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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characterization of road freight transportation and its impact on the national emission inventory in China" *by* X. F. Yang et al.

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We would like to thank anonymous referee #1 for his/her comments on our manuscript. Our response to his/her questions and comments can be seen below. A few changes have been made here compared with our former response.

General comments: Description: This manuscript describes development of a mobile source emission inventory for on-road freight traffic in China. The researchers gathered data from questionnaires and GPS units to estimate the fleet composition and typical speeds on different types of roads. The inventory included NOx and PM2.5 and was

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built from kilometers of certain types of roads and corresponding distance-based emission factors. The resulting inventory was 28 percent higher for NOx and 57 percent lower than the Ministry of Environmental Protection's estimates. Differences stemmed from simultaneous consideration of vehicle type, vehicle age, distance traveled on specific types of roads, and emission factors for specific types of roads. Maps showed that emissions were concentrated around areas of high population density but were also substantial along freeways and national roads. Relevance: Diesel trucks are responsible for well over half of mobile source emissions of NOx and PM2.5 in China, and both pollutants are highly problematic in many cities. The work contributes a detailed understanding of the age, activity, and emissions distributions of trucks on different types of roads, and results could lead to interventions to reduce on-road, freight-related emissions. Assessment: The manuscript contains much useful, new data about diesel truck emissions in China. Indeed it seems much more sensible to apportion emissions spatially by the places where trucks are driven rather than where they are registered, although the more significant contribution of the work is information about driving conditions by truck type, age, and road type and how these factors influence the emission inventory. The writing and figures are clear, with a few exceptions, and the research appears to have been executed carefully. Response: Thanks for the comments.

Specific Comment 1 (p. 15223, line 26): Clarify whether the classification of trucks into the four types was based on the 1060 questionnaire results or some other data source. Response: In this study we tried to keep a unified classification for the trucks for different sources of data. The classification followed how the National Bureau of Statistics reports the vehicle stock. Besides, in our 1060 questionnaires, we also kept the same classification so that all the numbers we used in this research, from statistics or questionnaire answers, could be matched with each other. To clarify the classifications, the edited lines 26/Page 15223 – lines 2/Page 15224 now reads as: "Trucks are classified into four types according to weight in this research, following the rule made by National Statistics Bureau (CATARC, 2012): . Mini Trucks (MiniT) with weights less than 1.8 t, light duty trucks (LDT) with weights of 1.8–6 t, middle duty trucks (MDT) with weights of

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6–14 t and heavy duty trucks (HDT) with weights greater than 14 ton. The classification is used on getting vehicle stock from national statistic, questionnaires investigation and data analysis in this study."

Specific Comment 2 (p. 15224, line 2): "Because the MiniT population only consists of a very small proportion. . ." How small is this proportion? Response: In 2011, Mini trucks only consisted of 0.98% of the total freight truck stock. As the referee suggested, it is very important to present the proportion of MiniTs in the paper. To present that MiniT's proportion in freight stock was not significant, the edited lines 2-3/Page 15224 now reads as: "Because the MiniT population only consists of a very small proportion of the total truck fleet, for instance, 0.98% in 2011, and the differences between MiniT and LDT are not significant. . ."

Specific Comment 3(p. 15226, line 3): It would be useful to include in the supplementary information a table or figure showing the emission rates by operating mode bin.

Response: I agree with the referee that presenting emission rates by operating mode bin would be useful. Detailed information about it has been added to supplementary information, in Figure S1 (Fig.1 here).

Figure S1. Emission Rates of Each Bin: a)LDT NOx Emission Rate; b)MDT NOx Emission Rate; c)HDT NOx Emission Rate; d)LDT PM2.5 Emission Rate; e)MDT PM2.5 Emission Rate; f)HDT PM2.5 Emission Rate.

Specific Comment 4 (p. 15229, line 14): ". . .therefore meet the China 3 tailpipe emissions standard." Provide a brief description of China's tailpipe emissions standards.

Response: I agree with the referee's suggestion that we should include a brief description of China's tailpipe emission standards for readers who are not familiar with it. Therefore, we added a few sentences in line 15/Page 15229, which are read as: "Chinese government adopted vehicle emission standards following emission standards in

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Europe since 1999. The emission level 1 to 3 in China are equivalent to Euro 1 to 3 standard respectively, while China 0 means no emission control was applied. The limits of NOx and PM based on China vehicle emission standards are shown in SI, Table S2. ”

Specific Comment 5 (p. 15233, line 2): “. . .long idling time without shutting down the engine. . .” The GPS data alone cannot reveal whether the engine is on or not. Does this claim stem from the questionnaires or some other observation? Response: It is true that the old style GPS receiver alone cannot reveal whether the engine is or not. The GPS receiver that we used is capable to capture this information. In this research, we used a multifunction Columbus GPS data logger V-990 produced by GPSWebShop (Canada) Incorporation. Its charger can be plugged in the jack that holds the cigarette-lighter. It is also capable to sense the voltage of jack to see whether the engine is on. When we were monitoring the trucks, we set the GPS receiver in a mode that made it only to record data when the engine is on. Therefore, whenever we have the GPS data shows that the speed equals to zero, it means the truck is idling. We explained this very briefly in the data collection section, lines 17-18/Page 15224. To clarify this, the edited lines 17-18/Page 15224 now reads as: “The GPS data logger is set to automatically turn on/off when the engine of the investigated truck is turned on/off. Therefore, the data was collected every second when the engine of the truck under investigation is running. We were allowed to do this because a sensor was put into GPS to capture the voltage change of cigarette-lighter.”

Specific Comment 6 (p. 15232, line 21): “The distribution of bins on each type of road is shown in Fig.4. ..” Fig. 4 shows the proportion of running time on different types of roads by truck type and not the distribution claimed. Response: I am sorry. The sentence should be corrected as: “The distribution of bins on each type of roads in shown in Supplementary Information, Fig. S6.” And the figure is added in Supplementary Information, Figure S6 (Fig. 2 here).

Figure S6. Bin Distribution on Different Types of Roads: a) Urban road; b) 1 Freeway;

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c) National Road; d) Provincial Road; e) Town / Country Road.

Specific Comment 7 (p. 15233, line 8): ". . .urban or suburban roads where the driving conditions are relatively worse." Are suburban roads lumped together with urban roads? Response: Yes, suburban road are lumped together with urban roads in our study. There are only 5 types of roads: freeway, national road, provincial road, country/town road and urban road. Here I used the phrase 'suburban road' to show that these roads are located in suburban areas. Mostly, roads in suburban areas are also urban roads. I understand that it could be very confusing and misleading. To clarify, the edited lines 8-9/Page 15233 now read as: "Generally, the emission factors tested on urban roads where the driving conditions are relatively worse, leading to a higher emission factor."

Specific comment 8 (p. 15233, line 14): Please explain briefly the inputs and methods used by the MEP to estimate emissions so that readers can better understand the differences between the two inventories. Response: The 2011 MEP emission estimations came from their annual report, China Vehicular Pollution Prevention Annual Report. The method that MEP used to estimate emissions was not introduced in the report. We contacted the technical staff in MEP to confirm their method of estimating emissions. Their method is briefly introduced as below. And the introduction is inserted into line 16/page 15233. And Table S2 mentioned in below text is added in supplemental information. "Briefly, MEP estimated vehicle emission on the basis of local vehicle stock, activity level and emission factors. The truck classification is the same with our study, according to gross vehicle weight and the national emission standards. For each group, the emission equals the product of local registration number, kilometer travelled per vehicle and emission factor. Adding up emissions of each group is the total emission. The emission factor that MEP used is based on the national emission standard. Detailed information of emission standards in China is shown in SI, Table S2. However, no further input data related to vehicle kilometer travelled was provided in this inventory."

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Specific comment 9 (p. 15233, line 15): “The NOx number is a little higher than the MEP’s estimation. . .” Calculate how much higher these NOx emissions are relative to the MEP’s inventory. Response: It should be clarified that how much higher our NOx result is than MEP’s inventory. And we added a new sector (3.5 Comparisons with other researches). The quantitative comparisons are now in the new sector 3.5 and related sentence now reads as: “This NOx number is 28% higher than the MEP’s estimation of 3 900 000 t NOx emissions from trucks in 2011”

Specific comment 10 (p. 15233, line 22): The finding that NOx reduction from diesel trucks was not as successful as expected seems worthy of being mentioned in the Conclusions section, for its policy-making implications. Response: Thanks for your suggestion. A few sentences talking about the reduction of NOx in freight truck sector was added in line 24/page 15238 in the conclusion sector. The newly added sentences read as:

“According to our research, the failure of reducing NOx emission of the China 3 diesel trucks is the main reason of high NOX emissions in total. And the challenge of NOx reduction will last for many years until all the existed trucks were replaced by new trucks with after-treatment system.”

Specific comment 11 (p. 15236, line 15): According to Figure 10, Henan ranks 3rd in NOx emissions and 3rd in PM2.5, not 3rd and 5th. Other claims in the following 10 lines are also not supported by the figure. A difference in ranking of one place does not seem like it would be significant. Response: Thanks for the correction. A major mistake was made here. Considering the less importance, we have deleted the whole paragraph of this conclusion from line 13/page 15236 to line 3/page 15237.

Specific comment 12 (Figure 3): Much more explanation of the legend colors and pie charts is needed. Same comment for Figure 7. Response: Thanks for the suggestion. We have already rearranged Figure 3 and Figure 7 as below (Fig. 3 and Fig.4 here).

Figure 3 Age and Total Mileage Traveled Distribution of the Diesel Truck Fleet in 2011,

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China: a) vehicle population; b) total mileage

Figure 7 Emissions from Diesel Truck Fleet in 2011, China a) NOx Emission; b) PM2.5 Emission

Technical corrections: All four technical corrections were accepted.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 15219, 2014.

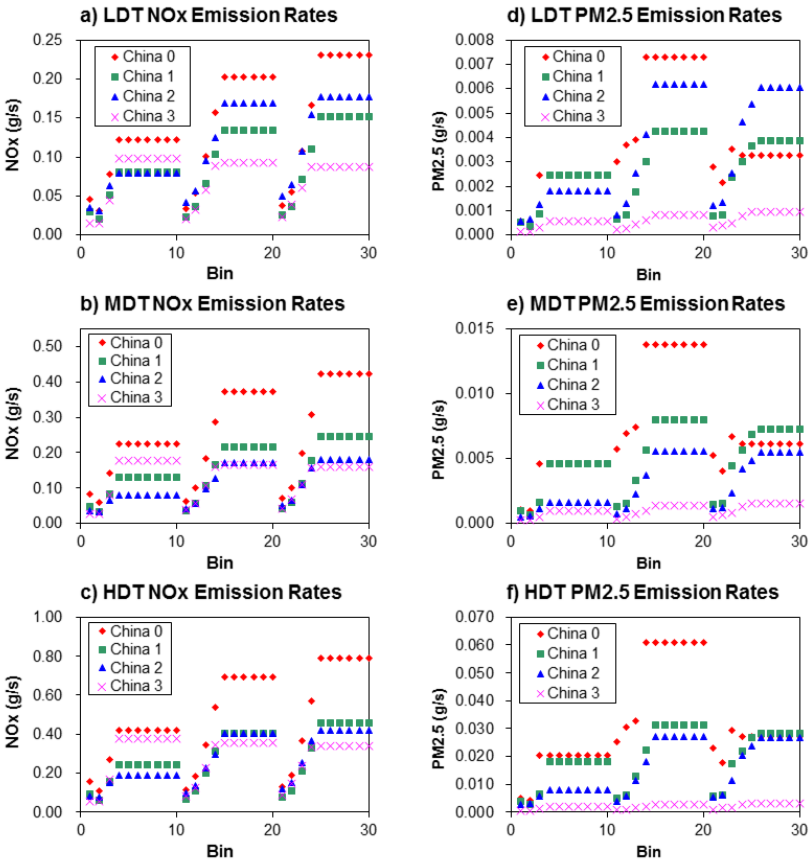

Fig. 1.

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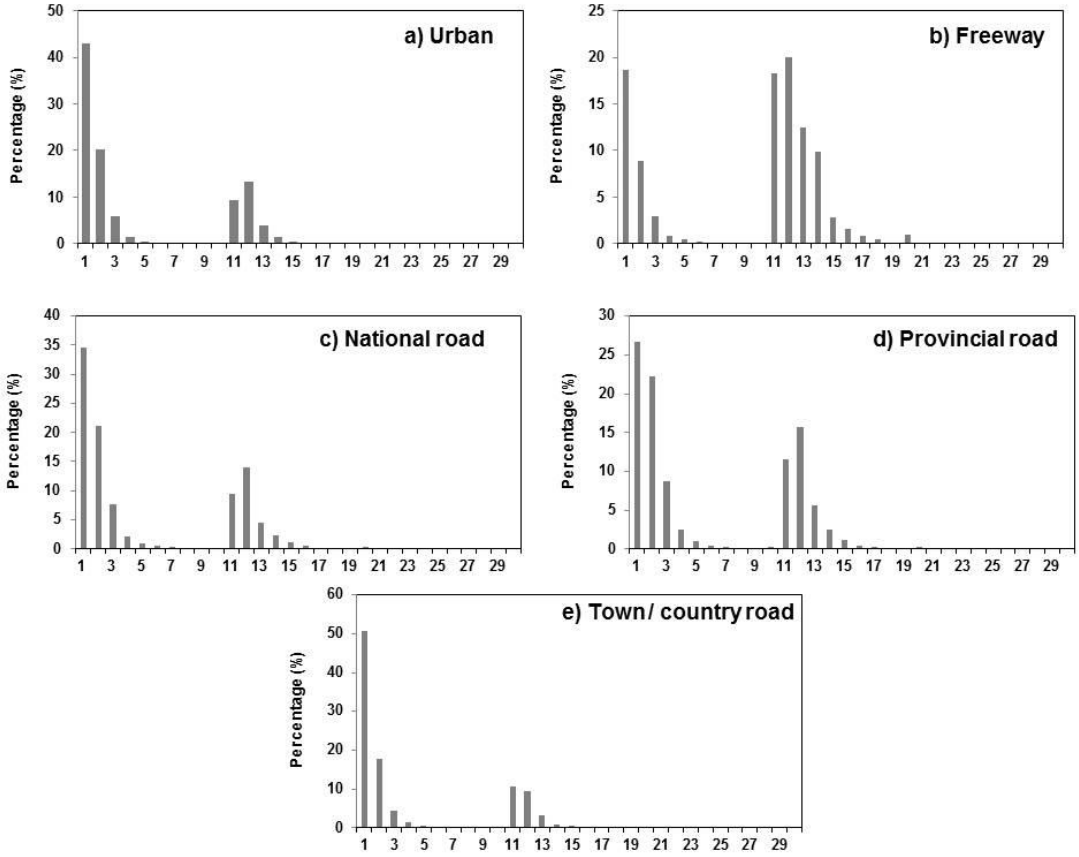

Fig. 2.

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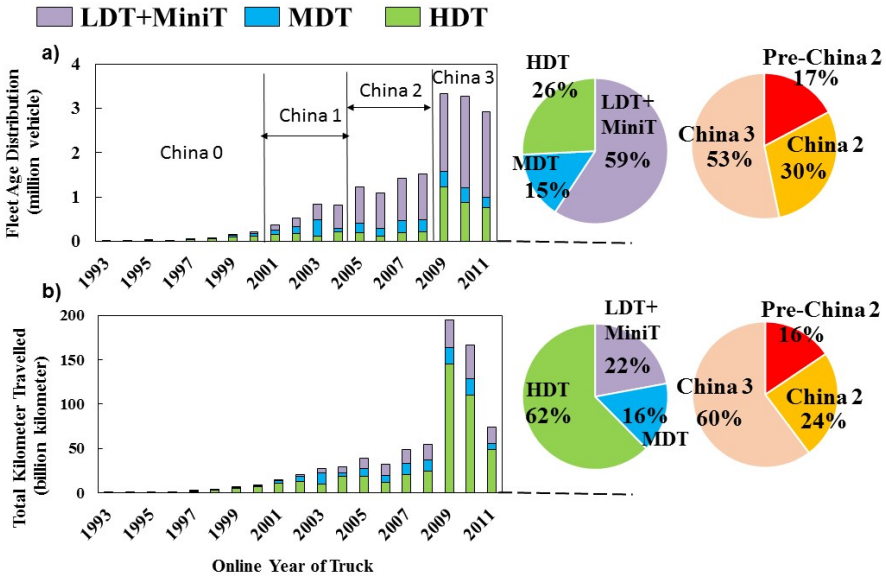

Fig. 3.

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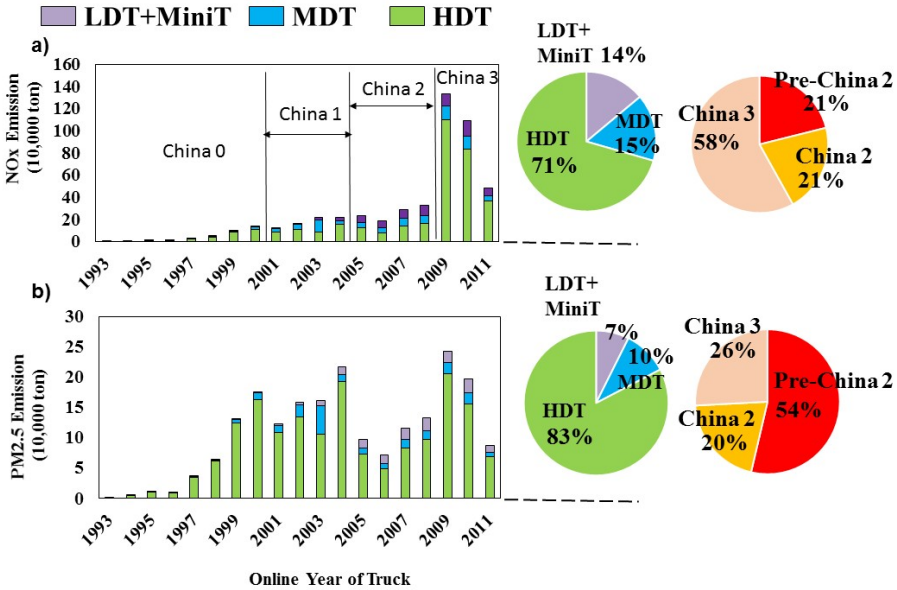

Fig. 4.

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