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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantifying black carbon from biomass burning by means of levoglucosan – a one year time series at the Arctic observatory Zeppelin" *by* K. E. Yttri et al.

Anonymous Referee #1

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This study describes the results of 1 year of filter sampling carried out at the Zeppelin Observatory. The focus is on apportioning the fraction of black carbon from biomass burning (agricultural/wildfires and residential burning). Levoglucosan was measured, and is the method used to estimate the black carbon fraction from biomass burning. The dataset is extensive, and the results are quite novel, owing to the unique measurement location. The observation that biomass burning emissions from northern Russia are likely strongly underestimated is an important finding. The paper is well organized and well written. I recommend it for publication in ACP after the following issues are addressed.

Overall Issues:

The biggest problem with the study is the emission ratios used to calculate the fraction of elemental carbon from biomass burning (Table 2). For both residential wood burning and wild/agricultural fires, I think the variability is much, much greater than that represented in Table 2. For example, the emission ratios for wild/agricultural fires come from the study by Saarikoski et al. (2007), in which wild fires burning primarily in western Russia impacted Helsinki after undergoing long range transport (at least several hundred km); thus, it is likely that levoglucosan had undergone some degradation during transport. Further, this was a single event, lasting 12 days. Numerous studies (i.e., McMeeking et al. (2009); Sullivan et al. (2008)) show enormous variability in levoglucosan, OC, and BC emission factors from different biofuels and under different burning conditions. It is highly probable that wild/agricultural burning of many different fuel types from different regions impacted the measurements across an entire year.

Similarly, the emission ratios used for residential wood burning from Yttri et al. (2009; 2011) are representative of the fuels and appliances in Norway. However, it is likely that residential burning from other areas (esp. northern Russia) had as much or more impact on the measurements over the course of the study. Heringa et al. (2011) show that the technology (appliance) and fuel can result in BC emission factors that vary by more than an order of magnitude in residential wood combustion.

All of this is to say that I think the uncertainty associated with the employed emission ratios has been greatly understated. This uncertainty is briefly discussed (pg. 31982), but it is not discussed at all in relation to interpretations of the results. The data from the study actually seem to support this point. First, could the employed emission ratios impact the apparent underprediction of residential burning emissions from northern Russia during winter? Second, during the Jan-Feb-March sampling, levoglucosan appears to be very well correlated with EBC (though with the resolution on Fig. 2 it is a little hard to tell). Nevertheless, it is surprising to see this level of structure in both traces, and yet the apportionment method only estimates 9-45

The uncertainty in using these emission ratios needs to be clearly discussed in relation to the interpretation of the results.

Specific Issues:

Pg. 31972, line 2: ". . .to remove insoluble PM and filter parts."

Pg. 31983, line 17-18: This finding could indicate something about the lifetime of levoglucosan. But what if the assumed levoglucosan and BC emission ratios were off during this period (see above comment)? That could greatly impact the interpretation of the findings as well.

For the model-measurement comparisons and discussion, a scatter plot would greatly help. As it is, the resolution in Fig. 2 makes it very hard to compare.

Figure 5 (the only figure that plots the ECbb/ECB ratio) shows the values assuming no degradation of levoglucosan (monthly mean values of only 2-16

References:

Herenga, M. F., et al. (2011), Investigations of primary and secondary particulate matter of different wood combustion appliances with a high-resolution time-of-flight aerosol mass spectrometer, *Atmos. Chem. Phys.*, **11**, 5945-5957.

McMeeking, G. R., et al. (2009), Emissions of trace gases and aerosols during the open combustion of biomass in the laboratory, *Journal of Geophysical Research*, **114**, D19210, doi:10.1029/2009JD011836.

Saarikoski, S., et al. (2007), Chemical composition of aerosols during a major biomass burning episode over northern Europe in spring 2006: Experimental and modelling assessments, *Atmospheric Environment*, **41**, 3577-3589.

Sullivan, A. P., et al. (2008), A method for smoke marker measurements and its potential application for determining the contribution of biomass burning from wildfires and prescribed fires to ambient PM2.5 organic carbon, *Journal of Geophysical Research*,

113, D22302, doi:10.1029/2008JD010116.

Yttri, K. E., et al. (2009), Carbonaceous aerosols in Norwegian urban areas, *Atmos. Chem. Phys.*, **9**, 2007-2020.

Yttri, K. E., et al. (2011), Source apportionment of the carbonaceous aerosol in Norway – quantitative estimates based on 14C, thermal-optical and organic tracer analysis, *Atmos. Chem. Phys.*, **11**, 9375-9394.

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