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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Carbonaceous aerosols at urban influenced sites in Norway" *by* K. E. Yttri et al.

K. E. Yttri et al.

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Reply to referee #2

We would like to thank the reviewer for the positive comments made to our manuscript and for the effort made to clarify and improve its content.

1. Title: urban influenced sites in Norway - this does not seem to be correct English. Suggestion: sites influenced by urban emissions or urban areas

Answer: The title as been changed to: Carbonaceous aerosols in Norwegian urban areas

2. Abstract: the last sentence should be clarified

Answer: We are not quite sure what part of the sentence needs clarification. However,

we have attempted to make the sentence more easily understandable by condensing it: Particulate carbonaceous material (PCM = Organic matter + Elemental matter) accounted for 46-83 % of PM10 at the sites studied, thus being the major fraction.

3. I suggest including a few central parameters of the EC/OC analysis method e.g. split temperatures.

Answer: The following section has been included: In brief, the temperature is raised in four steps in mode 1, terminating at 850 C (Step 1: 220 C for 60 sec., step 2: 360 C for 60 sec., step 3: 525 C for 60 sec. and step 4: 850 C for 90 sec.). During the second mode, the temperature is lowered to 550 C before it is raised to 890 C in seven steps (Step 1: 550 C for 30 sec., step 2: 650 C for 30 sec., step 3: 720 C for 30 sec., step 4: 790 C for 40 sec., step 5: 820 C for 30 sec., step 6: 860 C for 20 sec. and step 7: 890 C for 40 sec.). An EC/TC ratio of 22.7 +- 2.1 % (Mean +- 2 SD) (n = 3) was ...

4. Why is potassium written with capital P?

Answer: We have changed from capital P to minor p in potassium.

5. P19495 line 18: Subraminian et al. (2004) has been changed to Subramanian et al. (2004)

6. P19497 line 1: The word favorable has been changed to stagnant

7. P19497 line 6: Hard to compare. It is unclear what the authors mean. Please add a few more details to clarify why such measurements should not be compared

Answer: The difficulties of comparing EC/OC data generated from different types of analytical instruments have been stated in the introductory part of the paper: Although these definitions (EC and OC) have certain advantages, the quality of such data is affected by the use of sampling procedures and analytical techniques that fail to account for significant artefacts. Based on the request made by the referee we have extended the text to clarify this topic further:

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The wide range of analytical methods used to quantify EC and OC in different studies generate data that are hard to compare. This can be attributed to the fact that they operate according to different temperature protocols and that some fail to account for substantial artifacts such as charring of OC.

8. P 19499 line 3: It is not clear what the authors mean by the sentence: However, the source-reconciliation used by Hedberg et al. (2006) had a missing mass of 2.8 ug m-3, almost comparable with the identified PMwood of 3.01 ug m-3, so the real ratio may be closer to 20 %. Please add more information to support the statement.

Answer: The following sentence has been included to clear the statement:

However, the multivariate source-reconciliation used by Hedberg et al. (2006) accounted for only 61% of the measured PM2.5. The discrepancy was 2.8 μg m-3, which is almost comparable with the identified PMwood concentration of 3.01 μg m-3. Hedberg et al. (2006) discuseds some possible reasons for this discrepancy (e.g. TEOM conversion factors), but if all of the missing mass was associated with wood-burning, then the levoglucosan/OC ratio would be close to 20%.

9. P 19500: Was least squares orthogonal regression used for these calculations? Please clarify.

Answer: We have used ordinary least-square regression (OLS), not orthogonal regression (OR). We are aware of the fact that OLS assumes zero error in the dependent (x) variable, which is certainly not the case for atmospheric measurements, but we have preferred OLS for two main reasons: (1) the use of OR requires that we know the errors in both x and y reasonably well, but for compounds such as EC it is actually very difficult to establish such errors, and both systematic and random errors could be expected; (2) we wish to use the y/x ratios obtained at Elverum in our further analysis for other sites, but this further analysis involves use of similar instruments and experimental procedures. Thus, at least some of the uncertainties inherent in the x-values at Elverum should also be present in any related x-values at other sites. For example, we

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wish to use measured levoglucosan (LG) as a predictor of TC, and are assuming that the errors in the LG (x) variable associated with our regression will be similar across our different applications. In addition, the correlation coefficients found with the simple OLS method are quite high, ranging from R2 = 0.8 to 1.0, or R from 0.89 to 1.0. If we take Cantrell's (2007) rule-of-thumb that the fractional error in the slope derived using OLS is about 1-|R|, then this fractional error would range from 11% (for R2 = 0.8) to zero (for R2 = 1.0). Finally, we can note that the difficulties of determining the exact slope of such regressions is the main reason why we chose to adopt the rather wide range of slopes as illustrated in Figure 5. Although there are certainly uncertainties in the central value, our findings are robust to this wide-range of allowed slopes. Rather than using space to discuss all of the above points, we have added the following text: Given the difficulties of establishing the true errors in our x-values in these regressions, and the fact that we wish to transfer relations obtained in Elverum to other sites using similar experimental procedures, we have used simple least-square regression rather than any bivariate method. The high correlations we obtain provide support for using this simple procedure (e.g. Cantrell, 2007), and in case we will allow for a wide-range of uncertainty in the slope-values obtained, as illustrated in Fig. 5.

Reference included: Cantrell, C. A. Technical Note: Review of methods for linear least-squares fitting of data and application to atmospheric chemistry problems Atmos. Chem. and Phys., 2008, 8, 5477-5487.

10. 19500 line 5-7 : The sentence should be clarified. Especially the wording if anything is unclear.

Answer: We still prefer to use the term if anything, as it is a good qualifier since we think that any overestimate is likely small. Nevertheless, we have expanded the sentence slightly:

As it seems likely that the curbside site would give if anything an overestimate of the OCp/EC ratio from traffic emissions (since any non-traffic sources likely contribute more

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OC than EC), the amount of OCp we can attribute to traffic at Elverum is small even if all EC was assumed to be from traffic.

11. 19500 line 11 : Could this good relationship be due to the contribution of particles with diameters $<$ 2.5 micrometres to PM10? Answer: This sentence refers to the good relation between LG and TCp for both size fractions. As PM2.5 is 77% of PM10 at Elverum (Table 4) for both OCp and TCp, we would have expected a coarse fraction (23%) associated with non-wood-burning sources to cause a positive intercept when plotted against levoglucosan. The lack of intercept does suggest that this coarse fraction is associated with wood-burning. We have modified the text slightly to make this clearer:

Figure 5 and Table 5 show a rather good correlation between levoglucosan and TCp for both PM size fractions. The intercept of the least-square fit (TCp versus LG) is slightly negative on the TCp axis, implying that the changes in levoglucosan alone are more than sufficient to explain the variations in TCp. The very good relationship for the PM10 fraction is somewhat surprising, since Yttri et al. (2005) have shown previously that about 95% of levoglucosan is found in the PM2.5 fraction. As the fine fraction accounts for 77% of TCp (Table 4), much of the high correlation will be due to this fraction. However, the negative intercept also suggests that the coarse fraction (23% of TCp) also varies with the levogluocsan level. These results would suggest that some of the factors mentioned in Sect. 3.1 (i.e. agglomeration of fine OC followed by resuspension, or condensation of OC to the coarse mode) could play a role in associating coarse OC with wood-burning.

12. P19501 line 18: Kerbside -$>$ Curbside

Answer: Kerbside has been changed to curbside.

13. P19502 line 8: Add a reference to Table 5 here.

Answer: A reference to Table 5 has been made.

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14. Conclusion line 1: It is shown ... Please use a more general term or in the present study. The last sentence is not clear what corresponds to 6.7%?

Answer: We have rephrased the sentence based on the request of the referee:

In the present study we have shown that particulate carbonaceous material (PCM) is the major (46-83% of PM10) contributor to PM10 in the urban environment regardless of site classification and despite that the calculations are based on conservative estimates of particulate organic carbon (OCp).

Answer: 6.7% is the inverse of the OCp/LG ratio expressed in terms of percentage. We have extended the original sentence to clarify this:

This corresponds to a 6.7% contribution of levoglucosan to OCp in PM10 and a 8.9% contribution of levoglucosan to OCp in PM2.5.

15. Tables 1 and 3 are too small to read Answer: We agree that the content in tables 1 and 3 are small in the printed version. However, another referee requested that some tables were merged. In the final version of the paper it might be an option to present these tables, in particular Table 3, in landscape format. However, we leave this to the editorial/production office to decide.

16. Table 2: Include a sentence describing OC-B and OC-FF (as p 19494 line 20) since these abbreviations may not be familiar to most readers.

Answer: The following sentence has been included in the Table 2 caption: OCB is gaseous OC present on the backup filter and OCFF is the sum of gaseous and particulate OC on the front filter.

17. Table 5: Please consider the number of decimals for slopes and intercepts. Is the uncertainty really this low? In addition the table is easier to read with fewer decimals.

Answer: We have reduced the number of decimals for the slope and intercept to two significant numbers.

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18. Figures 4 and 5 should be clearer and larger. Figure 5 caption: no intercpt-> no intercept .

Answer: Regarding increasing the size of Figure 4 and 5, we leave this for the editorial/production office. If new files are request, we will of course provide these.

Answer: Intercpt has been changed to intercept

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 19487, 2008.