Author's response to reviews

Title: Mobile phone tracking: in support of modelling traffic-related air pollution contribution to individual exposure and its implications for public health impact assessment

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Author's response to reviews: see over
Dear Editors,

Thank you very much for considering our manuscript. We addressed the comments from the reviewer and revised the manuscript extensively. In the following pages, we address each of the specified comments from the reviewer, and explain how we incorporated their suggestions/critiques into the paper. In addition, we paid particular attention to grammar and syntax to ensure that the paper has the highest degree possible of “correct” English and is furthermore easy to read and understand.

1.1 Major Compulsory Revisions

Major Compulsory Revisions:

Reviewer comment 1: Methods: Pollution field modelling: Dispersion and CFD models are only two alternatives for predicting air pollution concentrations. The authors give a longer list later in the manuscript, so why not just list them here first and then later describe each in more details? Moreover, predicting the 3-dimensional flow of air and air pollution in a street canyon is not a trivial task, particularly when the domain includes megacities at a single street resolution as the authors present in this manuscript. The authors’ choice to mention dispersion and CFD models is not clear, given that: 1. Dispersion models only account for primary pollutants and treat them as inert, i.e., ignoring the photochemical reactions that lead to secondary pollutants (i.e., ozone). 2. CFD models are very demanding in terms of computational power. 3. Most importantly, for models to run at a street resolution (and account for local street canyon recirculation as the authors suggest) there is a need for high resolution input data for the models about the meteorology in the city, including temperature and wind speed and directions. Given the complexity of the urban surface (i.e., a variety of land uses, surface coverage, low vs. high rise buildings, etc.), obtaining high resolution meteorological input for such models is not feasible, regardless of the computational power needed.

Response to comment 1: As reviewer suggested, we have first listed here the existing models (dispersion models, CFD (Computational Fluid Dynamics) models, geo-statistical interpolation models, land-use regression models and hybrid models) that can be used for predicting air pollution concentrations. Second, we have addressed that high resolution meteorological input for such models is essential and some models are very demanding in terms of computational power.

Reviewer comment 2: P12: Dispersion models: several comments:

- This section does not explain what dispersion models are and what their basic principles are. - “Traffic emissions are usually estimated in roadway air dispersion modelling by…” Usually, traffic emissions are not calculated in the dispersion models themselves, but in a separate emission calculation model. The same is true for the meteorology used in the models.

- “The basic concept of the roadway air dispersion model is to calculate air pollutant levels in the vicinity of a highway or arterial roadway by considering them as line sources [92]”. Wrong. The basic concept is to calculate the dispersion of air pollution for the entire model domain (and not just near roads) with a given meteorology and emission sources as inputs to the model.

- I don’t see the need to list all pollutants for which dispersion models were applied.

Response to comment 2:

- We have explained what dispersion models are and what their basic principles are as follows, emphasizing the simplifying concept of a line source:

A simplifying concept of a roadway air pollution model is to treat the emission from many vehicles as one line source. The pollution is dispersed away from the line source to the entire model domain (and not just near roads) by the mechanisms of diffusion and convection (move with the local velocity of the air). However, due to the dispersive spreading the highest pollution levels are found at the line source.

- The list of all pollutants for which dispersion models were applied has been removed.

Reviewer comment 3: P13: Geo-statistical interpolation models:

- This paragraph does not explain what these models are.

- “…can be implemented to estimate the traffic-related air pollution in conjunction with a dense, well-distributed, monitoring work”. Should be “based on a statistical interpolation of instead of “in conjunction with”

- I don’t see the added value of giving so many citations here

Response to comment 3:
We have revised the sentence based on the suggestion as follows: “Geo-statistical interpolation models can be implemented to estimate the traffic-related air pollution based on a statistical interpolation of a dense, well-distributed, monitoring work [64].”

The sentence with the citations has been removed.

Reviewer comment 4: P13: Land-use regression models:

- Again, the authors do not give a clear and simple explanation of the model but rather make general statements and a list of citations. This does not help the reader understand the relevance of these models to the concept presented in the manuscript.

- Given that LUR models are based on long term averages of pollution levels measured at multiple locations, I do not see their relevance to the proposed concept of real-time or near real-time exposure estimates, as the authors state in the next paragraph on page 14.

- And again, more references than needed.

Response to comment 4:

- LUR models have been used to estimate traffic pollution, and we agree with the reviewer that for the near real-time application it is not really relevant, so we deleted the section of land use modelling; including the references.

Reviewer comment 5: P14: Essential factors...: In this section the authors give a detailed description of dispersion models and the calculation of emissions from traffic. It is not clear why the authors insist on including this in the manuscript. This is a technical aspect of the modelling approach. In addition, there are some errors in the text. In P14 the authors write “The roadway air dispersion models are usually used to estimate road traffic emission.” Dispersion models are USING emissions calculated by other models to calculate ambient pollution levels. It looks like the authors are confusing “traffic emissions” which is the emissions of primary air pollutants from the vehicle’s exhaust and other related sources (tire ware, etc.) with “traffic-related air pollution” which are the measured levels of ambient air pollution attributed to traffic sources.

Response to comment 5: One of the authors (E. S.) has a preference for theoretical modelling, and likes to see the relationship between various parameters. However, based on the reviewer’s repeated suggestion, we see the point and have deleted these parts.

The confusion of the ‘traffic emissions’ and ‘traffic-related air pollution’ has been distinguished here and through the manuscript.

1.2 Minor Essential Revisions

Reviewer comment 1: P3 Background, first paragraph: change “Traffic-related air pollution on health has diverse impacts...” to “Traffic-related air pollution may have diverse impacts on health”

Response to comment 3: Done

Reviewer comment 2: P3 Background, first paragraph: I would suggest citing just one source that summarizes the health effects of air pollution instead of giving 20(!) sources. I would also consider removing the second paragraph.

Response to comment 2: As reviewer suggested, we only cited one reference (i.e., HEI, Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects, Special report 17, January 2010) which summarized the health effects of traffic-related air pollution, and removed original 20 individual references.

We did not remove the second paragraph, but we did revised it and integrated it with first paragraph as one complete paragraph, to make our point as follows: (a) traffic can have health effects; (2) an exposure zone within a range of up to 300 to 500 m from a major road as the area most highly affected by traffic emissions and large number of people residing within 100 m of major roads; (3) certain percent of air pollutants, e.g., NOx and PM are from roadways; (4) car drivers are highly exposed to the airborne pollution; and (5) children are most vulnerable groups and huge amount of children suffer health problems caused by traffic-related air pollution.

Reviewer comment 3: P7: “There are several companies providing individual trajectory mobile phone based traffic monitoring services including...” Not all of these companies provide traffic data. I know TrendIT and AirSage do not.

Response to comment 3: We have rechecked the listed companies and removed the companies that do not provide traffic data.
Reviewer comment 4: Methods: Trajectory mapping by mobile phones: It is not clear from the text if the calculation time of 2 minutes for 1 hour trajectory is for the entire population (and if so, how many trajectories) or for a single mobile phone. If this is for a single phone, then it makes the calculation impractical.

Response to comment 4: We clarified in the manuscript that it is one individual’s 1 hour trajectory that takes two minutes to calculate.

At first sight we thought this was not only impractical, but rather impossible to use for population wide studies. However, there are ways to use one person’s data for more than one person to reduce computation. In principle it is enough to have the accurate speed of one person per road segment with say hundred vehicles and not at all times, but say every ten minutes and look up the speed of all other persons at the same segment the next ten minutes. Some traffic companies calculate their traffic jam maps by using a few persons at each segment. We think that it would be too technical to go into the details on this in this manuscript. We have written another more technical manuscript that describes this in mathematical detail.

Reviewer comment 5: Methods: Pollution monitoring using stationary sites: The paragraph starts with one sentence about stationary monitoring sites and then continues to discuss the use of satellite born air quality measurements to complement ground measurements. The authors should first describe how they envision the use of ground monitoring for this application, particularly as they suggest later in the manuscript that air quality models will be used. The authors should also address the limitations of monitoring networks, i.e., mainly the scarcity of sites in most cities and possibly other limitations (reporting hourly averages, possibly not at real time in some regions, etc.). As a possible complementing source of information remote sensing can then be discussed. While satellite measurements have many advantages and are developing rapidly, they do have some major limitations, particularly when considering intra-urban resolution. These are not mentioned in the manuscript.

Response to comment 5: The paragraph has been revised as reviewer suggested. We first described how we envision the use of ground monitoring for this application. Then we discussed the limitation of ground monitoring networks and how these limitations can be complemented by satellite observations.

Reviewer comment 6: P16 as reference to “UC Berkley Mobile Millennium project” the authors make reference to Google Maps.

Response to comment 6: The reference has been corrected. The correct reference number is 46.

Reviewer comment 7: P19 second alternative approach: The authors suggest using air quality monitoring network data (regulatory monitoring network) to assign exposures to individuals. However there is a stage missing here of interpolation the point measurements of the monitoring sites to a 3 dimensional field of pollution levels (including time as third dimension). In fact, this is exactly geo-statistical interpolation mentioned earlier as one alternative for exposure models. So the only true alternative the authors are suggesting is the use of the smart phones’ GPS instead of triangulation of the GSM signal.

Response to comment 7: We agree with the first part that the second approach uses stationary monitoring together with geo-statistics. It is true that we mentioned alternative (2) earlier in the article, but we did not put much emphasis on this approach in the article. Therefore we discuss alternative (2) as a separate alternative. We discussed alternative (2), but do not recommend it due to the high investment cost in establishing a high density monitoring network covering the entire road network (need to be placed at the road where the pollution levels are the highest).

Note that alternative (1) is relying on pollution micro sensors that can either be integrated in a smart phone or used as a separate device. Therefore the main difference between the base case in this article and alternative (1) is that alternative (1) measures the pollutants while our base case calculates it. We suggest using the lowest battery power by using mobile phone base station data (also applicable for GSM), but GPS can also be used.

To clarify we added a table that compare the three alternatives.

Reviewer comment 8: P19-20. With respect to the costs, the authors claim that the use of the smart phone’s GPS will be much higher when applied to “society-wide population scale studies”. I do not understand this argument. Most smart phones have GPS embedded in them, so the same smart phone that the authors suggest using for trajectory mapping can be used for collecting GPS data. The only price to pay is the much higher power consumption of the battery when using GPS. A statement like “One needs to multiply this cost by the size of the population. Thus the cost of a population wide citizen’s observatory is of the same order as the cost of the entire mobile phone and micro-sensor industry. This is not economically feasible.” is an exaggeration.
Response to comment 8: We think the reviewer misunderstands. The point in the discussion is not GPS versus GSM. The discussion is to compare using carried personal environmental micro sensors versus calculating pollution. Assuming that the micro sensor package including GPS (or the micro sensor integrated in the smart phone and use the smart phone GPS) cost approximately the same as a new smart phone makes the cost infeasible for population wide studies. Nobody would sponsor an environmental micro sensor package that may cost as much as a smart phone to each individual in the population. We made our point on cost in the new table, and therefore deleted the whole paragraph discussing the additional cost as that paragraph was confusing.

1.3 Discretionary Revisions

Reviewer comment 1: The list of references is unnecessarily long. I would suggest that the authors focus of a shorter list of highly relevant publications. See more detailed examples above.

Response to comment 1: The unnecessary references have been removed, and only keep the highly relevant publications as reviewer suggested. The total number of the reference has been reduced from 139 to 98.

Reviewer comment 2: Reference #49: please provide a full reference

Response to comment 2: The full reference has been provided, see reference No. 25.

Reviewer comment 3: Reference #50: please provide a full reference

Response to comment 3: The full reference has been provided, see reference No. 26.

Conclusion

By following the reviewer’s comments and the consequent revised the article that we believe we have addressed reviewer’s concerns. We hope that you find the paper acceptable for publishing in the Environmental Health journal.

Sincerely,

Hai-Ying Liu