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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Particle number, particle mass and NO_x emission factors at a highway and an urban street in Copenhagen" *by* F. Wang et al.

Anonymous Referee #1

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General Comments

"Particle number, particle mass and NOx emission factors at a Highway and an Urban street in Copenhagen", is a recent submission which adds to the collective knowledge and experience in measuring emission factors from field data. These contributions are important in as much as to pin down the parameters which the emission factors are the most sensitive to, e.g. fleet speed, fleet composition, dilution ratio, dilution temperature, fuel content, etc. The discussion paper is well written and provides a review of the field measurements taken in the Copenhagen region. The data is presented in such away to give a general overview of the measurements averaged over weekdays and weekends and where possible - e.g. for particle size distributions - numerical methods have been used to extract further emission factor information according to particle size

range by fitting lognormal modes to the data. Furthermore, in order to derive at 'tail-pipe' emission factors, dilution effects have been accounted for using the WinOSPM model, rather than rely on techniques based on CO or Nox values.

The findings of the values of HDV/LDV emission factors with vehicle fleet speed challenge the general observation that the value of an emission factor increases with vehicle speed from 50 to 100 kph. Emission factors aggregated across the whole vehicle fleet have been reported in the Abstract and Conclusions for measurements at an urban (∼50 kph) and highway (∼100kph) road and these are comparable with published values. For urban and then highway: the NOx values were 0.94 and 1.41 grams per kilometre; the particle number values were 187e12 and 215e12 particles/vehicles/km; and the PM2.5 values were 46 and 26 mg/vehicle/km. Except for the PM2.5 emission factor, the emission factor values generally showed an increase with fleet speed. The authors of this paper also report on the HDV/LDV ratio however the HDV and LDV emission factors themselves do not show a similar increase with fleet speed as shown by Jones and Harrison (2006); larger HDV emission factors are observed at the urban site.

Specific Comments

Page 19548 In section 2.1. The positions of urban kerbside and background sites are given. The kerbside measurement is taken 3m away from the 6 lane H.C. Andersens Boulevard and the urban background measurement is a roof top measurement in proximity to the 6 lane Norre Alle. In comparison to the H.C. Andersens Boulevard with 55 600 vehicles per day. In terms of vehicles per day, how busy is the Norre Alle and are contributions from this local traffic source evident in the data?

Page 19552, Line 14. Reports that traffic volume was not measured at the urban roadside site and instead there is a reliance on a pattern measured by the Copenhagen municipality one a year for 1-2 days. What measures were put in place in your calculation to ensure that the urban HDV/LDV emission factors were not under/over estimated

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due to the incorrect split between the heavy and light duty vehicles of the fleet measured during the campaign? Furthermore, how sensitive are the HDV/LDV emission factors to this split between light and heavy duty vehicle counts?

Page 19554, Line 3. Reference is made to the street canyon effect and authors such as Jones and Harrison indicate that wind direction is an important consideration when measuring traffic emission factors at the London Marylebone Road. Can the Urb-Kb be correctly defined as a canyon considering the open park located across the road? Also when selecting the data to measure a roadside increment, how sensitive is wind direction to this "street canyon" effect and are local sources, e.g. the train station, evident in the data when taking into account wind direction which may be elevating the average emissions measured at this site?

Page 19555 Line 8. The lowering of the boundary layer may also contribute to an elevation of concentration at night.

Page 19556 Line 17. Dyno and chase studies in the PARTICULATE programme also show the onset of a nucleation mode at 100 kph, i.e. the speed of the traffic on the Highway.

Page 19557 Line 20 onwards. The change in particle size distribution is considered with distance from the highway by comparing the measurements at the background site when the wind blew away and towards the site. When selecting measurement data according to wind directions 105 to 225, there are two roads, namely the Bondehojvej road and Roskildevej highway which air will pass over before reaching the background site. Can the arguments made in this section can be extended to justify the positioning of the background site?

Page 19566, Line 20 and Page 19566, Line 21. States, "the emission factors for HDV decreases with vehicle speed since engines run more efficiently on highways." The literature, e.g. Imof et al (2005), Morawska et al (1999), Kristensson et al (2004), Jones and Harrison (2006), all suggests that as fleet speed increases from 50 to 100

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kph the emission factors also increase for both LDV and HDV. Morawska did measure similar PN emission factors for fleet speeds of 60 and 100 kph, but this was for LDV; HDV PN emission factors showed a rise in value with speed. Laboratory and chase experiments also make this claim from the reports given by PARTICULATES http://www.lat.eng.auth.gr/particulates. Can the authors provide references to support this argument? Furthermore, does this contradict the statement on page 19561 line 15, stating that Mode 1 has obviously high concentrations due to high traffic speeds?

Page 19563, line 13. For equation 3, please check the consistency of the units used on either side of the equals sign. Are extra constants needed to account for the different measured values, e.g. comparing hours and seconds.

Page 19564, Line 1. It is stated that the WinOSPM model simulates pollutant dispersion in street canyons. How well did the model simulate the dispersion at the H.C. Andersens Boulevard site which appears to be asymmetric with buildings along just one side of the canyon?

Page 18564, Line 9. The term “multiple linear regression”. Be aware that purists statisticians may point out that is simply just “regression”.

Page 19565, Line 28 onwards to the end. This description needs just a little more clarification. It is difficult to understand what the fitted curve is and consequently the final argument.

Technical Corrections

Throughout the paper where there is an emission factor, please make it clear that the emission factor units are per vehicle. For NOx g/vehicle/km; for particle number particles/vehicles/km; for PM2.5 mg/vehicle/km.

Page 19552, line 1. Consider adding a synonymous word to flow to the sentence, "The average daily traffic flow during the..."

Page 19552, line 15. Consider making the phrase, "...and for buses a bit lower" more

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formal.

Page 19555, Section 3.5.1 "nighttime" -> "night-time".

Page 19557, Line 4. Should read "...even at distances...".

Page 19561, Line 12. The sentence starting “The number concentration...” needs to be checked for clarity and tense.

Page 19561, Line 14. The sentence starting “Mode 1 takes inappreciable contribution at...” needs to be checked for clarity.

Page 19565, Line 28. Should read, “However, the fitted curves...”

TABLES AND FIGURES.

In figures 7 & 8, it is difficult to differentiate between the curves using the same colour, please address this by for example using a different line style, e.g. dashed, for either the daytime or night-time measurements.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 19545, 2009.