Atmos. Chem. Phys. Discuss., 14, C2617–C2622, 2014
www.atmos-chem-phys-discuss.net/14/C2617/2014/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of the predictions of two road dust emission models with the measurements of a mobile van" *by* M. Kauhaniemi et al.

M. Kauhaniemi et al.

mari.kauhaniemi@fmi.fi

Received and published: 22 May 2014

We would like to thank the anonymous Reviewer #1 for his/her comments and suggestions. Our response to the reviewer comments is provided below. The reviewer's comments are numbered.

Response to anonymous Reviewer #1

1. The authors describe the predictions of two road dust emission models which are compared with mobile measurements of tyre-induced suspension of road surface dust. Neither model performs particularly well and probably the most useful outcome of the

paper is a better appreciation of the complexity of describing the processes determining the resuspension flux, and the consequent difficulties in estimating it. Before attempting such an exercise again, the authors need to think very carefully about how best to design their experiments in ways that go well beyond the provisional thinking revealed in their conclusions.

Answer:

Yes, we agree on these comments. We will revise the conclusions, including a much more detailed description of the optimal design of future experiments.

2. One of the key variables in resuspension processes is the surface loading of particulate matter in the appropriate size fraction on the road surface. One of the models appears to have the information to calculate the surface dust loading but does not output the data, whilst the other model depends upon reference values of emission factors for road sanding and non-road sanding periods which are adjusted according to the prevailing road surface conditions. Failure to calculate the road surface dust loading, and failure to verify through measurements is a very important weakness. If such an exercise had been conducted, there would be greater clarity as to the reasons for model under-performance.

Answer:

Both models evaluate the surface dust loading. The NORTRIP model calculates the road dust loading due to road wear, salt and sanding (in g/m2). This is the basis (source) of the suspension presented in the article. The FORE model on the other hand uses a normalised dust loading, so the actual loading (in units of g/m2) is not known, but is always relative to a maximum value defined relative to a maximum emission factor. We have used the reference emission values measured for Hornsgatan in Stockholm. Unfortunately, no measurements of road dust loading were available in Helsinki and so no comparison could be made for either model with modelled and measured loading. The authors agree with the reviewer that any future campaigns should

ACPD
14, C2617–C2622, 2014

include measurement of this parameter. The description of the above mentioned evaluation of dust loading should be described more clearly in a revised manuscript.

3. One of the underlying assumptions in this work is that movement of tyres over the road surface is the process determining resuspension and no consideration is given to turbulence in the vehicle wake as a cause of resuspension. This assumption may be correct but requires justification.

Answer:

The suspension in the models is described 'per vehicle' so it is all inclusive. We have not assumed that the vehicle–induced turbulence would be negligible. However, the models are not so advanced that they would distinguish between suspension due to direct tyre suspension and suspension due to vehicle turbulence. The observations on the other hand, taken from behind the wheel of the vehicles, imply that suspension is mainly from this source, though a certain amount of turbulence induced suspension will also be included in these measurements. Also measurements are not available to delineate between these two types of suspension. It is to be expected that the vast majority of suspension comes from the road tyre interaction for light duty vehicles (of the type used by SNIFFER). However, this assumption may not be the case for heavy duty vehicles. The manuscript should be clarified in terms of the impacts of vehicle-induced turbulence.

4. Another factor requiring some thought is whether for a given tyre type (winter, summer, studded), the configuration of the tyre tread and the extent of wear of the tyre is a significant factor. The SNIFFER mobile laboratory used in this work has to be "calibrated" against emission factors and this exercise has been conducted. However, have the measured relationships changed due to wear or changing of tyres?

Answer:

We agree with the referee that the tyre type affects the road wear and also the emis-

ACPD

14, C2617–C2622, 2014

sion of resuspended road dust as demonstrated and discussed in e.g. Kupiainen & Pirjola (2011). Consequently the tyre type has effects on resuspended emission factors. However, the variability in emission factors between studded and studless winter tyres with speeds 40 and 50 km/h was 10 to 20 percent; these are within the uncertainty observed in the road measurements, Kupiainen & Pirjola (2011). The difference between tyre types, i.e. studded vs studless tyres and also different tread patterns of the winter tyres, is an interesting one and we aim to continue to study and measure them, as new tyre models will come to market. Also these aspects could be discussed in a revised manuscript.

5. A further point which needs consideration especially in relation to the FORE model is how results will be extrapolated to other street locations. If the emission factors are to be incorporated within an urban model, then they need to be known for a range of street types rather than just a single street. The work with the FORE road dust model used reference values determined on a street in Stockholm but there appears to be no way in which these can be modified or made suitable for use in other locations. This is a huge weakness in the present approach unless a vast amount of work is done to determine reference emission factors for a wide variety of road situations.

Answer:

The reference emission factors used in the FORE model can be calculated for other locations according to a fairly simple method described in Omstedt et al. (2005). This method can be used if both urban background and roadside concentrations of NOx and PM are available. In this study, these datasets were not available, and thus, the reference emission values estimated by Omstedt et al. (2005) were used. However, the model could be used in the future for a range of locations (or approximately even for a whole city or whole metropolitan area); but this requires some additional analysis of experimental datasets.

6. There are also a number of relatively minor points requiring some attention: (a) On

ACPD
14, C2617–C2622, 2014

page 4274, reference is made to a fraction of 0.2% PM10 in the applied road sand, based upon previous measurements. Does this percentage change in use as a result of the grinding of the sand by continuous vehicle movement?

Answer:

In the application of the NORTRIP model in this article the percentage of sand that is PM10 is fixed, i.e. no grinding of the sand was included. Though this grinding, and also abrasion, process is described in the NORTRIP model, there is not enough observational data available to properly parameterise this with any level of certainty. The FORE model makes no such distinction. As previously mentioned, it uses a normalised loading, in which it is assumed that half of the loading is originated from sanding.

(b) The authors point out that one of the weaknesses relates to use of hourly data on the occurrence and intensity of precipitation (page 4282). Would it be preferable in future work to make on-site measurements of greater temporal resolution?

Answer:

In the further studies on-site weather data should be used, if possible. The use of finer temporal resolution is not possible in the current version of the FORE model, as the model uses hourly average input data. The NORTRIP model can use other time steps than 1 hour.

7. In summary, the paper can be recommended for publication, not because of what new knowledge it creates but because of its contribution to highlighting knowledge deficiencies which require resolution in order to enhance the skill of predictive models. These issues should be reflected more clearly in the final version of the paper.

Answer:

We agree with the referee; the deficiencies and difficulties in estimating the processes of the resuspension flux need to be highlighted in the paper more clearly. This will be corrected in the revised manuscript.

ACPD
14, C2617–C2622, 2014

References

Kupiainen., K. & Pirjola, L.; Vehicle non-exhaust emissions from the tyre–road interface – effect of stud properties, traction sanding and resuspension. Atmos. Environ., 45, 4141-4146, 2011.

Omstedt, G., Bringfelt, B., and Johansson, C.: A model for vehicle-induced non-tailpipe emissions of particles along Swedish roads, Atmos. Environ., 39, 6088-6097, 2005.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 4263, 2014.