Response to Reviewer #1:

With the upcoming China-7 regulation is including GHG as a new creteria for the control of new vehicle emissions, this research presents good innovation and solid scientific basis, and its findings makes important contributions to addressing the gap in GHG emission factors for motor vehicles in China. Additionally, this study provides valuable data to support the estimation of total greenhouse gas emissions in the country. I recommend acceptance minor revisions. Some issues listed below need further take-of-care.

Response: We greatly appreciate your valuable suggestions that would help us improve the manuscript. Below is our response to the specific comments, highlighted in blue, with changes to the manuscript highlighted in red.

1. It is recommended that the authors add a comparison of this study's results with previously reported findings. For instance, incorporating a table that summarizes some of the published results would provide readers with a more intuitive understanding of GHG emissions from vehicles.

Response: Thank you for the valuable comment. We have added the comparison of GHG emission factors in the various studies in Table S1 in the Supplementary Information. Additionally, we have added the related description in Section 3.1.

Section 3.1: A comparison with previous studies shows that the CH_4 emissions for China V and China VI vehicles in our study were lower than those for Euro 5 and Euro 6 vehicles reported by Clairotte et al. (2020), and a similar trend was observed for N_2O emissions, as demonstrated by the summary of previous studies provided in Table S1 in the Supplementary Information. Furthermore, lower CO_2 emissions was found in our study than those for gasoline vehicles reported by Zhu et al. (2022) and Wang et al. (2022b) as well as those for diesel vehicles reported by Wu et al. (2017), Cai and Xie (2010), Wang et al. (2022a), and Li et al. (2024) in Table S1 in the Supplementary Information.

The Table S1 is presented in the next page.

Table S1 Comparison of CO_2, CH_4, and N_2O emission factors in different studies.

GHG	Tested vehicles	Fuel types	Methods	Emission factors	References
CO₂	China 6	Gasoline	PEMS[1]	313.7 g/km (urban area, expressway) 304.4 g/km (suburban area, expressway)	(Zhu et al., 2022)
	China 6	Gasoline	PEMS	275.7 g/km (urban area, expressway) 273.9 g/km (suburban area, expressway)	(Zhu et al., 2022)
	China 6	Gasoline	Chassis dynamometer	≈ 300 g/km (-10 °C, cold start, TWC[2]) ≈ 289 g/km (0 °C, cold start, TWC) ≈ 230 g/km (23 °C, cold start, TWC) ≈ 259 g/km (40 °C, cold start, TWC) ≈ 257 g/km (-10 °C, cold start, TWC + GPF[3]) ≈ 259 g/km (0 °C, cold start, TWC + GPF) ≈ 210 g/km (23 °C, cold start, TWC + GPF) ≈ 238 g/km (40 °C, cold start, TWC + GPF)	(Wang et al., 2022b)
	UK fleet using 2015 new car sales car	Gasoline	PEMS	175.2 g/km (urban conditions, extra small displacement) 199.2 g/km (urban conditions, small displacement) 231.5 g/km (urban conditions, medium displacement) 340.9 g/km (urban conditions, large displacement) 140.6 g/km (motorway conditions, extra small displacement) 154.3 g/km (motorway conditions, small displacement) 174.4 g/km (motorway conditions, medium displacement) 213.0 g/km (motorway conditions, large displacement)	(O'Driscoll et al., 2018)
	China 0 ~ China 2	Diesel	IVE[4]	409.9 g/km	(Yao et al., 2011)
	China 2	Diesel	COPERT[5]	245.8 g/km	(Cai and Xie, 2010)
	China 3	Diesel	COPERT	238.2 g/km	(Cai and Xie, 2010)
	China 3	Diesel	PEMS	304 g/km	(Wu et al., 2017)
	China 4	Diesel	PEMS	310 g/km	
	China 4	Diesel	COPERT	238.2 g/km	(Cai and Xie, 2010)

	China 4	Diesel	Chassis dynamometer	214.1 g/km (NEDC[6])	(Wang et al., 2022a)
				209.7 g/km (WLTC[7])	
	China 4	Diesel	PEMS	415.06 g/km	(Li et al., 2024)
	China 5	Diesel	PEMS	447.48 g/km	
	China 6	Diesel	PEMS	335.26 g/km	
	Euro 6	Diesel	Chassis dynamometer	239.0 g/km	(Vojtíšek-Lom et al., 2018)
				133 g/km	
				134 g/km	
	UK fleet using 2015 new car sales car	Diesel	PEMS	141.9 g/km (urban conditions, small displacement) 163.4 g/km (urban conditions, medium displacement) 205.1 g/km (urban conditions, large displacement)	(O'Driscoll et al., 2018)
				137.1 g/km (motorway conditions, small displacement) 149.0 g/km (motorway conditions, medium displacement) 170.0 g/km (motorway conditions, large displacement)	
	Heavy-duty vehicles in Korea	Diesel	Chassis dynamometer	320 g/km (case 1) 411 g/km (case 2) 634 g/km (case 3) 727 g/km (case 4) 877 g/km (case 5) 537 g/km (case 6)	(Seo et al., 2018)
CH_4	Euro 5	Gasoline	Chassis dynamometer	4.8 mg/km	(Clairotte et al., 2020)
	Euro 6b/c	Gasoline		3.2 mg/km	
	Euro 6d-TEMP	Gasoline		1.7 mg/km	
	Euro 5	Gasoline hybrid		0.8 mg/km	
	Euro 6b	Gasoline hybrid		4.5 mg/km	
	Euro 6b	Dual-LPG/Ga		2.3 mg/km	

			soline		
	Euro 5	Diesel		3.6 mg/km	
	Euro 6b/c	Diesel		10.3 mg/km	
	Euro 6d-TEMP	Diesel		3.6 mg/km	
	China 0	Diesel	COPERT	18 mg/km	(Wang et al., 2022a)
	China 1	Diesel	COPERT	11 mg/km	
	China 2	Diesel	COPERT	5 mg/km	
	China 0 ~ China 2	Diesel	IVE	90 mg/km	(Yao et al., 2011)
	China 2	Diesel	COPERT	7 mg/km	(Cai and Xie, 2010)
	China 3	Diesel	COPERT	2 mg/km	(Wang et al., 2022a)
	China 3	Diesel	COPERT	0 mg/km	(Cai and Xie, 2010)
	China 4	Diesel	COPERT	1 mg/km	(Wang et al., 2022a)
	China 4	Diesel	COPERT	0 mg/km	(Cai and Xie, 2010)
	China 4	Diesel	PEMS	5 mg/km	(Li et al., 2024)
	China 5	Diesel	COPERT	1 mg/km	(Wang et al., 2022a)
	China 5	Diesel	PEMS	3 mg/km	(Li et al., 2024)
	China 6	Diesel	PEMS	3 mg/km	(Li et al., 2024)
	Euro 6	Diesel	Chassis dynamometer	3 mg/km 5 mg/km 7 mg/km	(Vojtíšek-Lom et al., 2018)
N_2O	Euro 5	Gasoline	Chassis dynamometer	3.1 mg/km	(Clairotte et al., 2020)
	Euro 6b/c	Gasoline		0.9 mg/km	
	Euro 6d-TEMP	Gasoline		0.3 mg/km	
	Euro 5	Gasoline hybrid		0.3 mg/km	
	Euro 6b	Gasoline hybrid		3.2 mg/km	
	Euro 6b	Dual-LPG/Ga		0.9 mg/km	

	soline			
Euro 5	Diesel		6.2 mg/km	
Euro 6b/c	Diesel		13.5 mg/km	
Euro 6d-TEMP	Diesel		15.2 mg/km	
China 0 ~ China 2	Diesel	IVE	197 mg/km	(Yao et al., 2011)
China 0	Diesel	COPERT	0 mg/km	(Wang et al., 2022a)
China 1	Diesel	COPERT	2 mg/km	
China 2	Diesel	COPERT	5 mg/km	
China 2	Diesel	COPERT	167 mg/km	(Cai and Xie, 2010)
China 3	Diesel	COPERT	8 mg/km	(Wang et al., 2022a)
China 3	Diesel	COPERT	200 mg/km	(Cai and Xie, 2010)
China 4	Diesel	COPERT	8 mg/km	(Wang et al., 2022a)
China 4	Diesel	COPERT	200 mg/km	(Cai and Xie, 2010)
China 4	Diesel	PEMS	2 mg/km	(Li et al., 2024)
China 4	Diesel	COPERT	8 mg/km	(Wang et al., 2022a)
China 5	Diesel	PEMS	4 mg/km	(Li et al., 2024)
China 6	Diesel	PEMS	3 mg/km	(Li et al., 2024)
Euro 6	Diesel	Chassis dynamometer	13 mg/km	(Vojtíšek-Lom et al., 2018)
			5 mg/km	
			7 mg/km	

Notes:

[1] Portable Emission Measurement System

[2] Three-Way Catalyst

[3] Gasoline Particulate Filter

[4] International Vehicle Emissions model

[5] Computer Programme to Calculate Emissions from Road Transport

[6] New European Driving Cycle

[7] Worldwide Harmonized Light Vehicles Test Cycle

2. Line 75-76 "vehicular g GHG emissions" seems to be a writing error.

   Response: Thank you for the helpful suggestions. We have revised accordingly.

   The results indicated that vehicular GHG emissions generally tend to increase with engine displacement.

3. In this study, the vehicle with high mileage was labeled as "TWC failed". I am contemplating whether it would be renamed as "TWC deteriorated" vehicle, as the study did not intentionally disable the TWC through removal or tampering but rather defined them based on their high mileage and correspondingly high emissions of conventional pollutants. Therefore, I suggest describing this high-mileage vehicle as "TWC deteriorated" rather than "TWC failed".

   Response: We appreciate your insightful comments. In this work, rather than deliberately crush TWC to verify complete failure, we used high-mileage vehicles to represent a highly degraded TWC state. While their CO, NOx, and THC emissions were substantially elevated (see Figure S1 in the Supplementary Information), we cannot conclusively determine full TWC failure. Thus, as suggested, we have revised "TWC failed" to "TWC deteriorated".

   Since the "TWC failed" appears frequently in the manuscript, we have uniformly revised it to "TWC degradation" throughout the manuscript and will not list each instance here. Furthermore, we added some information on Figure S1 in Section 2.1:

   Figure S1 in the Supplementary Information demonstrates the emission characteristics of the two vehicles representing distinct TWC operational states: (1) a properly functioning under the "TWC worked" condition and (2) a degraded system under the "TWC deteriorated" condition. The analysis revealed that the "TWC deteriorated" vehicle emitted substantially higher levels of carbon monoxide (CO) and total hydrocarbons (THC), with emission factors elevated by over 24-fold and 97-fold, respectively, compared to the "TWC worked" vehicle.
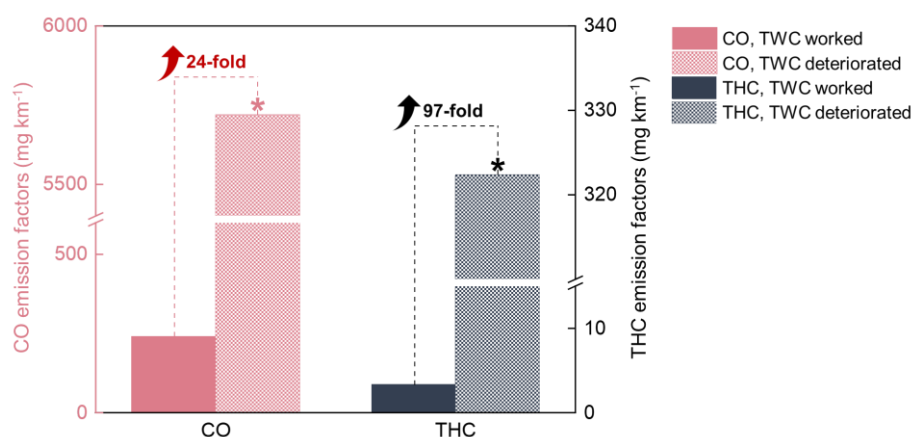
Figure S1. CO and THC emission factors from the fueled taxi fueled by conventional gasoline under the "TWC

worked" and "TWC deteriorated" conditions under the WLTC protocol. The symbol * represents that the pollutant concentrations exceeded the upper limit of the measurement instrument.

4. Why is some of the information for vehicle #3 missing in Table 1? It is advisable to include descriptions of the reasons for missing data in the notes.

Response: The information, including model year, max. net engine power, and max authorized mass of this vehicle, was not unrecorded. Herein, the reason for missing vehicle information has been annotated in Table 1 (marked with superscript "d").

[d] The unrecorded data, being a non-essential parameter, have no bearing on the subsequent analysis.

5. Line 141. The GWP values of N_2O and CH_4 are not provided in the formula.

Response: Thanks for your valuable comment. We have added an explanation of the GWP values for N_2O and CH_4 in the text in Section 2.3:

where R_{CO_2} is the relative growth rate of CO_2, M_i denotes the emissions of CH_4 or N_2O, and M_{CO_2} denotes the emissions of CO_2. The GWP of N_2O and CH_4 is 298 and 25, respectively.

6. The values in the article should retain the same significant figures, for example, the significant figures of the CO_2 emission factor and CH_4 emission factor in line 165 need to be unified.

Response: Thanks for your helpful suggestions. We have revised the values as accordingly.

Section 3.1: Nevertheless, the emission factors for CO_2 of the China V vehicles (155 g/km for the hot start) were comparable to those of China IV vehicles (151 g/km for the hot start) and those for N_2O of the China V vehicles (2.0 mg/km for the hot start) even were higher than those of China IV vehicles (1.5 mg/km for the hot start), particularly for hot start mode.

Section 3.1: China V vehicles showed a reduction from 2.8 mg/km to 2.2 mg/km, and China VI vehicles from 1.4 mg/km to 1.0 mg/km.

7. Despite the sufficient number of vehicles tested for the overall analysis in this study, the principles for selecting these vehicles were not clearly elaborated in Chapter 2.

Response: Thanks for your valuable comments. We further added the principles for selecting tested vehicles in Section 2.1:

Among the eight light-duty gasoline vehicles (vehicles #1 to #8), representation was provided from China IV, China V, and China VI emission standards. This is mainly since China's current light-duty vehicle fleet is predominantly composed of China IV, China V, and China VI compliant vehicles. These vehicles featured two distinct engine techniques: Gasoline Direct Injection (GDI) and Port Fuel

Injection (PFI), all equipped with Three-Way Catalysts (TWC) converters. With the advancement of vehicular emission control technologies, GDI engines are progressively replacing traditional PFI engines due to their superior combustion efficiency, which is achieved by directly injecting fuel into the combustion chamber.

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