

## ***Interactive comment on “Cost effective determination of vehicle emission factors using on-road measurements” by N. Hudda et al.***

**Anonymous Referee #1**

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This is an interesting paper presenting average emission factors of light duty and heavy duty vehicles in the LA region by measuring in-freeway pollutant concentrations. The method is indeed a cost-effective method as the authors suggest. However, there are some significant limitations with such an approach, which are not at all discussed by the authors. The main ones are:

1. Equation 1 requires a 'background' level of concentrations so that concentration incremental increases on the roadway are calculated. Therefore, the whole calculation is very sensitive to the background concentration selected. The authors should: (i) discuss how background concentrations were determined in each location, (ii) estimate the uncertainty in the background concentration, and (iii) estimate the uncertainty that this induces on the emission factor calculation.

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2. Equation S.1 is critical in the calculation. It basically assumes that the ratio of pollutant over CO<sub>2</sub> concentrations for gasoline vehicles remains constant in all freeways measured. The corresponding diesel ratios are then estimated using this assumption. However, it is well known that pollutant over CO<sub>2</sub> ratios substantially differ for gasoline vehicles depending on the driving conditions. For example, 20-fold CO/CO<sub>2</sub> ratios can be observed for different VSPs (EPA - Methodology for Developing Modal Emission Rates for EPA's Multi-Scale Motor Vehicle and Equipment Emission System, p.69). Similarly, the authors have measured significant differences in these ratios over the 110 freeway. Hence, it cannot be unanimously assumed that the average P/CO<sub>2</sub> ratio over the 110 freeway holds for all other freeways/times of day/driving conditions. Ideally, the authors should estimate the contribution of the uncertainty in the P/CO<sub>2</sub> ratio to the uncertainty of the emission factors calculated. At a minimum this should be clearly identified as a limitation to the study.

3. Freeway emission rates have been calculated per mile of freeway and unit time, using constant fuel economy values which represent the average fuel economy in the LA region. Fuel economy may substantially differ according to driving conditions, hence this value is far from constant per mileage driven on freeways. Similarly to point #2 above, the impact of this on emission factor uncertainty should be estimated or at minimum be clearly discussed. This is particularly true to the diurnal emission rate variation (section 3.4.1).

I would suggest that all these are discussed on a separate (new) section of this paper.

The authors report that the study average EFs are generally in good agreement with recent studies, which are assumed to be shown in Table 1 (l.227-8). I have a number of questions on Table 1:

1. I see no emission factors for other studies in Table 1.
2. The average values shown seem rather inconsistent with the distribution statistics. For example, average CO of 39 g/kg fuel and median of 89 g/kg fuel. Do the authors

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confirm these large differences?

3. What does the variability range shown for the g/kg-fuel values express? Is it standard deviation? In any case, this is a huge variability, even without taking into account the uncertainties discussed in the previous points. Some discussion on the sources and reasons for this variability should be given.

4. Despite this, the distance-based emission factors are given in Table 1 without any variability. This is inconsistent and has to be corrected.

The discussion in lines 253 to 262 (HDV Fleet EFs . . .only lower emissions by 20%) is not at all understood. First, I do not see substantial evidence from Fig. 2 that NO<sub>x</sub>/NO is much closest to normal distribution than BC. If this is indeed the case, the relevant statistics (e.g. goodness of fit) should be presented to support the argument. Second, the authors make the implicit assumption that the frequency of observation (and not 'fraction of observation' as erroneously stated in Fig. 8 and 9) is equal to the frequency of high emitters. However, the authors do not monitor individual vehicles but individual road sections. Hence, high emissions are not delivered by individual vehicles but by individual driving conditions.

The authors imply in section 3.3 that a different HDV mix operates on I-710 than other freeways, mostly composed of newer vehicles. If this is the case, then this should be reflected to an improvement in fuel economy as well. Hence, retaining the original LA-wide fuel economy for HDVs also on I-710 introduces a bias to average emission rates estimated in section 3.4.2. Can the authors estimate its impact?

Minor points l.268: "2012" not "2102" l.182.: No "Ban-Weiss et al. 2008" reference included in the references list. Is it the 2008 or the 2009 paper the authors refer to?  
l.300: Correct syntax

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