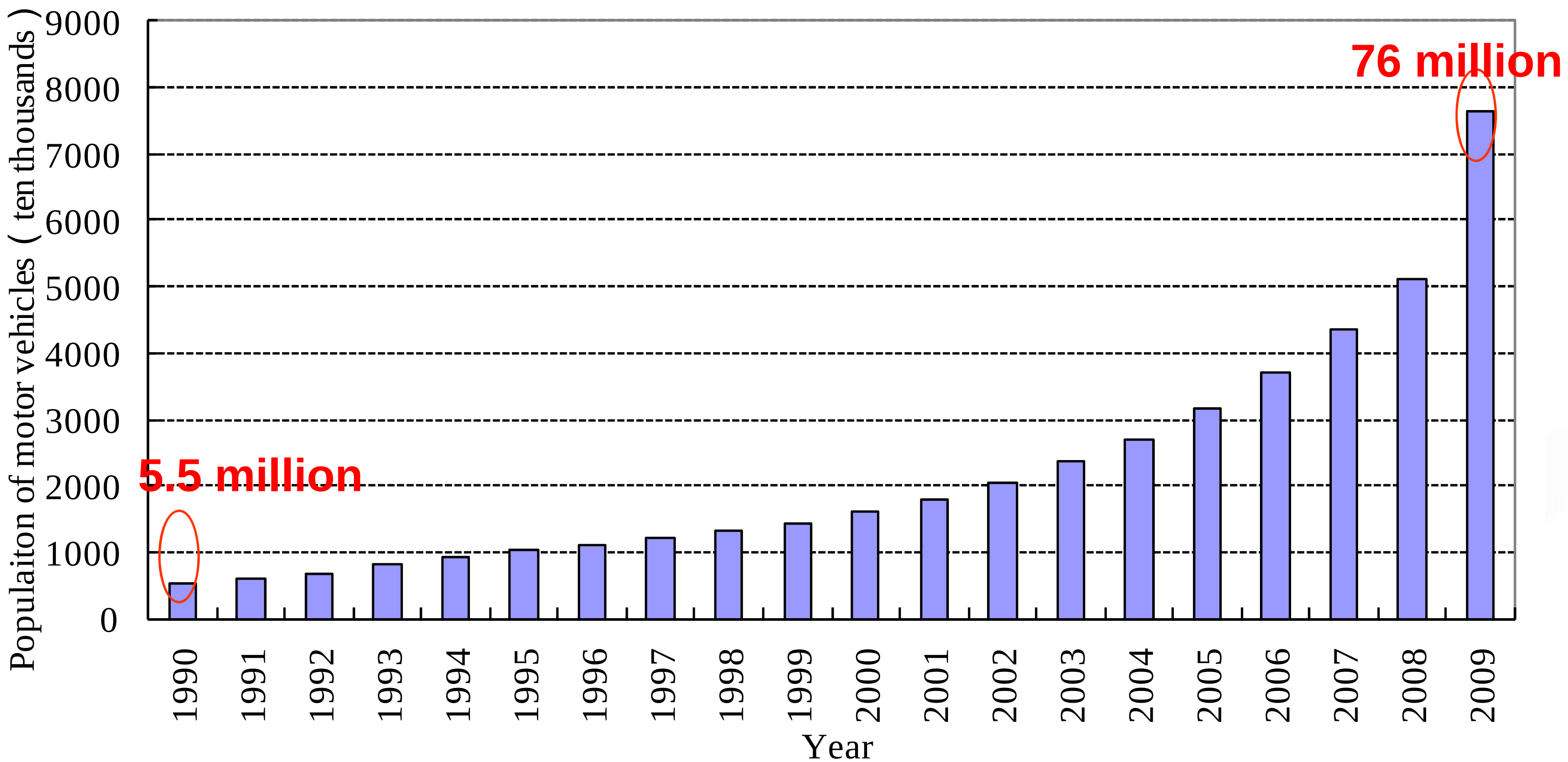
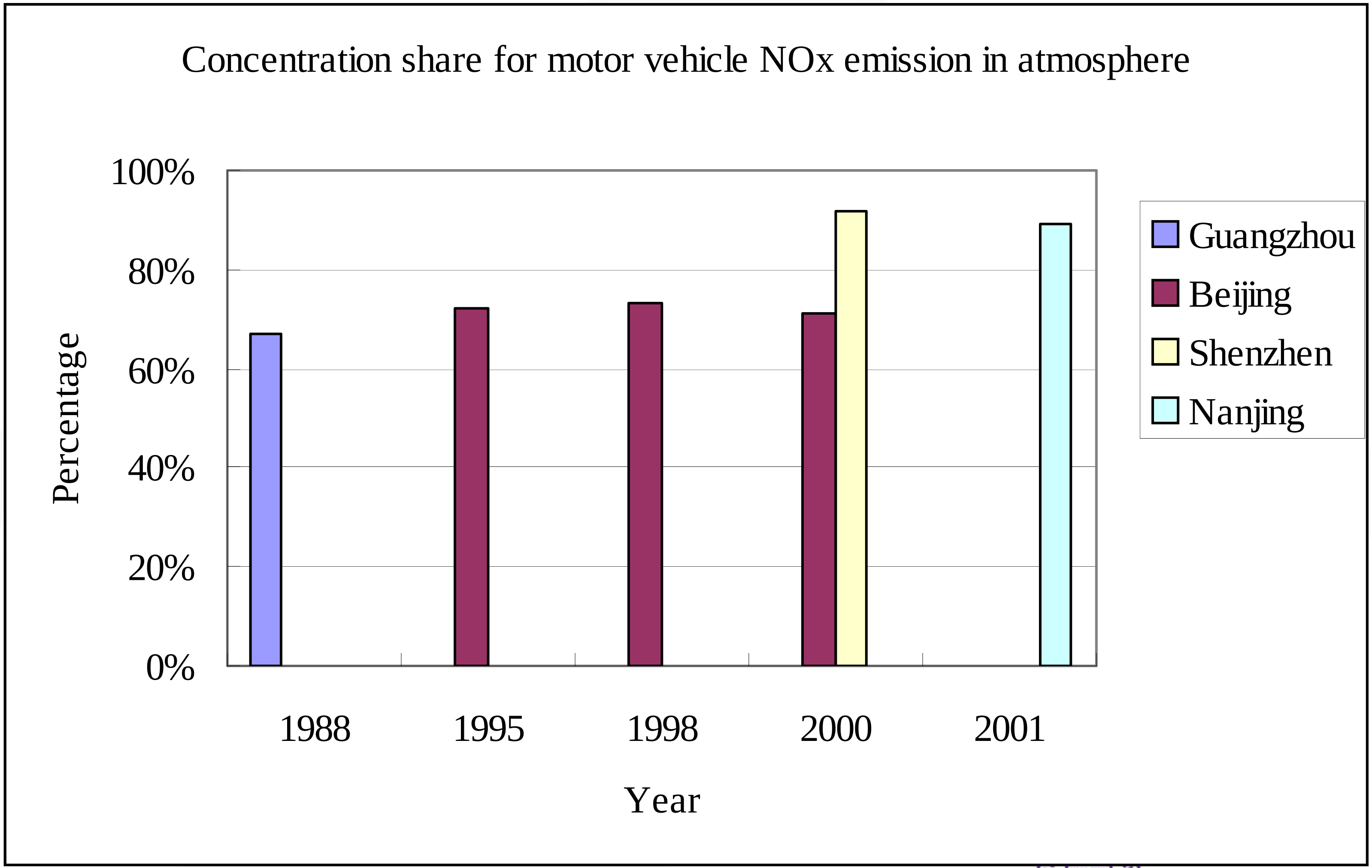
Background Motorization



- **The average annual growth rate is about 14%.**

Serious air pollution from vehicles



NOx concentration has an increase trends

Ground Monitoring: 2004/2001
NO_2 concentration in major cities

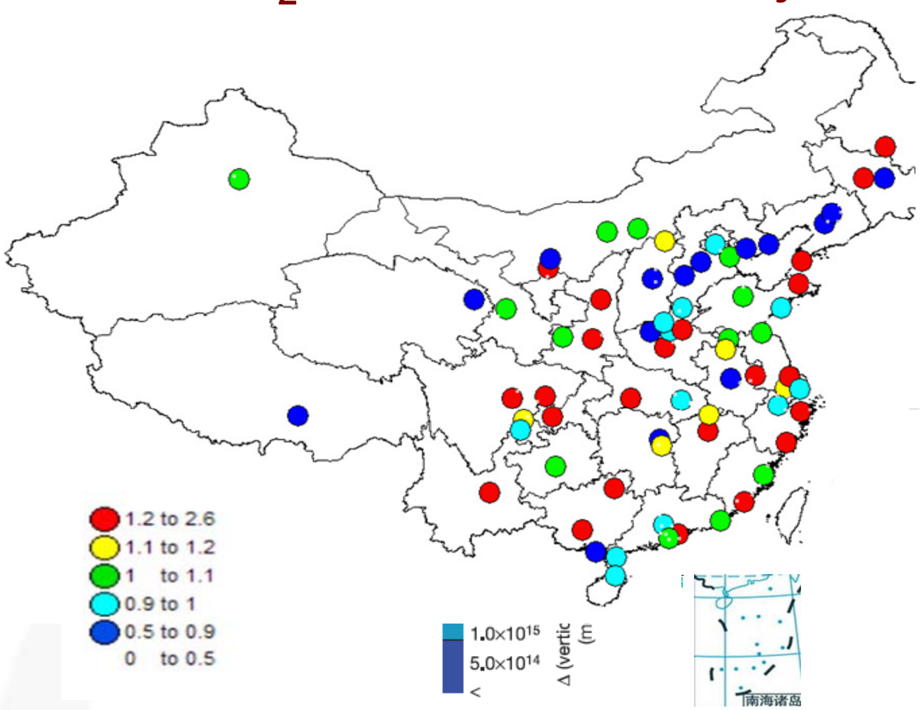
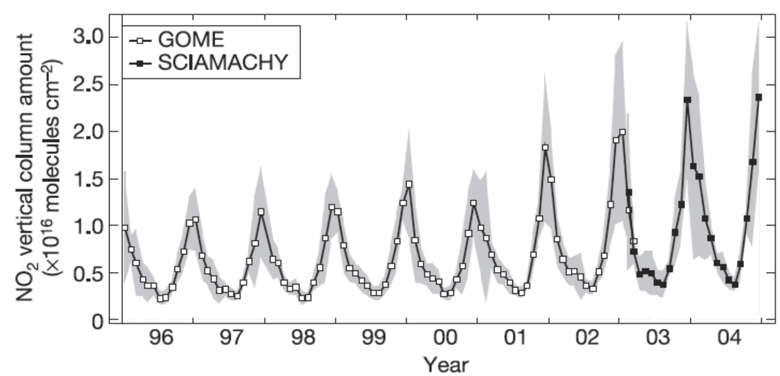


Figure 2 | SCIAMACHY tropospheric NO_2 vertical columns averaged between December 2003 and November 2004 for selected industrial regions. SCIAMACHY measurements are taken close to 10.00 a.m. LT. A nonlinear colour scale has been used because of the large range of NO_2 vertical columns. The numbered rectangles indicate the regions used in Fig. 3.

Satellite view alerts China to soaring pollution

Visitors to hazy Beijing can see how China's industrialization is fouling the air. Now data suggest that the situation is even worse than it looks, and pollution levels are rising.

sky to it," says John Burrows at the University of Bremen in Germany, an author on the *Nature* paper. Burrows originally proposed both instruments: "We wondered, can you see this



(source: Andreas Richter, 2005)

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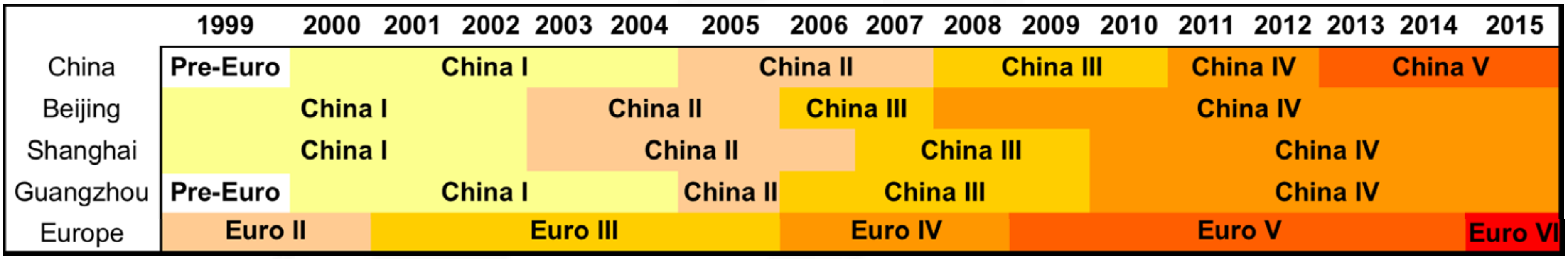
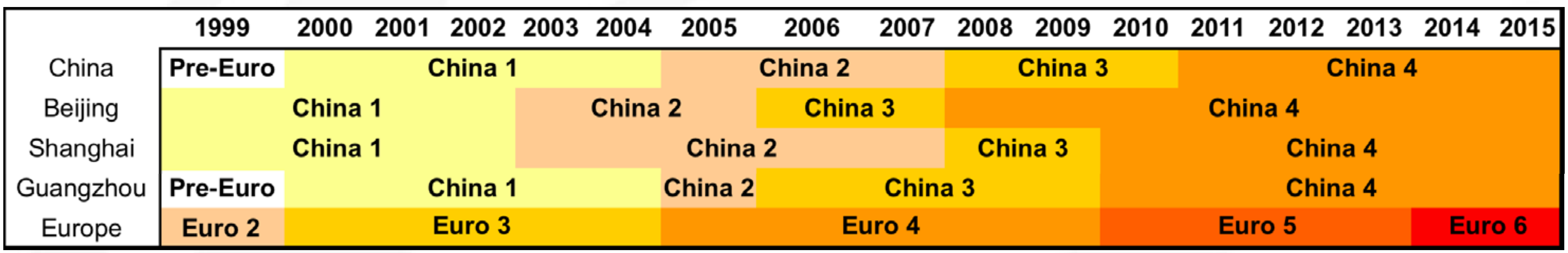
Vehicle Standards Implementation Timeline

HDV emission standards



LDV emission standards



Michael P. Walsh,2009

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A question is raised

- How are the effects of these measures on vehicular emissions?
- In order to answer this question, it is important to understand the emission characteristics of vehicles under actual running conditions.

Purpose of this work

- To examine the real-world emission levels of vehicles of various technologies using a PEMS, and based on which to develop a vehicle emission data set for China.

Research focus in this work

- Light-duty gasoline vehicles (LDGVs)
- Diesel trucks (DTs)
- Rural vehicles (RVs)

PEMS (Portable Emission Measurement System)

PM2.5

Exhaust mass flow meter

Dilution system

Dekati Mass Monitor DMM-230

CO2,CO, NOx, THC. Pass the certification of EPA

SEMTECH-DS

GPS，HR sensor

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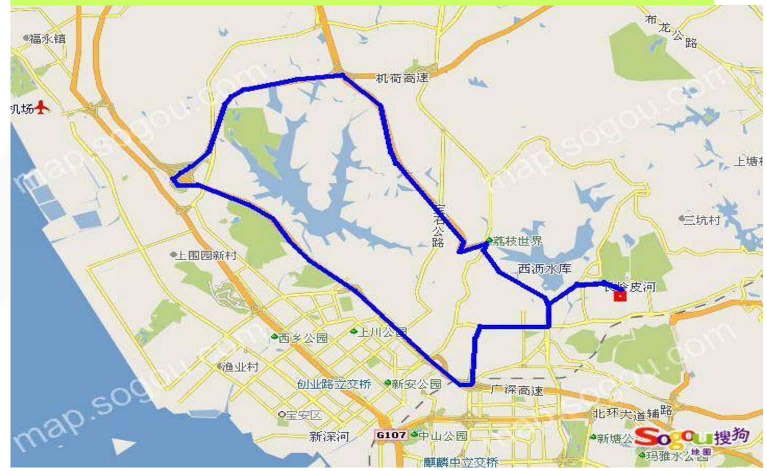
Test routes in different city

Beijing LDGVs 21.4km

Shenzhen LDGVs 37km



Xi'an DTs 23.4km

Beijing RVs 10.7km

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On-road testing for different vehicle was carried out in Beijing, Xi’an and Shenzhen

Car

LD Truck

MD Truck

HD Truck

Rural Vehicle

Totally, 152 vehicles have been tested in China (Beijing, Xi’an and Shenzhen)

Number of the measured vehicles by type in the three cities

	Beijing	Xi'an	Shenzhen
LDGVs	20 (1 Euro 0, 8 Euro II, 6 Euro III and 5 Euro IV vehicles)	-	20 (1 Euro 0, 5 Euro I, 11 Euro II and 3 Euro III vehicles)
DTs			
Light-duty		29 (1 Euro 0, 5 Euro I, 20 Euro II and 3 Euro III vehicles)	-
Medium-duty	28 (10 Euro I, 11 Euro II and 7 Euro III)	9 (6 Euro I and 3 Euro II vehicles)	-
Heavy-duty	26 (6 Euro I, 5 Euro II and 15 Euro III)		-
RVs			
3-wheelers(3-w)	10	-	-
4-wheelers(4-w)	10	-	-

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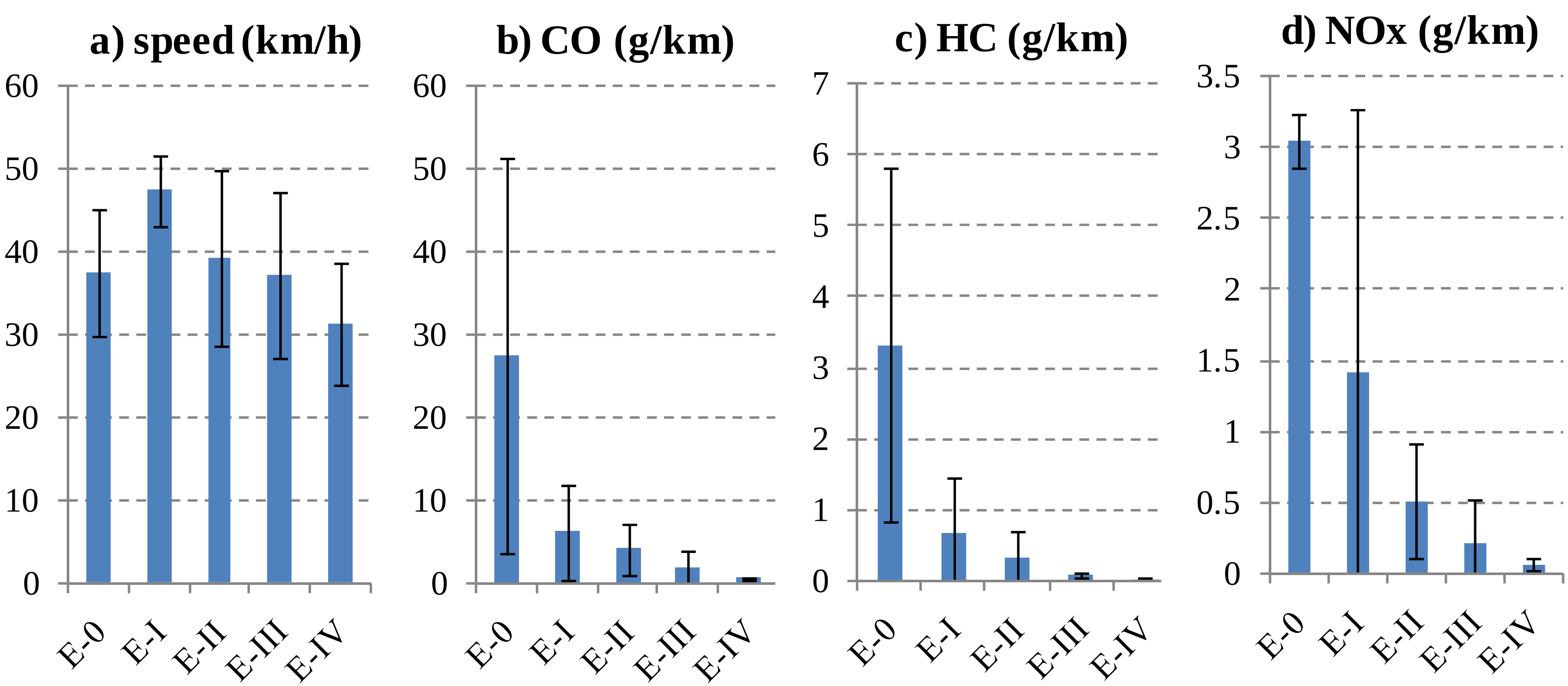
Kilometer traveled-based EFs of LDGVs with different emission control technologies



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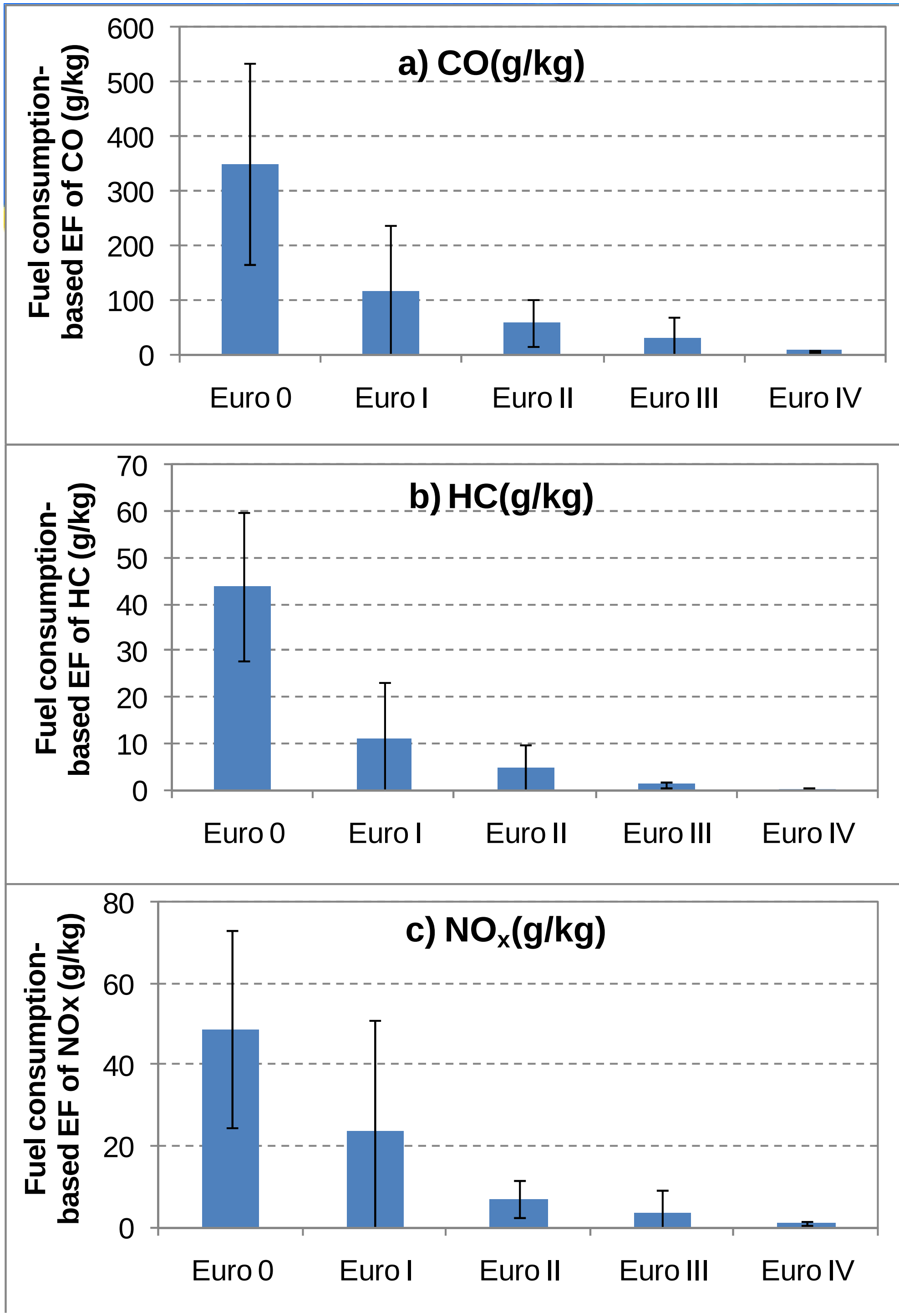

- **LDGVs with Euro I, Euro II, Euro III and Euro IV technologies can achieve a reduction in CO emissions by 67%, 83%, 91% and 98% respectively compared to Euro 0 LDGVs;**
- **75%, 90%, 97% and 99% reduction in HC emissions, respectively;**
- **and 52%, 85%, 93% and 98% reduction in NOx emissions, respectively.**

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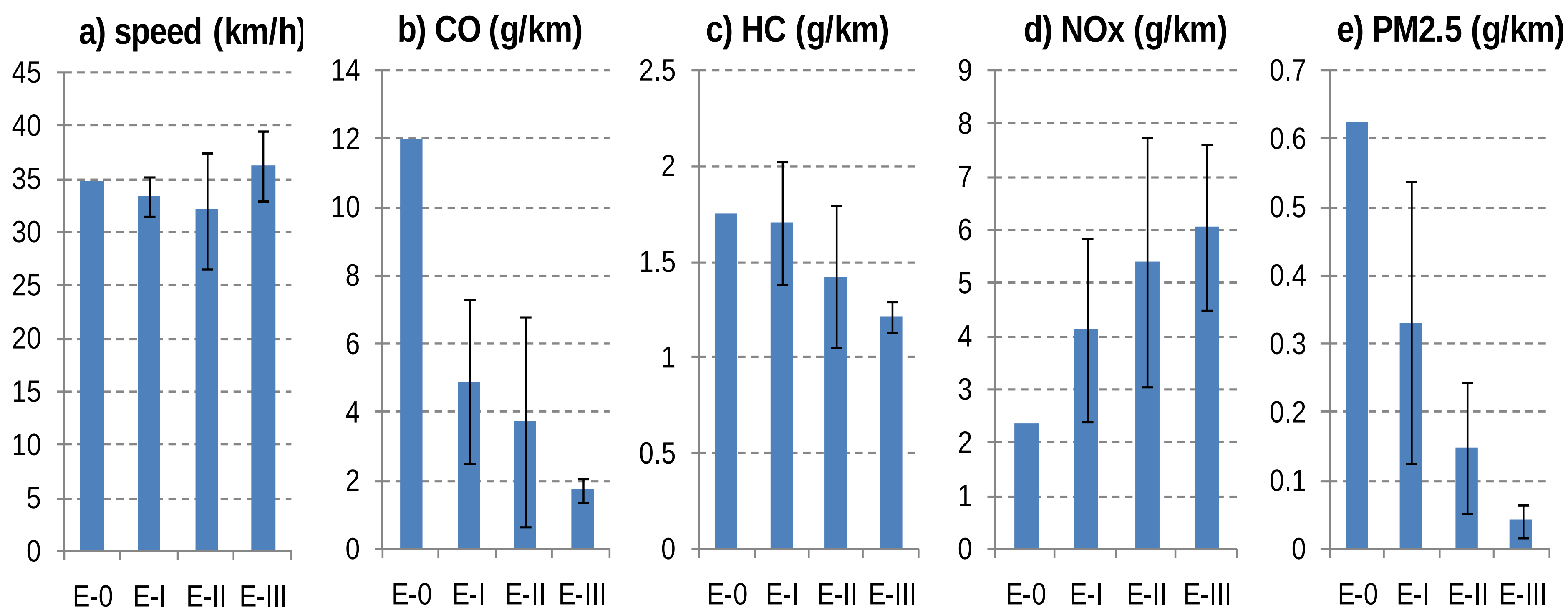
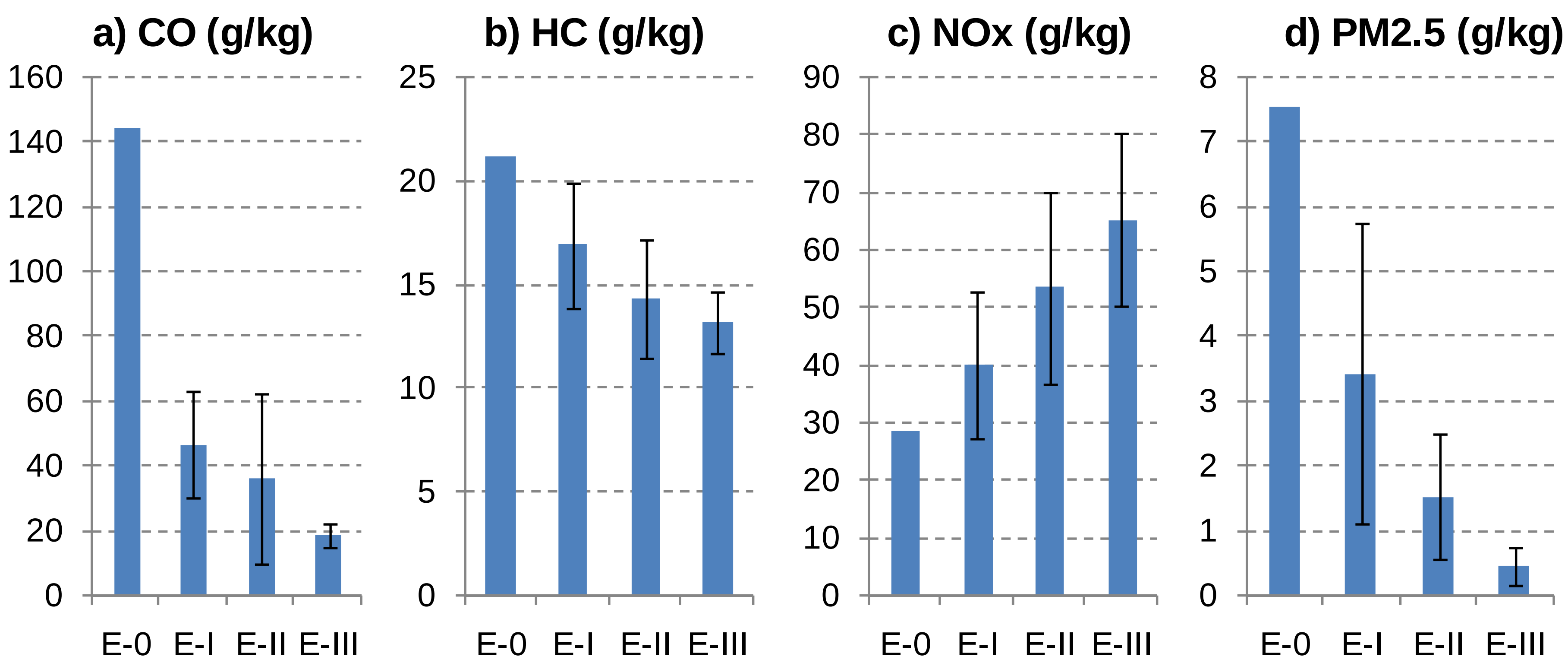
Kilometer traveled-based EFs of LDDTs with different emission control technologies

- Compared to Euro 0 LDDTs, the emission factors of CO, HC and $PM_{2.5}$ for Euro III LDDTs are lower by 85.8%, 30.8%, 93.5%. The NOx EFs of LDDTs increase as the emission control technology improves.



Fuel consumption-based EFs of LDDTs with different emission control technologies

- The fuel consumption-based EFs of CO, HC and $PM_{2.5}$ also deceased gradually as the emission control technology improves, but the NOx EFs show a reverse trend.



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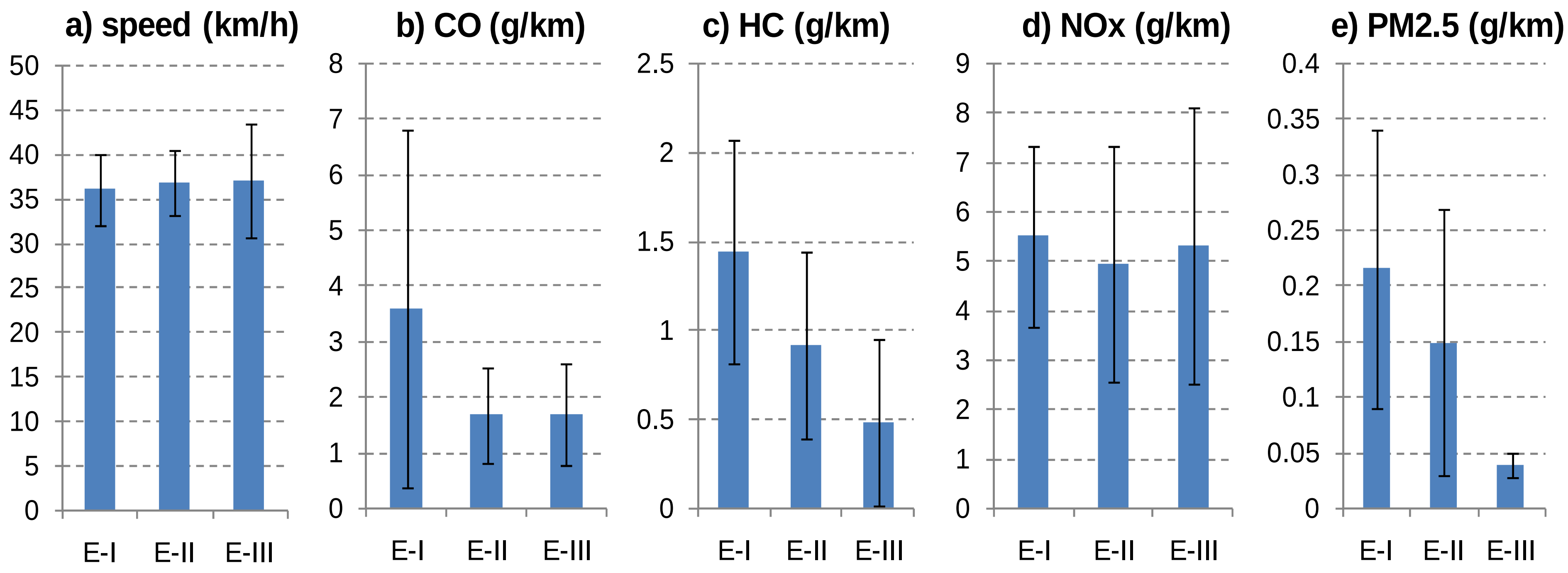
Kilometer traveled-based EFs of MDDTs with different emission control technologies

- The CO, HC and $PM_{2.5}$ EFs of Euro III MDDTs are 53.3%, 66.3% and 82.1% lower than that for Euro I MDDTs, respectively.
- There is no significant reduction in NOx emissions for advancer vehicle technologies.



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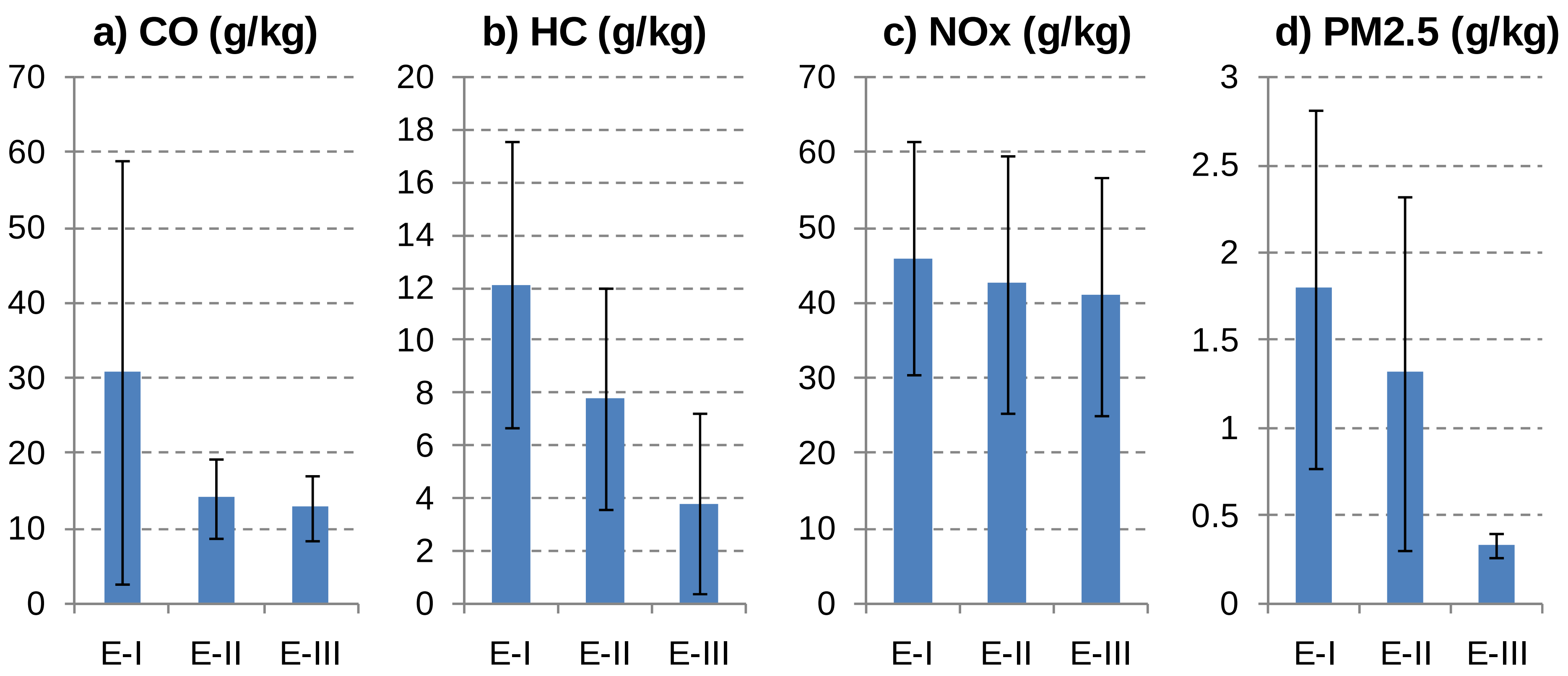
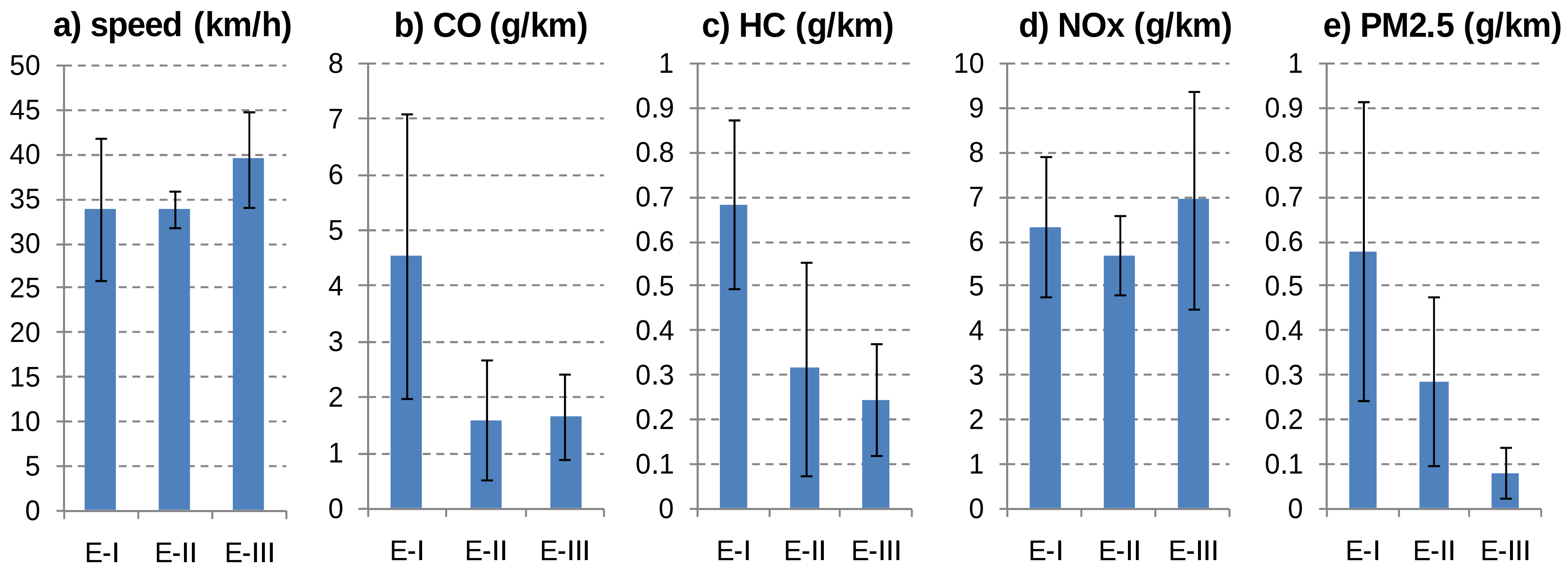
Fuel consumption-based EFs of MDDTs with different emission control technologies

- The CO, HC, NOx and $PM_{2.5}$ EFs of Euro III MDDTs decrease by 58.6%, 68.7%, 11.0% and 81.8% compared to their Euro I counterparts.
- The magnitude of the reduction in the NOx EF is the smallest as the vehicle emission control technology improves from Euro I to Euro III.



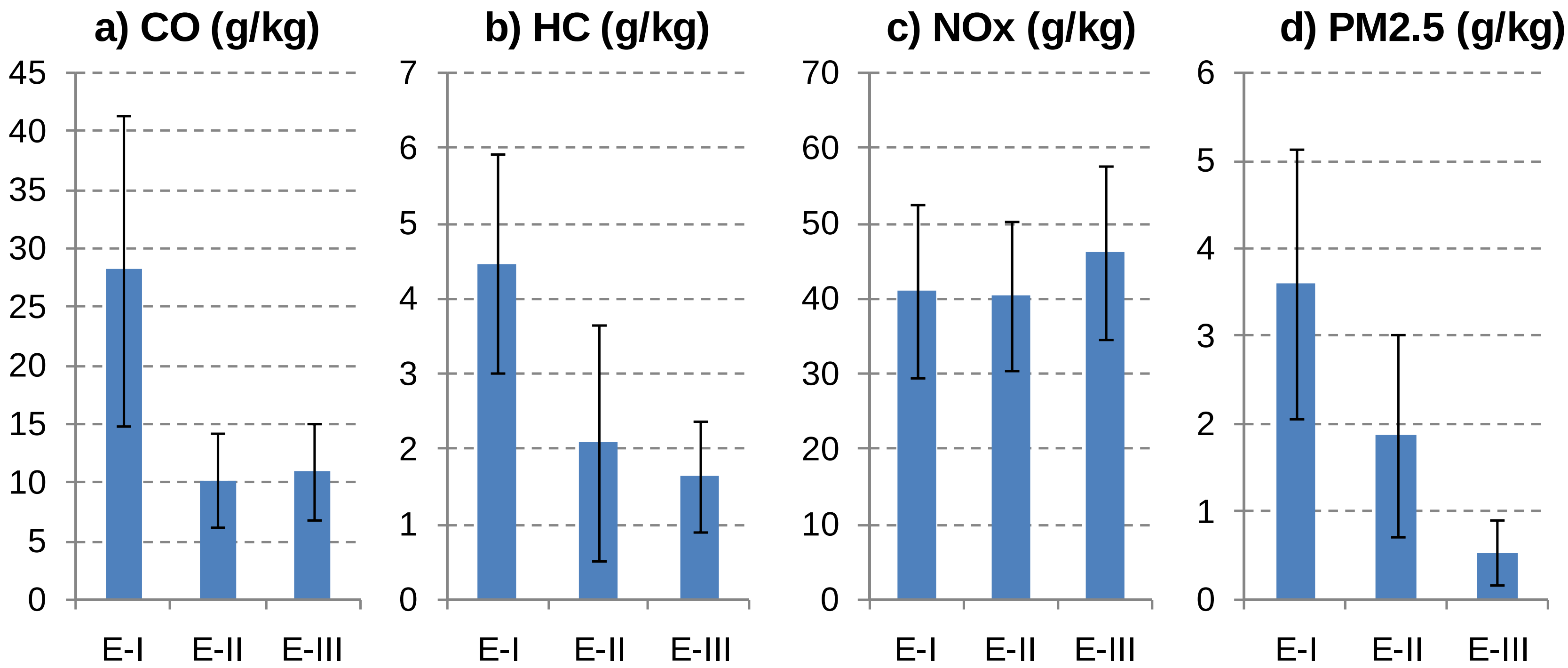
Kilometer traveled-based EFs of HDDTs with different emission control technologies

- **The EFs of CO, HC, and $PM_{2.5}$ of Euro III HDDTs decreased by 63.7%, 64.5%, and 86.3% compared to those of Euro I HDDTs, but the NOx EF increases by 9.5%.**



Fuel consumption-based EFs of HDDTs with different emission control technology

- The fuel consumption-based EFs of CO, HC, and $PM_{2.5}$ of Euro III HDDTs decreased by 61.4%, 63.2%, and 85.2% respectively compared to those of Euro I HDDTs.
- An increase in NOx emissions (12.6%) is also observed as the vehicle technology improves from Euro I to Euro III.



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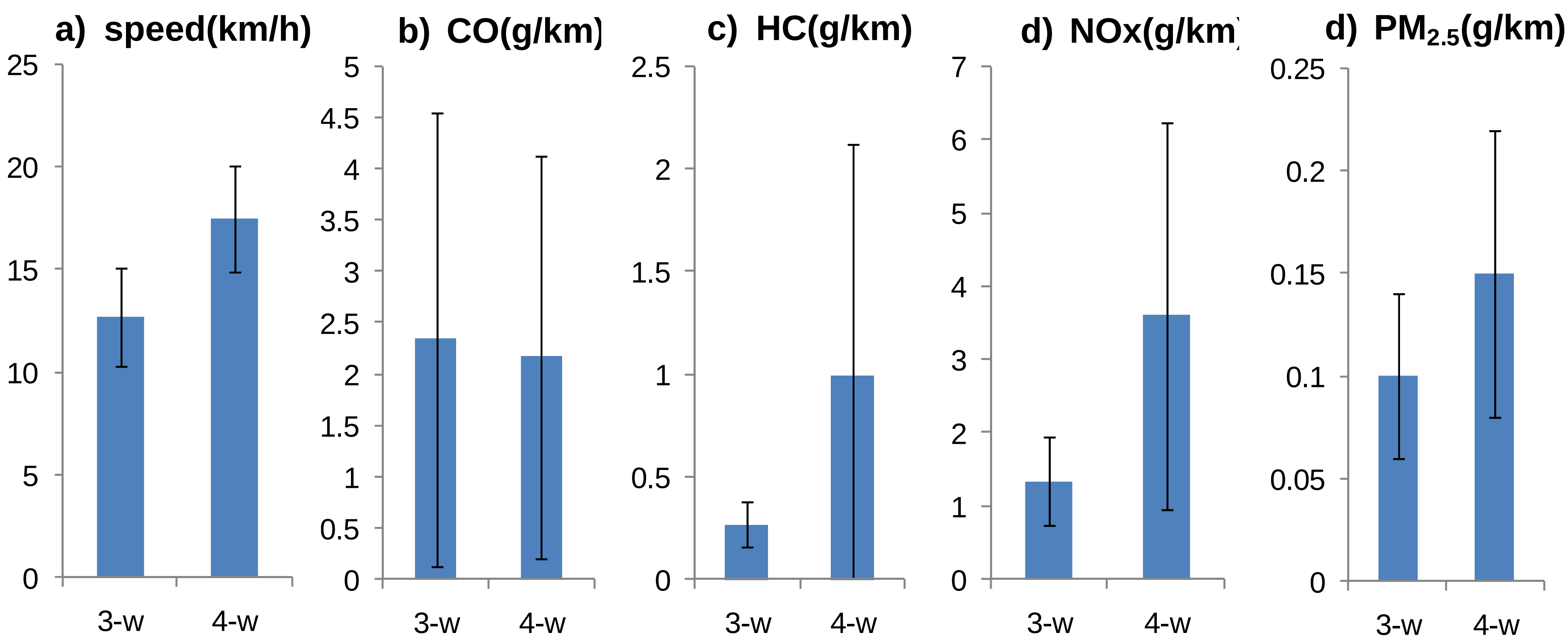
Kilometer travel-based EFs of RVs

- Generally, the EFs of 4-w RVs are higher than those of 3-w RVs.



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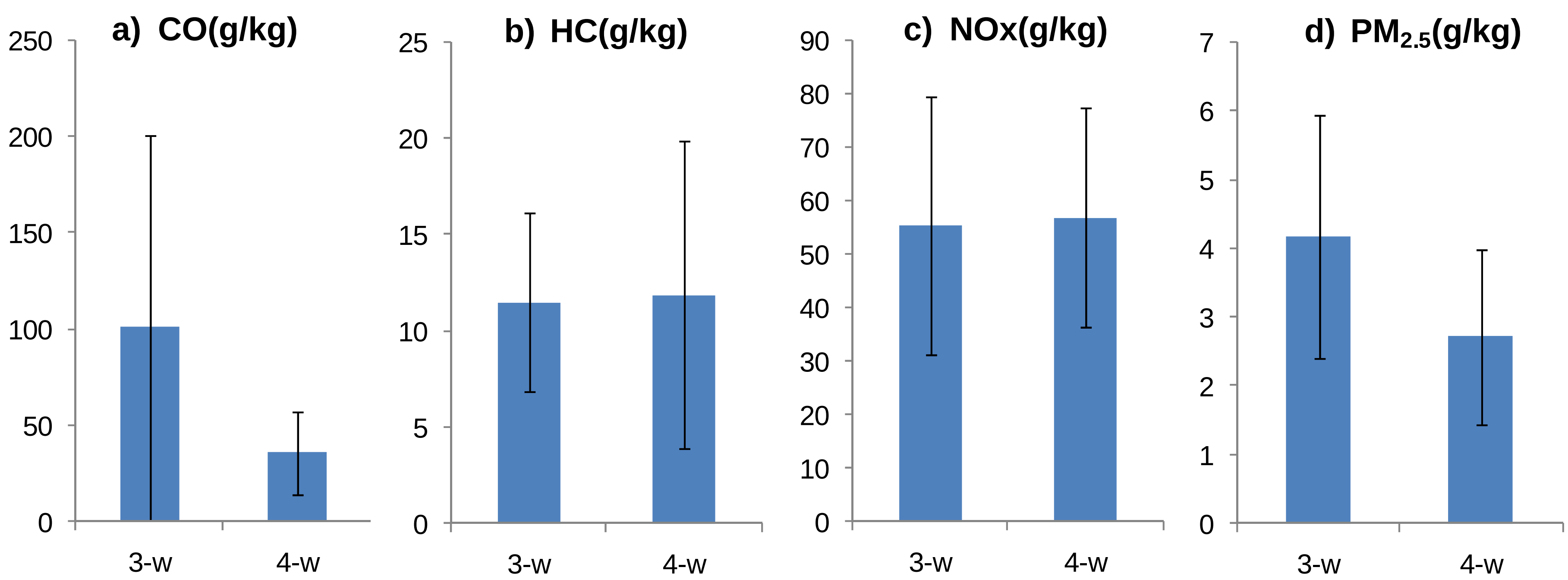
Fuel consumption-based EFs of RVs



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- **RVs have the similar g/kg-emission factor as to LDDTs;**
- **According to our previous study , RVs contributed 3.4% CO, 3.7 % HC, 17.8% NOx, and 11.0% $PM_{2.5}$ to the total vehicle emissions in 2005.**
- **Therefore, the emissions from RVs should be paid more attention.**

Conclusions

- Compared to Euro 0 LDGVs, Euro IV LDGVs can reduce CO, HC and NOx emissions by more than 90%. Therefore, China should promote more stringent emission standards, and at the same time accelerate the scrappage of the vehicles with Euro 0 technology;
- The $PM_{2.5}$ emission factors of Euro III diesel vehicles is more than 80% lower than those of Euro I diesel vehicles. But little reduction benefit for NOx EF is observed, especially for light- and heavy-duty diesel trucks.

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Conclusions

- RVs' EFs are comparable to those of Euro II LDDTs. RVs could be potentially important because of their high population and poor emission control technologies, and more attention should be paid to control their emissions;
- This study is a start. Further work on vehicular emissions in China needs to be done.

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Thanks!

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