Response to the comments of anonymous referee #2

We thank the referee for the valuable comments which have greatly to helped us improve the manuscript. Please find below our responses (in black) after the referee comments (in blue). The changes in the revised manuscript are written in *italic*.

Specific comments:

a) In Figure 2a, time delay seems to exist between LABB1 and LABB2 and levoglucosan (C6H10O5) for peaks on 28-29 Jan. Also, in Figure 4a, LABB1 has a higher O:C and lower H:C compared to LABB2EESI. These might indicate LABB1 is more oxygenated. It could also originate from a different source from LABB2. How does the wind regression analysis for these factors show?

Concentrations of LABB2 are high only on three days, roughly corresponding to the $EVENT_{EESI}$ factor that we now associate with a local festival (the Zurich game festival, the event is held in a building on the SW side of the courtyard in which the instrument is deployed). As a result, the reviewer's suggestion of a different source is likely correct. This is further supported by wind regression analysis of these two factors, shown below and added to the supplement as Fig. S7. LABB1 does not correspond to a specific wind direction, consistent with local, widespread domestic wood combustion. In contrast, LABB2 originates predominantly from a single wind direction while the smaller source to the SE is on the third day.

The sentences are added to the manuscript (P13, L5-11): *"The wind regression analysis of these two factors are shown in Fig. S7. $LABB1_{EESI}$ does not correspond to a specific wind direction, in contrast, $LABB2_{EESI}$ originates predominantly from a single wind direction, excluding the smaller source to the SE on the third day."*

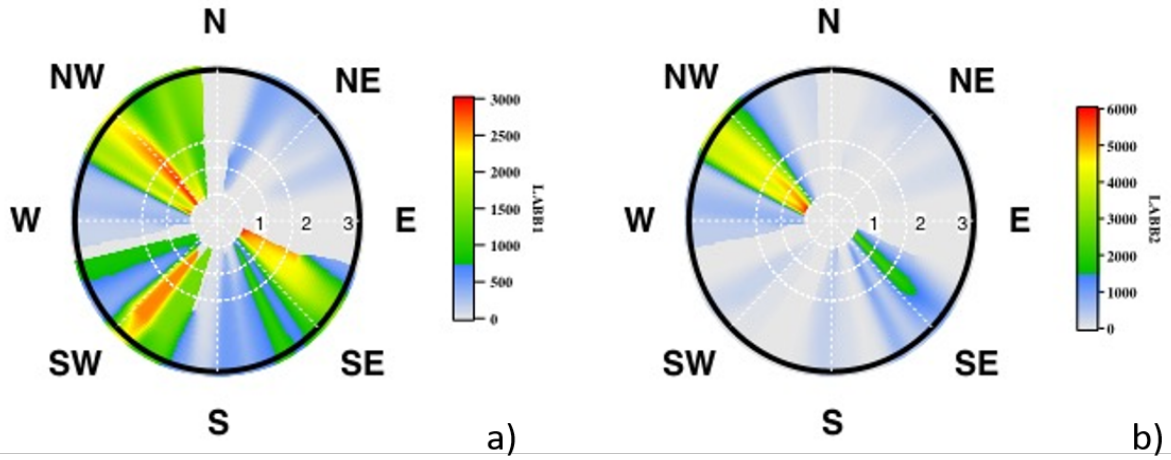


Fig. S7. Wind analysis results using the SWIM model on the concentrations of LABB1 (a) and LABB2 (b).

b) In the discussion of SOA factors (Pg. 15 Lns. 12-15), instead of a time series plot (Figure 6b), a diurnal plot will better show the daytime cycle of SOA2. Also, I am not sure what is the evidence of that both factors (SOA1 and SOA2) are associated with SOA as opposed to the OOA-AMS factors. If it is due to similarities of the SOA

factors mass spectra to the monoterpene-related factors (Pg. 15 Lns. 5-6), I think it is more convincing to compare (plot correlation) of the mass spectra.

This is a good point, we added diurnal plots of the EESI-TOF factors to the supplement (Fig. S6), shown below. We have also added a comparison of the SOAEESI mass spectra with the monoterpene-related SOA factor from the Zurich summer campaign as Fig. S9.

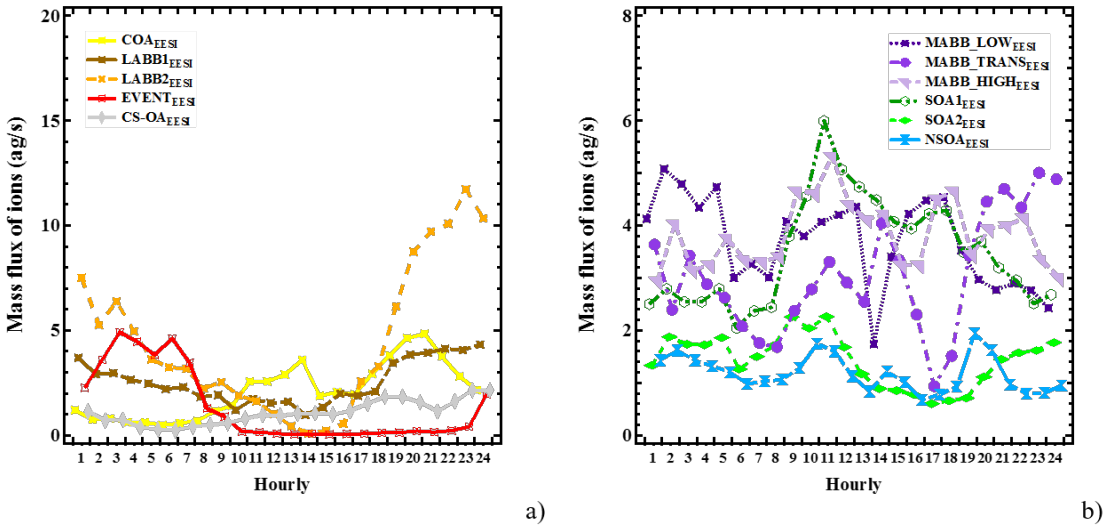
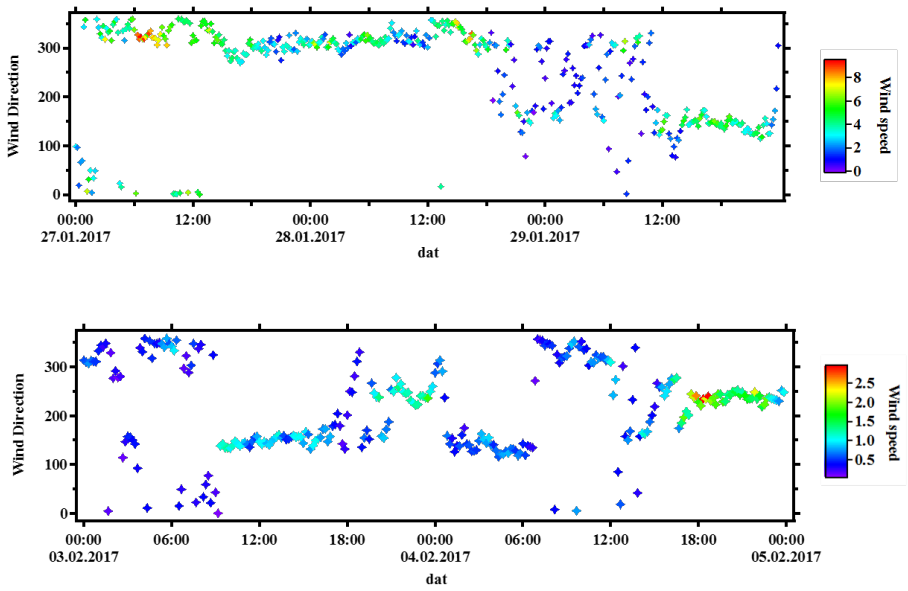


Fig. S6. The diurnal variation of EESI POA factors (a) and EESI SOA factors (b).

c) For the nitrogen-containing SOA factor, could the variability in time between the high peak at the night of 3-4 Feb and the small peak at the night of 28-29 Jan associated by a change in temperature, or was it caused by shifting of air masses? What the wind analysis or back-trajectory analysis suggest?

Yes, we agree with the comment, it is possible that the two nitrogen peaks are associated by a change in temperature. The temperature on 3-4 Feb was much higher than 28-29 Jan, but it was enhanced from 1 Feb. We assume the unique time series may also indicate other chemistry or emission process of the nitrogen-containing compounds, which we also plan to further study.

We plot the time series of wind speed and wind direction on 3-4 Feb and 27-29 Jan, shown below. The wind direction during these days are variable, especially on 3-4 Feb, which may not be a clear evidence.



d) The factor dendrogram seems to resolve five groups instead of three (Figure 11); SOA1 and EVENT factors are one group, and SOA2 and NSOA factors are another group. What do these groupings suggest in terms of characteristics? The discussion of factors dendrogram in Pg. 17 Lns. 6-10 could be expanded to include these groups.

We agree with the comment and have clarified the figure description. In the current study, the agglomerative hierarchical clustering is conducted based on the profiles from PMF. The dendrogram is generated with Euclidean distance metric and average linkage, showing relationships between each group and each factor. However, the dendrogram does not directly show which groups are "tight" (i.e. containing closely related factors or elements) and which are loose. With respect to the factors, the original text focused on three of the five groups where the grouping was consistent with factor definitions (implicitly assuming them to be tightly grouped) while not commenting on the other groups (assumed to be more loose).

We add a short illustration in the main text.

The revised text reads (P18, L12-19): *"The factor dendrogram identifies several groups of EESI-TOF PMF factors consistent with the interpretations provided above: (1) more aged biomass burning factors (MABB_LOW$_{EESI}$, MABB_TRANS$_{EESI}$ and MABB_HIGH$_{EESI}$), (2) less aged biomass burning factors (LABB1$_{EESI}$ and LABB2$_{EESI}$), and (3) the cooking-related OA and cigarette smoking OA factors. The more aged and less aged biomass burning factor groups are themselves likewise grouped. This clustering is consistent with our interpretation of these factors, as discussed in the previous section. Ions are clustered to different groups using the standardized values. In each factor, there are distinguished molecules (lists of the specific ions (standardized value above 1.5) for each factor is shown in Table S2). The other two resolved groups, one group including SOA1 and EVENT factor, one group containing SOA2 and NSOA factor, apparently don't retrieve the common ions, which make less sense for the current study."*

Technical comments:

a) Pg. 15 Ln. 21: Ratio of N:C of NSOA in Table S1 is 0.04.

Done (P16, L21). The value in Table S1 (0.04) is correct, and the value in the main text has been fixed.

b) Pg. 16 Lns. 13-14: Check the percentage contribution of syringic acid and vanillic acid that are apportioned to MABB factors. Based on Figure 10b, they are supposed to be 52% and 66%, respectively.

Done (P17, L19). *"..., which in turn are a major component of biomass combustion emissions, and are apportioned primarily to the* $MABB_{EESI}$ *factors (52 % for syringic acid and 66 % for vanillic acid)."*

c) Pg. 16 Lns. 23-24: Be consistent with the decimal of percentage. The percentage can be off if the decimal is included.

Done (P17, L29). The main text is changed. *"Tetrahydroxy toluene (*$C_7H_8O_4$*) and pentahydroxy toluene (*$C_7H_8O_5$*) are apportioned mainly to secondary factors (85 % and 78 %, respectively)."*

d) Table S2: LAWB1 refers to LABB1? Check the acronyms of factors and make them consistent throughout the main text and supporting information.

Done. Yes, it should be *LABB1*. we correct the other names, *LABB2, MABB_LOW, MABB_TRANS, MABB_HIGH, CS-OA.*