1. What is the difference between the results of this study and the emissions at the sector level? If the difference is within an order of magnitude, authors should consider whether this work is still meaningful.

   Although the difference in total CO_2 emissions from global on-road vehicles is within an order of magnitude, source category of emissions in this study is refined into vehicle and fuel type, and age distribution is also offered in our public data at the same time. The fuel-, vehicle type-, and age-specific emissions offered in this study could not be obtained from existing studies and would better support the policy-making of emission mitigation.

2. Since the article has established a model, how did the author validate the model results?

   As the verification of the vehicle stock estimated by our model, we compared them with the statistical vehicle stock (Figure 2(a) and Figure S3). The relative deviation ratios in countries that own top 85% of global vehicles stock were between -28% and 25.6%, and ranges of the relative deviation in rest countries were a bit larger due to the limited availability of statistics. The deviation of the modeled vehicle stock from the statistics in most countries was less than ±25%, especially in the United States, countries in the European Union, China, and India. The relatively good consistency between the modeled and statistical vehicle stock indicates the relatively high reliability of this model.

   To verify the age distribution simulated by our model, survived vehicles calculated by newly registered vehicles and survival rates were compared to the vehicle stock from our integrated vehicle stock database (Figure 2(b) and Figure S4). Except for several years in Argentina and Thailand, the relative deviation ratios of light-duty vehicles during 1970-2020 ranges from -30.9% to 30.8%, heavy-duty vehicles had larger relative deviation ratios which were between -36.5% and 34.9%. The relatively good consistency between the vehicle stock and simulation indicated that the dynamic balance function set up in this study could well model the entry of newly registered vehicles and the retirement of existing vehicles and the estimated age distribution was reliable.

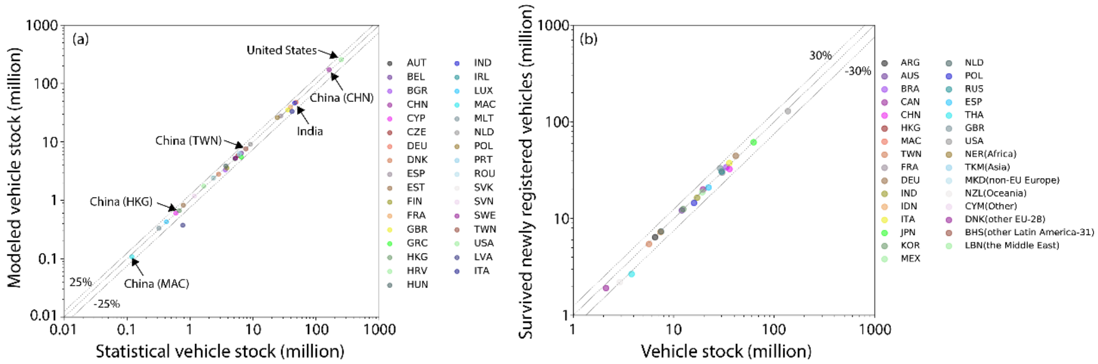

Figure 2: Verification of the modeled vehicle stock in United States, the European Union, China, and India (a) and the age distribution for PLDVs (b) in 2015.

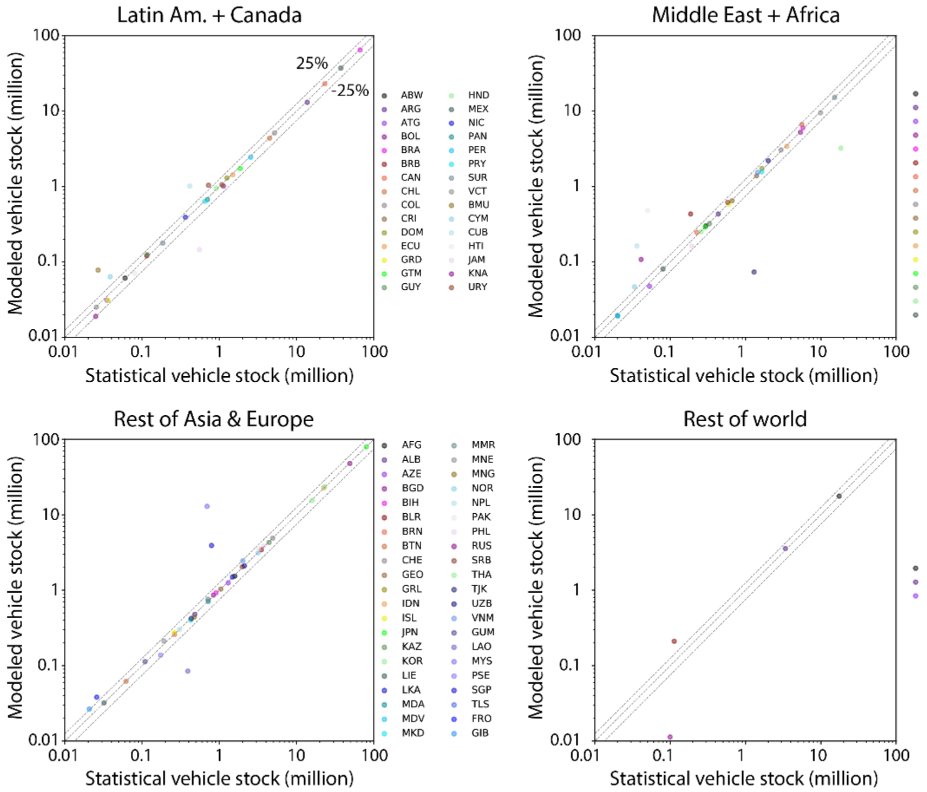

Figure S3. Verification of the modeled vehicle stock in rest countries in 2015.

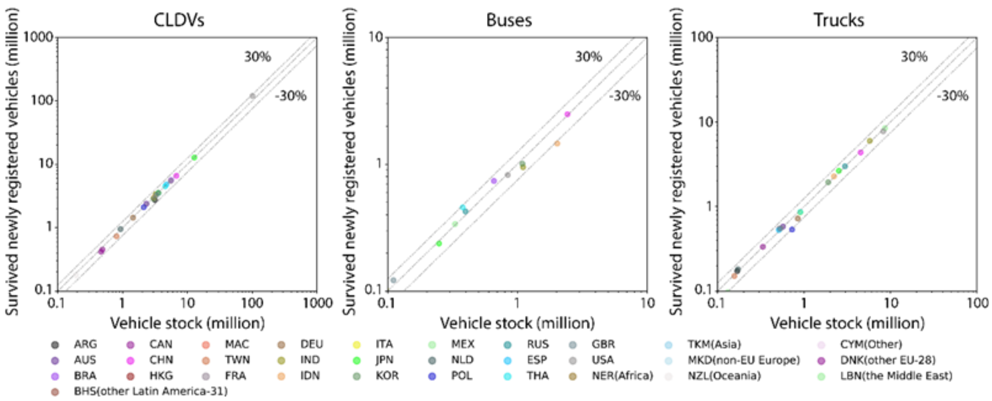

Figure S4. Verification of the age distribution for CLDVs, buses, and trucks in 2015.

3. The spatiotemporal resolutions of this dataset are too low to apply to other models.

   This study is aimed to offer global on-road CO_2 emissions with detailed source category (refined into vehicle and fuel type) and age distribution, the spatiotemporal distribution of emissions will be completed in our follow-up work.

4. Emission factors from the IPCC overestimate CO2 emissions, which increases the uncertainty. If the activity level data in this paper are reliable, where are the differences between the sector level and yours?

   In this study, local emission factors were used in countries where local data was available and emission factors from IPCC were used in countries lack of local studies. Local CO_2 emission factors used in this study were lower compared to that from IPCC. Taking China and Europe as an example, CO_2 emission factor of diesel vehicles from IPCC was 3186.3g/kg, while in our local references it was 3159.091 g/kg for China and 3140 g/kg for Europe. In this study, 52 to 70% of CO_2 emissions were estimated with local emission factors, the rest 30 to 48% were estimated using IPCC emission factors.

   Differences between the sector level and ours mainly lie in the source category of emissions. Source category of CO_2 emissions offered in this study is refined into vehicle and fuel type, and age distribution is also offered in our public data at the same time. However, existing CO_2 emissions from global on-road vehicles were publicly available, at best, by fuel type.

5. The whole paper describes the results and lacks an analysis to explain why it shows this trend.

   Explanation has been added. According to the ESSD guidelines which require authors give focus to the data and less on its interpretation, the texts do not stretch much.

6. This work can provide a basic dataset for other research; however, they did not provide and discuss the reliability of this work.

   The corresponding uncertainty was calculated in this study to quantify CO_2 emission uncertainty. In the uncertainty assessment, uncertainty values of emission factors were derived from EEA, and countries in this study were divided into 12 groups in accordance with IPCC tiered approach and EDGAR to evaluate the uncertainty of activity data. For 15 member countries of European Union (EU15), uncertainty values were obtained from Olivier et al. (2016). For countries belonging to the OECD in 1990

(OECD90), we assumed that they had the lowest uncertainty values. For countries with Economies in Transition of 1990 (EIT90), we assumed that they were more uncertain than OECD90 but less than countries in development (the UNFCCC nonAnnex I). Australia, India, China, Canada, Japan, Russia, Ukraine, and United States did not belong to above four groups, their uncertainty values were obtained from Olivier et al. (2016) and Hong et al. (2017).

The uncertainty in the global on-road CO_2 emissions was estimated to range from -7.2% to 8.1%, which is close to the expert judgement suggested value (approximately ±5%) in GPG (2000). It's found that uncertainty in CO_2 emissions from on-road vehicles varied significantly among countries and regions. United States and European Union had the lowest uncertainty in the range of -3.8% to 4.0% and -2.9% to 3.0%, respectively, which owes to their sufficient local data. Due to the less-developed statistical systems, Latin Am. + Canada and Middle East + Africa have the largest uncertainty, which ranged from -12.3% to 14.6% and -15.4% to 18.3%, respectively. China's relatively larger uncertainty, with the range of -12.6% to 14.4%, came from the relatively large apparent uncertainties (~15.8%) in oil consumption statistics in China during 1996-2003 (Hong et al., 2017). India had relatively low uncertainty that varies between -4.7% and 5.0% because of the low uncertainty values derived from Janssens-Maenhout et al. (2019) in which India was classified as countries with well-developed statistical systems. It could also be found that uncertainties at regional level decreased over time with the development of statistical systems in more countries. But uncertainty in global on-road CO_2 emissions slightly increased during 1970-2020 due to the growing contribution of regions with larger uncertainty to the global total CO_2 emissions. Table S4 shows the he corresponding uncertainty (σ) of CO_2 emissions for regions

Table S4. The corresponding uncertainty (σ) of CO_2 emissions for regions.

Region	**1970**	**1980**	**1990**	**2000**	**2010**	**2015**	**2020**
World	(-5.5%, 6.2%)	(-5.8%, 6.5%)	(-5.8%, 6.5%)	(-6%, 6.7%)	(-7%, 8%)	(-6%, 6.7%)	(-5.9%, 6.6%)
United States	(-3.8%, 4%)	(-3.7%, 3.8%)	(-3.5%, 3.6%)	(-3.4%, 3.5%)	(-3.2%, 3.3%)	(-3.2%, 3.3%)	(-3.1%, 3.2%)
European Union	(-2.9%, 3%)	(-2.7%, 2.8%)	(-2.5%, 2.6%)	(-2.3%, 2.4%)	(-2.5%, 2.7%)	(-2.5%, 2.6%)	(-2.7%, 2.8%)
China	(-6.8%, 7.3%)	(-7.1%, 7.7%)	(-7.5%, 8.2%)	(-7.9%, 8.5%)	(-11.8%, 13.4%)	(-1.4%, 1.4%)	(-1.2%, 1.2%)
India	(-4.7%, 5%)	(-4.5%, 4.7%)	(-4.3%, 4.5%)	(-4.2%, 4.4%)	(-4.1%, 4.2%)	(-3.9%, 4.1%)	(-3.9%, 4%)
Latin Am. + Canada	(-12.2%, 14.6%)	(-11.9%, 14.1%)	(-12.1%, 14.3%)	(-12.2%, 14.3%)	(-11.9%, 13.9%)	(-11.8%, 13.7%)	(-11.3%, 13.1%)

Middle East + Africa	(-15.4%, 18.3%)	(-15.1%, 18%)	(-14.3%, 16.8%)	(-13.9%, 16.2%)	(-13.6%, 15.8%)	(-13.2%, 15.3%)	(-12.8%, 14.9%)
Rest of Asia	(-7.3%, 8.6%)	(-7%, 8.2%)	(-7.1%, 8.3%)	(-7.4%, 8.6%)	(-8.5%, 9.8%)	(-9.1%, 10.5%)	(-9.3%, 10.7%)
Rest of Europe	(-6.4%, 7.1%)	(-5.9%, 6.5%)	(-5.4%, 5.8%)	(-4.7%, 5.1%)	(-4.9%, 5.3%)	(-4.9%, 5.3%)	(-4.9%, 5.3%)
Rest of world	(-4.5%, 4.8%)	(-4.4%, 4.8%)	(-4.4%, 4.8%)	(-4.3%, 4.7%)	(-4.5%, 5%)	(-4.3%, 4.7%)	(-4.2%, 4.6%)

7. The content of this paper is thin and slim, authors should provide at least one application of this dataset (such as Earth system models, atmospheric chemistry and transport models, and integrated assessment).

   This study is focus on the set-up and evaluation of emission model, which is the general framework for emission inventory studies. Compared to existing global inventories, our study built a global fleet turn-over model, improved the source resolution of CO_2 emissions, and published fuel-, vehicle type-, and age-specific CO_2 from global on-road vehicles with could not be obtained from other database. It's a little unfair to require emission inventory development research to be applied to models such as Earth system models, atmospheric chemistry and transport models, and integrated assessment at the same time.

8. Although the writing seems good, there are problems in this paper:
9. L247: 2020 appears at the end of the sentence and the beginning of another sentence；

   The expression has been changed as:

   … in India in 2020. The majority of vehicles in the European Union in 2020 were still PLDVs, for which the proportion was 79%, …

10. L247-249: The subject of the before and after inflection is inconsistent；

    The expression has been changed as:

    …, but the dominant vehicle type in United States has changed from PLDVs to CLDVs and CLDVs accounted for 50% of the local vehicle stock.

11. L249-251：The first half of this sentence is ambiguous.

    This sentence has been changed as:

As the dominant position of developed countries in global vehicle stock replaced by developing countries during the 1970-2020 period (Figure S6), the share of MCs in the global vehicle stock increased accordingly to 32%, and the proportion of PLDVs decreased to 50% in 2020.

12. The dashed line in Figure 1 exceeds the boundary.

Figure 1 has been changed as: