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Interactive comment on "Black carbon modelling in urban areas: investigating the influence of resuspension and non-exhaust emissions in streets using the Street-in-Grid (SinG) model" *by* Lya Lugon et al.

Anonymous Referee #2

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General Comments

This research article provides new and very useful information regarding the contribution of on-road traffic to urban air pollution. The focus is on particulate black carbon (BC) and its vehicular emission sources. The authors use a novel advanced modeling technique, the SinG model, which simulates urban air pollution at various spatial scales (urban background and street-level pollution) in an internally consistent manner. Furthermore, they improved this model by implementing a more detailed dry deposition

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model and conducting a dynamic simulation of the emission, deposition, and resuspension of particulate matter.

In this work, they apply this model to investigate the vehicular emissions of BC. In particular, they evaluate the relative contributions of exhaust and non-exhaust (tire, brake, and road wear) emissions of BC to air pollution in streets. The non-exhaust emission source is particularly uncertain and the authors do an excellent job at reviewing the literature, identifying the major uncertainty sources, and systematically investigating their impact on simulated BC concentrations. They conduct a thorough evaluation of the modeling results using experimental results of a field program that provides both ambient air BC concentrations in a Paris suburban street and deposited PM mass in that same street. This evaluation allows the authors to propose that the greater estimates of non-exhaust emissions are more realistic and that current non-exhaust BC emission inventories may significantly underestimate actual BC vehicular emissions. This conclusion is consistent with the fact that some earlier modeling studies needed an arbitrary increase in BC vehicular emissions to match observations. The fact that their comparisons with both BC air concentrations and deposited mass are consistent is particularly interesting, because it provides closure to the air pollution process being modeled.

In addition, this work confirms the importance of treating urban air quality at various scales in a joint consistent manner. Previous work by the authors and others had demonstrated this point for reactive gaseous pollutants. It is demonstrated here for chemically inert particulate matter.

Therefore, I recommend publication of this work in GMD with minor modifications to address the following comments. Also, the text needs some editing by the authors to correct some English mistakes and improve the style overall.

Specific comments

The conclusion that non-exhaust BC emissions are currently underestimated in Eu-

ropean emission inventories (according to the results presented here) has important policy implications. It means that replacing internal-combustion engines by electric vehicles will not eliminate BC air pollution, but only reduce it by about half (in terms of vehicular emissions). This point should be highlighted, both in the conclusion and in the abstract. Clearly, additional work (mostly experimental) should be conducted to confirm this result, but the work presented here makes a very strong case for revising current BC vehicular emission inventories and taking non-exhaust emissions explicitly into account in air quality simulations. Some recommendations regarding additional studies to refine those results could be provided in the conclusion.

The introduction is rather long (about one quarter of the entire text) and the authors should consider breaking this current introductory section into two sections: (1) a general introduction and (2) a section that provides an overview of the current state of the science for non-exhaust vehicular emissions (since it corresponds to the main topic of this work).

In the first paragraph of the introduction, it is stated that BC is mainly emitted by traffic. It should be pointed out that during winter, wood burning (for residential heating) is also an important source of BC in some areas (including the Paris region).

Among the potential health effects of BC, should its carcinogenic effects be mentioned (e.g., Lequy et al., Environ. Health Perspectives, 129, March 2021)?

The sentence on the environmental impacts of BC needs to be rewritten, because visibility reduction is due to the radiative effects of BC. I suggest: "... environmental impacts due to its radiative properties (light absorption), which lead to visibility reduction (references) and global warming (references).

p. 2, line 49: delete "in models" (the under-estimation affects the emission inventory in general, which may be used for modeling or other tasks, such as reporting).

p. 3, line 82 and others: the unit mg.vkm-1 is used throughout (milligrams per vehicle-

kilometer travelled); however, later in the text (e.g., p. 9, line 255) the unit veh.h-1 (vehicles per hour) is used for traffic flow. Unit notations should be consistent for "vehicles". I suggest using mg.(veh-km)-1 for the former.

On p. 4, lines 107-109, it is mentioned that the road-wear emissions calculated by Thouron et al. (2018) were greater than those of the EMEP guidelines. Can the authors specify whether this is due to the algorithm used or the road characteristics (or a combination of both)?

p. 4, line 105: I think that "soil" would only apply to a dirt road. I suggest "road characteristics" instead (also p. 13, line 360).

p. 5, line 133: "worst quality codes"; I am not sure what the authors mean.

In Sections 2 and 3, it is mentioned that particulate BC is treated using a sectional size distribution with 6 size sections, which is useful to correctly simulate dry deposition. Since atmospheric chemistry is not treated, I assume that aerosol dynamics (condensation/evaporation, nucleation, and coagulation) is also not treated. This seems appropriate as it would have little effect on the BC size distribution (in particular, considering the uncertainties associated with its initial size distribution). The authors should mention this point. Also, the initial size distribution of emitted particulate BC should be specified, either with a reference or by providing the size distribution.

p. 10, line 280: it is not clear why Qemis, exh represents both exhaust and non-exhaust emissions. Please clarify.

p. 10, line 280: it is not clear in Qdep, v what the second subscript, v, represents. Please clarify.

In Section 3, p. 12, Equation 10: please specify the units of EF.

In Section 4.1, p. 13, line 343: "to estimate and control"; please specify what "control" refers to.

At the end of Section 4.1, the authors mention that their correction factor for exhaust BC emissions used in simulation 6 is based on traffic flow characteristics and BC/PM2.5 uncertainties. Could this be explained in greater detail?

In Section 4.2, the authors provide two different sets of criteria for model performance evaluation. The stricter set includes 6 performance metrics (5 were initially defined by Hanna et al., Atmos. Environ., 38, 4675-4687, 2004; the normalized absolute difference was added later), whereas the less strict set (suitable for urban areas according to Hanna and Chang, 2012) includes only 4. It is not clear whether the authors consider that the stricter criteria defined for MG and VG should also apply to the less strict set or whether those metrics must simply be dropped from the less strict set; this point should be clarified. It may be a moot point since, in any case, simulations 1 through 3 fail the less strict criteria (except NMSE) and simulations 4 through 6 meet all the stricter criteria.

In Section 4.3, p. 17, lines 425-426: I would not say that the observations of Amato et al. are “quite similar” because the result obtained in this work is slightly above the upper bound of the range given by Amato et al.

In Section 4.3, the authors refer to PM10 as fine particles. This definition of PM10 is unfortunately commonly used in France by some agencies, although it is incorrect. Fine particles correspond to PM2.5 (give or take 1 ïĄ■m) and PM10, therefore, includes fine particles and a fraction of coarse particles.

In Section 5, p. 19, line 477: “lower concentrations”? Should it be “higher concentrations” if there is double counting?

As mentioned above, the authors should mention the policy implications of their results concerning BC emissions from vehicles in the conclusion. Also, some suggestions for additional experimental studies to confirm the results of their work would be appropriate.

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