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Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Determination of car on-road black carbon and particle number emission factors and comparison between mobile and stationary measurements" *by* I. Ježek et al.

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We thank the reviewers and Jon M. Wang for their comments and recommendations. We have addressed all the comments and have accordingly revised the manuscript. We address the points raised by reviewers specifically below.

Reviewer #1

Comment #1/1: There has been more work than suggested by the authors on using the 'chase' technique. For example, Shorter et al: Shorter, J. H., Herndon, S., Zahniser, M. S., Nelson, D. D., Wormhoudt, J. Demerjian, K. L., Kolb, C. E., 2005. Real-time



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measurements of nitrogen oxide emissions from in-use New York City transit buses using a chase vehicle. Environmental Science & Technology 39 (20), 7991–8000. The authors need to consider more of the previous work in this area.

Answer: We extended the relevant parts of the results and discussion by adding a new paragraph in Chapter 4.2.1, where we compare chasing methods and hence reference the work by Shorter et al. (2005) and Herndon et al. (2005). Additionally, we added a full new paragraph at the end of Chapter 4.3.1, comparing our results to results of other on-road studies using different methodologies, adding the reference to Hudda et al. (2003).

Comment #1/2: I find the terminology rather clumsy e.g. EURO3 (00) etc. It would be better to use a system that revealed the Euro class and the fuel for all vehicles studied.

Answer: We agree that the abbreviations for cars are indeed rather clumsy. We changed the abbreviations, so that they use a simpler notation, providing information on the vehicle category, fuel and date of manufacture: Diesel powered Euro 3 compliant, made in year 2000 (D3-00); Gasoline powered Euro 5 compliant, made in year 2011 (G5-11).

Comment #1/3: The use of 'emission factor' needs to be considered carefully. Usually when considering vehicle emissions the units most commonly used are g/km (as the authors suggest 4.3.3). Most of the time the authors are considering emission ratios or g/kg fuel burnt (also a ratio). A careful definition of these terms earlier on in the manuscript would help the reader.

Answer: We added a new paragraph to the introduction where we first introduce the emission factor (EF) in g/km and describe the measurements that are used to determine these EF's, taking as an example the Euro standard legislation. At the end of the paragraph we explain how the EF in g/km relates to the EF in g/kg.

Comment #1/4: There needs to be much more information on the vehicles tested in-



AMTD
7, C3337–C3341, 2014

cluding fuel type, engine size, mileage and after-treatment used (e.g. particle filter). These factors are very important when considering the results and it is currently difficult to draw clear conclusions from the discussion. I would recommend a new table.

Answer: We have added a new table (now Table 1) with more vehicle information to Chapter 2.1. The information from this table is used in the discussion.

Comment #1/5: In the discussion and conclusions there should be a much fuller treatment of the results in terms of fuels used etc. i.e. how much better are gasoline vehicles than diesel for BC, effect of vehicle age etc.

Answer: The manuscript focuses on the ability of the presented methods to measure real-world on-road emissions of different types of personal vehicles powered by different engines and fuels. While we do report the differences in the EF's and comment them in terms of the technology and fuel, we do not attempt to draw conclusions on the emissions from these different types of vehicles or to generalize the results: measuring just one new gasoline car (Euro5) and four diesel cars (Euro3 and 5), we can't really conclude how much better the gasoline vehicles are. We know that this topic is of great interest and have carried out an on-road campaign, using the technique described in this manuscript, measuring a large fleet of vehicles on European highway transport corridors and regional roads in Slovenia. The data processing is finished and the manuscript describing the campaign and reporting the on-road EF of the measured fleet is very close to submission.

Reviewer #2

Comment #2/1: Introduction section would benefit from better explanation of emission factors. At present it only becomes clear in the beginning of chapter 3.

Answer: Please see reply to Comment #1/3.

Comment #2/2: Also for a more general reader, it would be good to understand better the Euro3, 5 etc. standards, with a sentence or two to describe how those limit PM.



AMTD

7, C3337–C3341, 2014





Answer: We added a short description of the relevant parts of the legislature on the Euro3 to Euro5 standards for the personal vehicles, focusing on the importance of BC (as a constituent of PM) and of PN, which was a newly regulated parameter. We added additional description next to Eq. 1, to improve the clarity and the comparison to emission standards and laboratory measurements. We have also included a new table (Table 1), which provides more information on the tested vehicles.

Comment #2/3: X-axes in fig 3 & 5 for measurement data points. Just a running measurement number?

Answer: The data points are shown so that the thickness of the distribution in the direction of the x-axis is related to the frequency distribution of the EF, showing the reader, that the distribution is far from symmetric. Overlaid on the measurement points are the box plots showing the median, average, percentiles and minima and maxima.

Response to comments by J.M. Wang and other changes: We have found two mistakes in our EF calculations (unit conversion factors) and have corrected the results. Tables 2 and 3 (previous Table 1 and 2) and Figures 3 – 7 have changed. We have included references to Shorter et al. (2005), Herndon et al. (2005), and Hudda et al. (2013), where advised.

References

Herndon, S. C.; Shorter, J. H.; Zahniser, M. S.; Wormhoudt, J.; Nelson, D. D.; Demerjian, K. L.; Kolb, C. E. Real-time measurements of SO2, H2CO, and CH4 emissions from in-use curbside passenger buses in NewYork City using a chase vehicle. Environ. Sci. Technol., 39, 7984-7990, 2005.

Hudda, N., Fruin, S., Delfino, R.J., Sioutas, C.: Efficient determination of vehicle emission factors by fuel use category using on-road measurements: downward trends on Los Angeles freight corridor I-710, Atmos. Chem. Phys., 13, 347–357, doi:10.5194/acp-13-347-2013, 2013.



AMTD

7, C3337–C3341, 2014

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Interactive comment on Atmos. Meas. Tech. Discuss., 7, 5423, 2014.