

## **Comments to referee#1 on the paper: “Organic molecular markers and signature from wood combustion particles in winter ambient aerosols: Aerosol mass spectrometer (AMS) and high time-resolved GC-MS measurements in Augsburg, Germany”**

The authors thank the referee for carefully reading the manuscript, the advice and suggestions. We will change all “specific comments” directly in the manuscript text. The other comments of the referee regarding the wish to argue the following issues more deeply will be discussed on the following pages.

### **1) The contribution of HOA to total OM is very significant compared to most of previous studies in urban environment. Due to heavy traffic?**

The referee is correct. However, we think that the contribution of HOA to total OM is rather due to the general traffic surrounding the measurement site. The measurement site is located next to the old city centre in the south-east, but it the site still remains in the city. The city centre itself is surrounded by residential areas and also some industrial areas. Next to the measurement site there is also a residential area, as well as the city circle motorway which surrounds the city centre. The city circle motorway is approximately 120 meters away from the site. This could be the reason for the comparatively high contribution of HOA.

We therefore agree with the referee and will provide more information in the manuscript about the location of the measurement site and a discussion of how this is a reason for of the high HOA impact.

We will enter the following sentence in section 2.1 of the manuscript:

“The measurement site... is located at the University of Applied Sciences in Augsburg (48.3581 latitude; 10.9070 longitude), around 1 km south southeast of the city centre. The city centre is surrounded by compact residential areas and some industrial districts. Significant impact of traffic next to this site may be caused by the city circle motorway (approx. 120 m) and the tram headquarter (approx. 50 m).”

and in section 3.2 of the manuscript the following sentence:

“The high content of HOA, compared to other studies, is probably due to the surroundings of the measurement site with the city circle motorway and some main route of the city being close by.”

### **2) the morning peak of AMS-derived wood burning contribution is in good agreement with previous wintertime studies using AMS (and multiwavelength aethalometers) but not with GC-MS analysis. How could this latter phenomenon be explained?**

In older unpublished studies carried out in Augsburg, we also could not detect a morning peak when applying time resolved sampling followed by GC-MS measurement of levoglucosan. This could be the due to the fact that the levoglucosan to OC, EC or OM ratio changes depending on the combustion conditions, for example under good combustion conditions (good oxygen supply, high

burning temperatures) the levoglucosan to EC ratio is generally lower than under burning conditions with relative air deficiency and lower combustion temperatures. We may assume that in the morning, when stove users are warming up their homes by wood combustion, the combustion conditions are better on average than in the evening times, when stove users tend to keep the fire alive for longer times and therefore often reduce the air supply. Additionally, the disagreement of the GC-MS analysis may also be attributed to the high impact of the AMS wood combustion results from m/z 60; however, other sources, like the HOA, could also have some impact on the m/z 60 signal. During periods with high HOA, the signal of m/z 60 could increase as well. In analyses carried out with GC-MS we quantified specific source compounds, which were not be affected by other sources and therefore no morning peak of levoglucosan probably was found. In this study we could not identify, together with the GC-MS results, the direct impact of traffic on our AMS WC results and neither the signal at m/z 60.

**3) As mentioned in introduction, WC emits a considerable amount of SOA precursors. In which extent could thus WC contributes (indirectly) more importantly to OM concentrations than seen by PMF on organic mass spectra?**

The OOA is associated with SOA, for example the high correlation of OOA with secondary inorganic aerosol marker sulphate. SOA is a fraction of the OOA, but in addition, OOA includes aged and thereby oxidized POA. As the four factor PMF solution indicates, some parts of the OOA could come from WC. For example, Heringa et al. (2011) showed that WC gas phase compounds (Hawthorne et al., 1989) could increase the SOA production. So far it has not been possible to estimate the impact of WC gas phase on OOA/SOA product. The discussion on this topic will be added to the manuscript as follows:

“The contribution of OOA to total organic matter is approximately 55% in the periods of high PM concentrations and approximately 25% in the warm and humid periods. As it is indicated by the four-factor PMF solution, some parts of the OOA could come from WC. For example Heringa et al. 2011 showed that WC gas phase compounds (Hawthorne et al., 1989) could increase the SOA and the OOA production, respectively.”

**4) a probable, but not seen here using AMS and PMF, contribution of cooking emissions (cf. GC-MS dodecanoic acid peaks) might be in good accordance with recent studies in some other European cities (e.g. Allan et al., Atmos. Chem. Phys., 2010).**

Cooking emission is an interesting subject. We therefore looked at the AMS data and checked whether there is an increase in the signal at m/z 55 or an increase of the ratio of m/z 55 to 57 during lunch time and typical cooking hours. Mohr et al. (2012) found that an increase of the m/z 55 to 57 ratio is a robust marker for food cooking. Therefore, it can be concluded that there was no impact from food cooking detectable during this measurement period in the AMS data. The GC-MS analysis of dodecanoic acid provides a slight increase during lunch and afternoon hours, but we could not find a factor in the PMF analysis for food cooking in the AMS data and hence could

not establish a correlation from these data. We will provide a short discussion of the AMS food cooking results in the manuscript as follows:

“A possible food cooking factor has not been found in PMF analysis. Additionally, the AMS does not provide a high ratio of the m/z 55 and 57, which would be a robust marker for food cooking (Mohr et al., 2012).”

#### **Literature:**

Hawthorne, S. B., Krieger, M. S., Miller, D. J., and Mathiason, M. B.: Collection and Quantitation of Methoxylated Phenol Tracers for Atmospheric Pollution from Residential Wood Stoves, *Environ. Sci. Technol.*, 23, No. 4, 1989.

Heringa, M. F., DeCarlo, P. F., Chirico, R., Tritscher, T., Dommen, J., Weingartner, E., Richter, R., Wehrle G., Prévôt, A. S. H. and Baltensperger, U.: 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, doi:10.5194/acp-11-5945-2011, 2011.

Mohr, C., DeCarlo, P. F., Heringa, M. F., Chirico, R., Slowik, J. G., Richter, R., Reche, C., Alastuey, A., Querol, X., Seco, R., Peñuelas, J., Jiménez, J. L., Crippa, M., Zimmermann, R., Baltensperger, U., and Prévôt, A. S. H.: Identification and quantification of organic aerosol from cooking and other sources in Barcelona using aerosol mass spectrometer data, *Atmos. Chem. Phys.*, 12, 1649-1665, doi:10.5194/acp-12-1649-2012, 2012.