Atmos. Chem. Phys. Discuss., 7, S4090–S4096, 2007
www.atmos-chem-phys-discuss.net/7/S4090/2007/

Atmospheric
Chemistry
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Discussions

Interactive comment on “Ambient aerosol concentrations of sugars and sugar-alcohols at four different sites in Norway” *by* K. E. Yttri et al.

K. E. Yttri et al.

Received and published: 16 August 2007

Response to specific comments made by referee “Anonymous”:

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. It is a pity that different sampling methodologies and sampling protocols were used for the sampling of aerosols in different locations because this makes more difficult a correct interpretation of data.

Replay: We can nothing but agree to this statement. That is also why we have stated this fact rather explicitly in the manuscript (See section 3.1).

2. Page 5771, line 12-27 - The aim of the discussion about di-carboxilic acids, highly oxygenated compounds and HULIS is not evident, in the context of the paper. Only in

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the next paragraph it is understandable that through the crossing of data from previous surveys and source analysis data carbohydrates are possibility of importance in the OC mass balance. Even in this context, the purpose of the reference to DCAs is still not clear.

Replay: The purpose of including information on the constituents of the WSOC fraction, which includes the DCA, is to provide background information of this fraction, and to show that there is a significant fraction which is not accounted for and which could be attributed to the presence of sugars and sugar alcohols (tracers of PBAP). As stated by the other referee, this section acts as a review on the various classes of organic compounds that contribute to the hydrophilic properties of the ambient aerosol.

3. Page 5771, line 8 - Falcovich

Replay: Falcovich have been corrected to “Falkovich”.

4. Page 5772, line 19 - it would be useful to refer the size range of “ambient aerosols” studied by Graham et al. (2003).

Replay: The referee’s request to include the size range of the “ambient aerosols” studied by Graham et al. (2003) has been met.

“In a recent work on primary biological aerosol particles (PBAP), Graham et al. (2003) make a thorough study in resolving the potential sources of both sugars and sugar-alcohols in fine and coarse ambient aerosols in the Amazon region.”

5. Page 5776, lines 23-27: Clarify the meaning of “shift towards higher particle diameters”. Are you referring to the true size cut-off the impaction plates or to the estimated mass size distribution, when using quartz filters as impaction surfaces? If available, give a relative value of cut-off changes and add a reference. Other authors use usually aluminium foil when sampling particulate carbon with Berner impactors because of the problems of correct cut-off impaction evaluation when quartz filters are employed as impaction surfaces (although aluminium surfaces hinder the possibility of pyrolisis

correction during thermal analysis of OC and EC).

Replay: The paragraph “It should be noted that obtaining size distributions of sugars and sugar-alcohols using quartz fibre filters may have some drawbacks, as they are somewhat thicker than polycarbonate, reducing the jet to plate distance. Along with the rough surface of the quartz fiber filters, this may influence the 50% cut-off size of the impactor stages, leading to a shift towards higher particle diameters.” has been clarified according to the request by the referee.

“It should be noted that obtaining size distributions of sugars and sugar-alcohols using quartz fibre filters may have some drawbacks, as they are somewhat thicker than polycarbonate, reducing the jet to plate distance. Along with the rough surface of the quartz fiber filters, this may influence the 50% cut-off size of the impactor stages, leading to an increased collection efficiency of fine aerosols on impaction stages meant for collection of coarser aerosols. This will in turn lead to a mass size distribution that is shifted towards larger diameters for sugars and sugar-alcohols.

Replay: The referee asks us to give a relative value of cut-off changes and to add a reference of such if available. Unfortunately, this is not available.

Replay: The referee states that other studies tend to use aluminum foil when sampling particulate carbon with Berner impactors because of the problems of correct cut-off impaction evaluation when quartz filters are employed as impaction surfaces. The reason why we did not use aluminum foil or polycarbonate for our subsequent analysis of sugars and sugar-alcohols, is that we wanted to perform Thermal-Optical Analysis (TOA) of the size segregated samples as well. As stated by the referee, it is possible to quantify EC and OC on aluminum foil, however then it will not be possible to use the pyrolysis correction of the TOA instrument, which was one of our goals when quantifying EC and OC in these size segregated samples.

6. Page 5776, Section 2.3 - Give a short explanation of how WINSOC was calculated and refer to possible loss of particles during the water extraction of WSOC.

Replay: The WSOC fraction was quantified indirectly by means of the remaining OC (=WINSOC) left on a 1.5 cm2 filter punch after extracting with Milli-Q water (100 ml). The WSOC-extraction is based on gravity feed of water through the exposed filter punch. To prevent loss of carbonaceous material that is not water-soluble and to keep the EC uniformly distributed, a supporting filter punch (1.5 cm2) is placed on top of the exposed punch during extraction. After extraction, and prior to analysis, the filter punches are left to dry in a desiccator. The reproducibility of the WSOC measurements, including aliquot preparation, extraction procedure and instrument variability, was found to be satisfactory (RSD $<$ 8%).

With respect to possible loss of particles during the extraction of WSOC, it cannot be excluded that also some constituents that are not water-soluble could have been removed during WSOC extraction.

The following sentence has been added to section 2.3 to explain how WINSOC was calculated:

“The WSOC fraction was quantified indirectly (Eq 1.) by means of the remaining OC (=WINSOC) left on the 1.5 cm2 filter punch after extracting with Milli-Q water (100 ml).”

In addition the following sentence have been added based on the request of the author:

“It cannot be excluded that also some constituents that are not water-soluble could have been removed during WSOC extraction.”

With respect to loss of EC during water extraction more extensive data could be provided if the referee finds it necessary.

7. Page 5780, lines 1-4. It is not clear nor evident that it is re-suspension of PBAP (as result of turbulence by vehicular traffic) the main cause of the predominant presence of sugars in coarse particles at the kerbside site. The levels of coarse sugars and some sugar alcohols (taken from Tables 2 and 3) are not higher at the kerbside by comparison with the urban background Oslo sites, as they should be if traffic re-suspension was so

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important.

Replay: By looking at Table 5 you will find that the PM2.5/PM10 ratio for six of the seven sugars and sugar alcohols are lower at the curbside site compared to the urban background site. For fructose the PM2.5/PM10 ratio is the same at the two sites. Thus, the relative abundance of sugars and sugar alcohols in the coarse fraction is higher at the kerbside site compared to the urban background site. In the text we only suggest that resuspension caused by vehicular traffic could be a source at the kerbside site. However, we find it in place to rephrase the sentence so that it doesn't seem like it is the dominant source. Further, the referee indicates that the difference between the two sites should be larger if traffic induced resuspension was that important. We do not disagree with this statement, but we find it hard to estimate how much greater the difference should be. On the other hand, as most of the sugars and sugar alcohols appear to be in the coarse fraction in the first place, the additional contribution following from agglomeration of fine sugar and sugar-alcohol containing particles to coarser particles on the ground doesn't necessarily add that much, hence the difference between the kerbside site and the urban background site isn't necessarily that pronounced.

“Only 5-10% of the sugars and sugar-alcohols could be attributed to PM2.5 at the curbside site, when not accounting for inositol. We suggest that resuspension of PBAP promoted by turbulence from vehicular traffic could be a possible reason why so much PBAP was found in the coarse fraction at this highly trafficked site.”

8. Page 5780, line 5 - A concentration of 45ng/m3 for levoglucosan is referred, in order to explain that some of the sugars measured at the Kerbside site could possibly originate from wood burning. It is expected that ambient air masses impacted by residential wood burning exhibit concentrations in the range of hundreds of ng/m3 for PM10. The concentration referred is probably due to open biomass burning, more likely to occur at the time of the year at which sampling took place (end of spring, beginning of autumn). Being the levoglucosan level so low, and keeping in mind that primary sugars are a very minor group of compounds emitted by biomass burning, in relation to levoglucosan, it

does seem not evident from these data that biomass burning contributed significantly to the observed primary sugars levels.

Replay: In section 3.1 we stated that: “Although combustion of cellulose and hemicellulose, which are the major constituents of wood, primarily favours monosaccharide anhydride formation (Sanders et al., 2002), monomeric and dimeric sugars are emitted as well (Nolte et al., 2001). Thus, concurrent measurement of monosaccharide anhydrides is important to sort out non-PBAP sources of fine sugars. Thus, our purpose of adding levoglucosan analysis to the dataset is that this could aid us in the origin of sugars/sugar-alcohols. I.e.; if no levoglucosan is present in a fine aerosol filter sample, that would be a fairly good indication that the sugars/sugar-alcohols in the sample did not originate from biomass/wood burning, but rather from PBAP. On the other hand, when levoglucosan is present in a sample it cannot be excluded that some the fine sugars/sugar alcohols originates from biomass/wood burning and not PBAP.

We agree with the statements made by the referee that the low levels of levoglucosan indicate that only a minor part of the fine sugars and sugar alcohols are likely to originate from biomass/wood burning. Thus we have rephrased the sentence in order to include this.

“The mean concentration of levoglucosan at the curbside site was 45 ng m-3, which indicates that only a minor part of the fine aerosol content of sugars could be attributed to wood burning.”

9. Replay: “is present” has been changes to “are present”, as requested.

10. Table 4 - Not clear or explained why monosaccharide anhydrides were only analysed in PM10 particles, while the other poly-hydroxyl compounds were measured in both PM2.5 and PM10 size ranges.

Replay: As stated in bullet point number eight, the purpose of quantifying levoglucosan was to aid us regarding the origin of the sugars/sugar-alcohols, and for this purpose we don’t need to measure in both PM10 and PM2.5. Further, it is fairly well documented that emissions of levoglucosan is predominantly associated with fine aerosols, thus measuring in the PM10 fraction we are sure to include all levoglucosan, even that which occasionally is found in the coarse fraction of PM10.

11. Table 6b - Clarify if the values are corrected for polar VOC adsorption on the filter, or not.

Replay: The WSOC fraction was not corrected for polar VOC adsorption on the filter. This has been included in the table text of Table 6b.

“Table 6b. Mean (min-max) relative contribution the carbon content of sugars and sugar-alcohols to the non-corrected water-soluble organic carbon (WSOC) fraction of PM10 (%).”

12. Figure 3 - Make the different lines representing the variability of concentrations more clearly distinguishable.

Replay: Has been done.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 5769, 2007.