Supplementary material to: Source apportionment of size and time resolved trace elements and organic aerosols from an urban courtyard site in Switzerland

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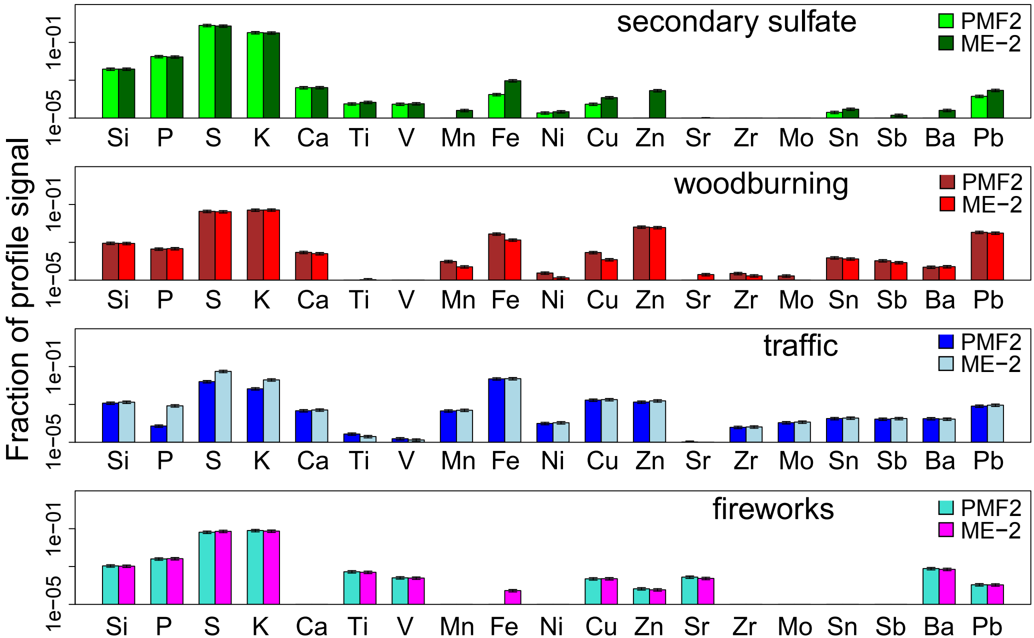

Fig. 1. *Supplementary*: Comparison of the PMF factor profiles for $PM_{1-0.1}$ obtained with ME-2 and PMF2 algorithms for a calculation with the full data set (including NYE data) from top to bottom: secondary sulfate, wood combustion, road traffic and fire works.

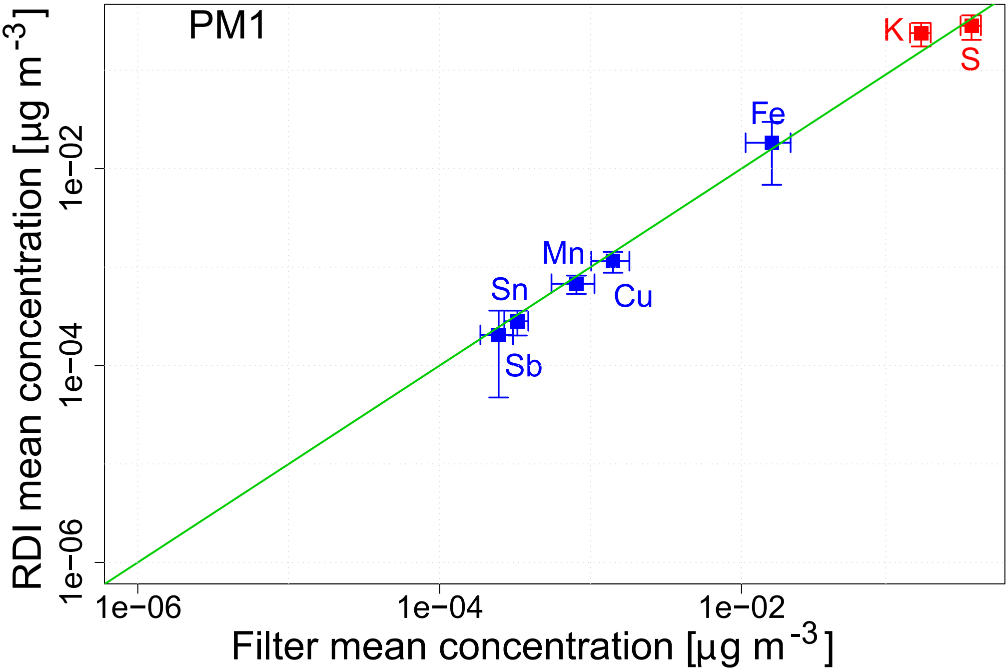

Fig. 2. *Supplementary*: Comparison of the mean values of 18 PM_1 filter samples from high-volume samplers and RDI data. Elements measured at the X05DA beamline at SLS are displayed in red, elements measured at HASYLAB L beamline are displayed in blue.

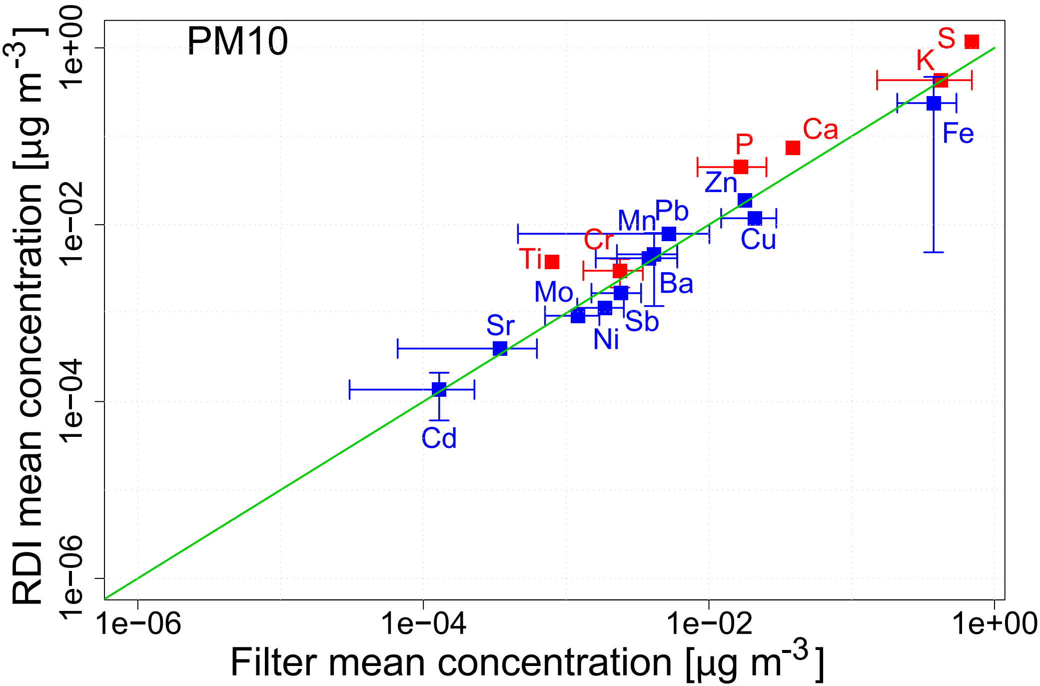

Fig. 3. *Supplementary*: Comparison of the mean values of nine PM_{10} filter samples from high-volume samplers during the long-term campaign and RDI data. Elements measured at the X05DA beamline at SLS are displayed in red, elements measured at HASYLAB L beamline are displayed in blue.

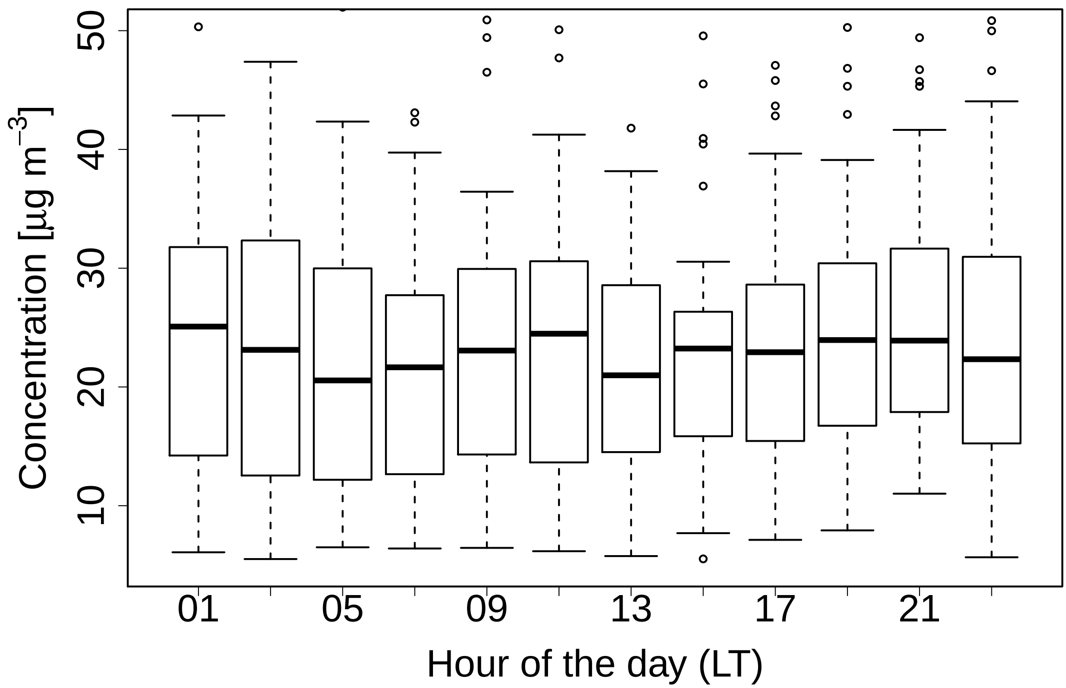

Fig. 4. *Supplementary*: Average diurnal variations of PM_{10} mass concentrations.

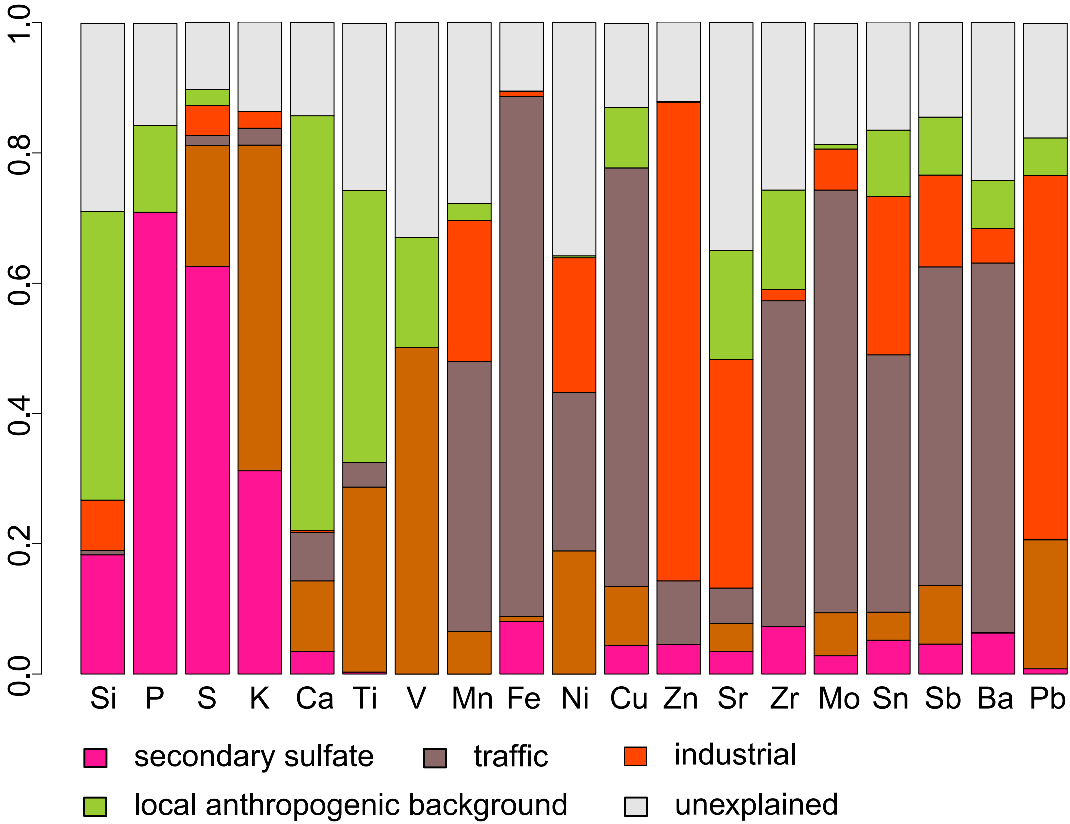

Fig. 5. *Supplementary*: Explained variation of the factor profiles for $PM_{1-0.1}$, secondary sulfate (magenta), wood combustion (brown), road traffic (grey), industrial (orange), local anthropogenic background (green) and unexplained (bright grey).

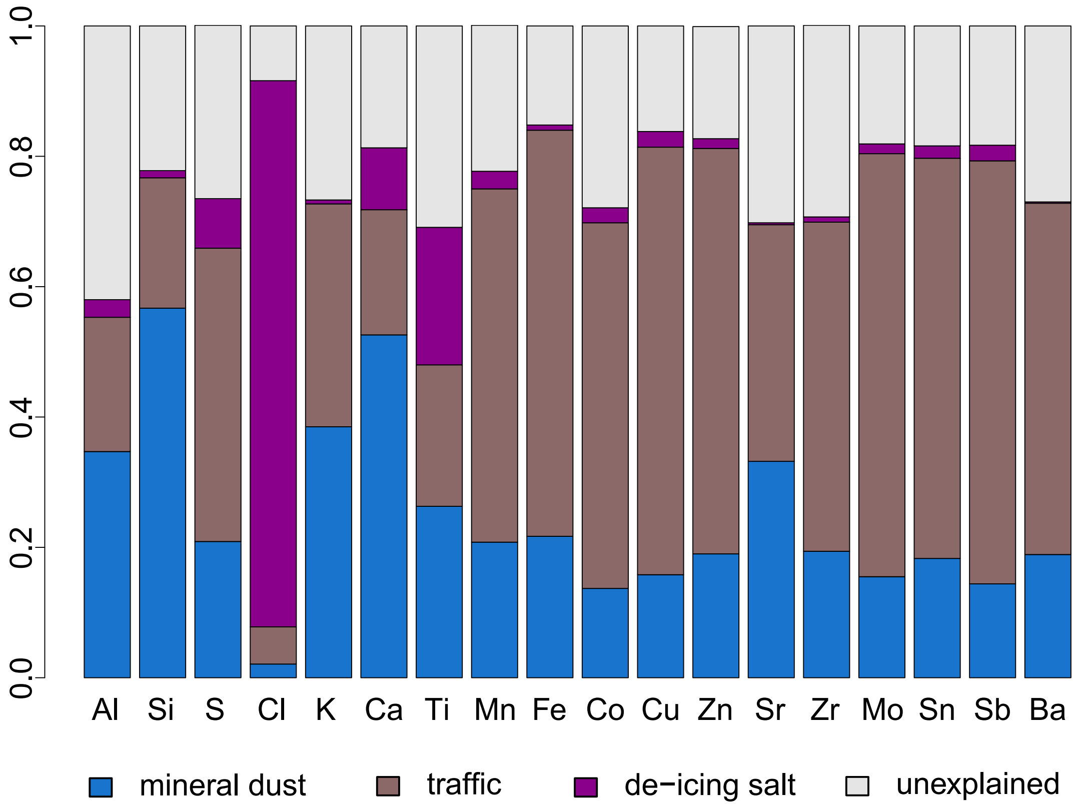

Fig. 6. *Supplementary*: Explained variation of the factor profiles for $PM_{10-2.5}$, mineral dust (blue), road traffic (grey), de-icing salt (purple) and unexplained (bright grey).

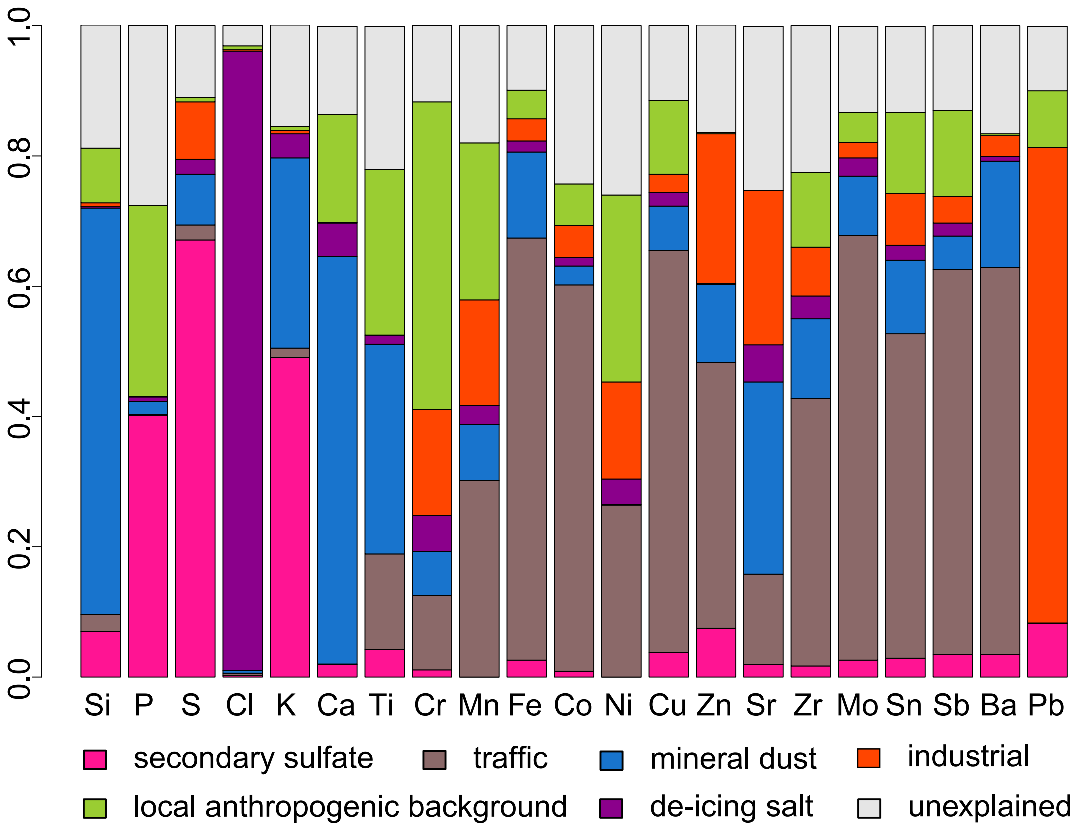

Fig. 7. *Supplementary*: Explained variation of the factor profiles for $PM_{2.5-1}$, secondary sulfate (magenta), road traffic (grey), mineral dust (blue), de-icing salt (purple), industrial (orange), local anthropogenic background (green) and unexplained (bright grey).

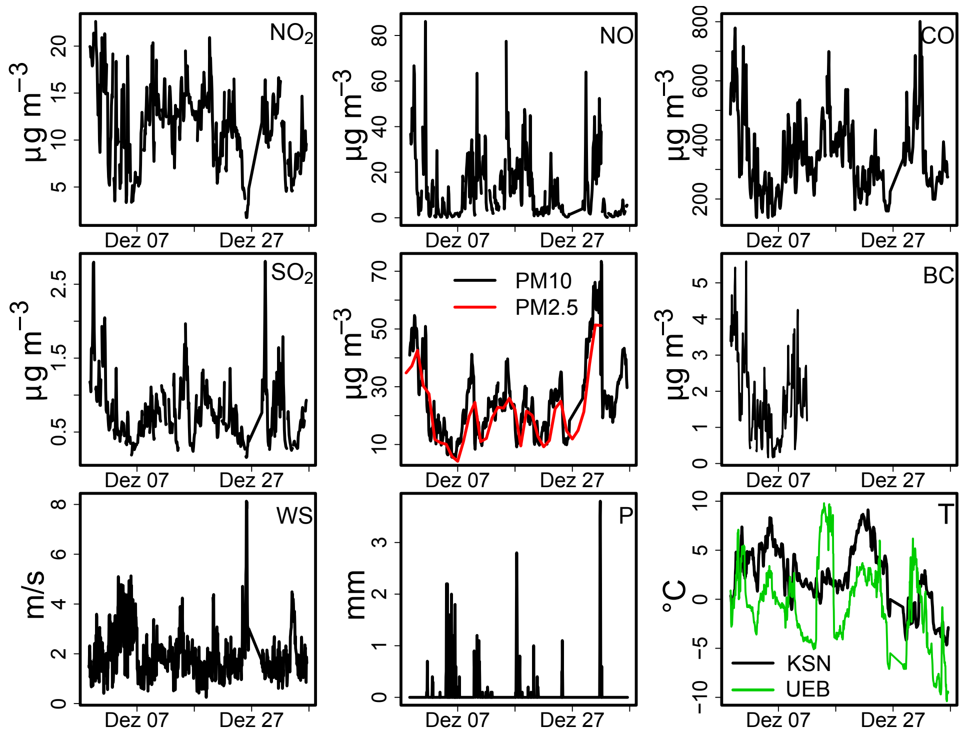

Fig. 8. *Supplementary*: Additional data from the NABEL network (NO_2, NO, CO, SO_2, PM_{10} and $PM_{2.5}$), BC at the beginning of the campaign from black carbon measurements with a multi-wavelength Aethalometer and wind speed, precipitation and temperature from the Swiss Meteorological network. The temperature is shown in black for Zürich Kaserne and in green for an elevated station, revealing two short thermal inversion periods with respect to a height of Üetliberg (871 m a.s.l.). The data were recorded with a time resolution of one hour (2 min for Aethalometer) and are binned into 2-h intervals for this plot.

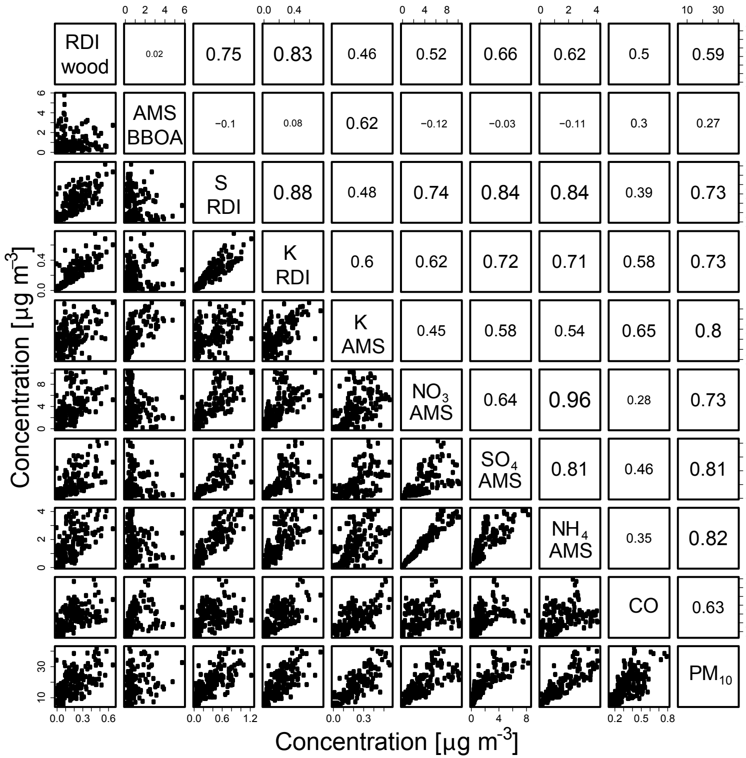

Fig. 9. *Supplementary*: Matrix of scatter plots to show the pair-wise correlations of the wood combustion factor found for $PM_{1-0.1}$ with RDI-PMF, AMS-BBOA factor, S and K measured with RDI, K, NO_3^-, SO_4^{2-} and NH_4^+ measured with AMS, CO and total PM_{10} mass concentrations. The panels in the upper right half show the Pearson correlation coefficients and the lower left panels show corresponding data points.

Determination of the number of factors of the AMS-PMF solution

To identify the most appropriate number of factors, PMF was run by varying the number of factors between 2 and 7. The most reasonable number of factors was determined following the interpretability of the identified factors (according to the methods applied by Lanz et al. (2007) for measurements at the same sampling site) and the criteria of the ”Uniqueness of the derived factors” as discussed by Allan et al. (2010).

In the following the different results for varying number of factors are presented, all calculations are performed with Fpeak = 0.

2-factor solution (Figure S10):
In the 2-factor solution the first factor presents the typical features shown by OOA: its mass spectrum is clearly dominated by 44 (and therefore also 28, which is calculated from the m/z 44 peak), while time series of this factor correlate with secondary AMS-inorganics (R^2= 0.7 for NH_4^+, 0.64 for SO_4^{2-} and 0.59 for NO_3^-). Concerning the second factor, its mass spectrum is dominated by m/z's 27, 29, 41, 43, 55, 57, and presents also relevant peaks at m/z's 60 and 73. These are fragments mainly related to both HOA and BBOA. Due to the presence of a mixed factor the 2-factor solution cannot be considered the optimal one.

3-factor solution (Figure S11):
The 3-factor solution yielded oxygenated (OOA), hydrocarbon-like (HOA) and biomass burning (BBOA) organic aerosol. All the factor profiles and time series were mostly unique without evident correlations of different factors. The identified factors are in agreement with the same three sources detected by Lanz et al. (2008) in an earlier winter measurement campaign at the same site.

4-factor solution (Figure S12 and S13):
Increasing the number of factors to 4 did not yield a reasonable solution since the OOA factor was split into a profile dominated by 44-28 and a second one dominated by 28-29-43-44 (Fig.

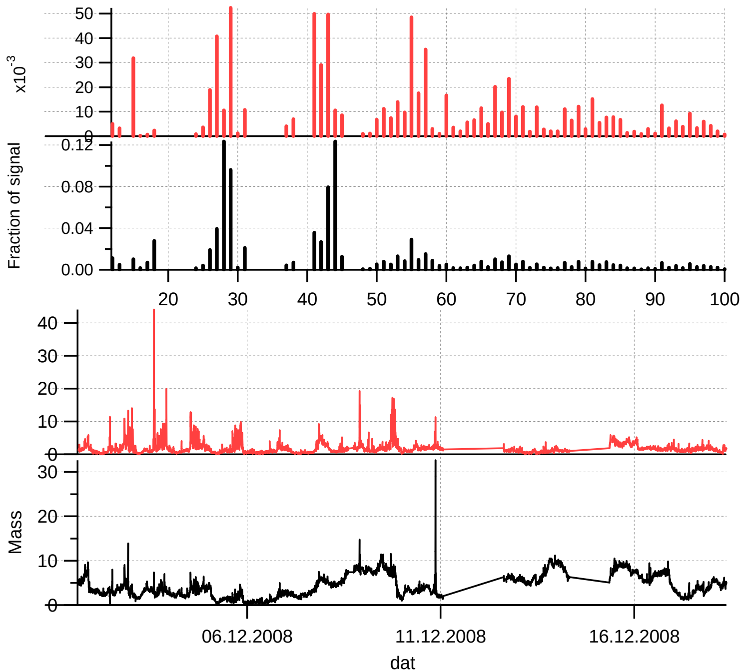

Fig. 10. *Supplementary*: 2-factor solution of AMS compounds, red = BBOA and black = HOA.

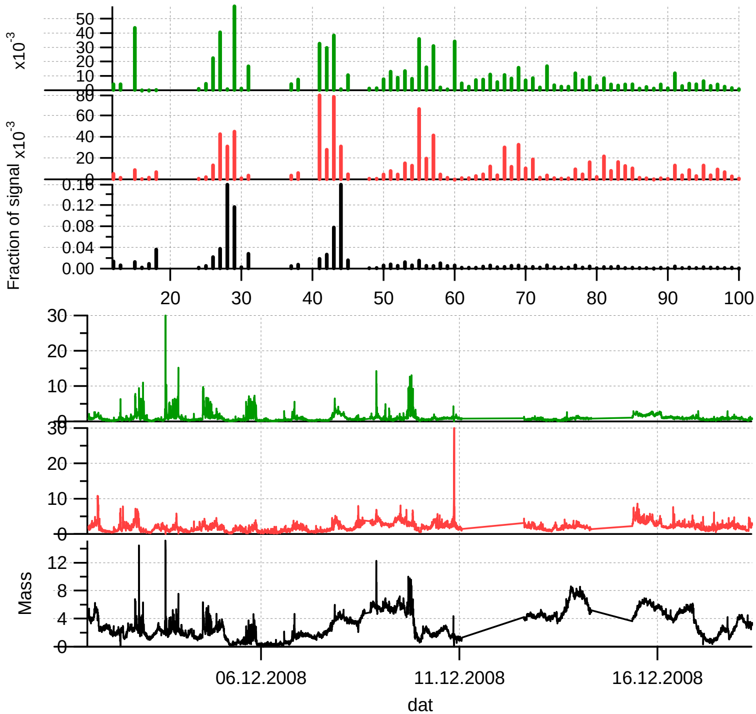

Fig. 11. *Supplementary*: 3-factor solution of AMS compounds: green = BBOA, red = HOA , black = OOA.

S12). Furthermore the time series are not unique anymore, since the new factor dominated by 44-28 and the BBOA factor have the same time trend in the beginning of the measurement campaign as can be seen from Figure S13.

5-factor solution (Figure S14 and S15):
Increasing the number of factors even one step further, did not yield any reasonable improvements either, since now there are three factors showing a similar time trend in the beginning of the measurement campaign. Furthermore, this new factor shows again mainly peaks for 28 and 44 and therefore does not contain any new information and is also not related to a food cooking factor.

6- and higher factor solutions:
These solutions lead to increased splitting of the three identified sources (OOA, HOA, BBOA), but not to a food cooking factor.

In conclusion, no food cooking factor could be identified with higher-order solutions. Lanz et al. (2008) did not find a cooking factor for Zürich Kaserne in winter either, even with the hybrid model approach. In contrast, a food cooking factor was found by Lanz et al. (2007) in summer and is rather attributed to leisure activities such as barbecues and charbroiling than domestic cooking. It therefore has to be considered as a seasonal source only. In the surrounding of Zürich Kaserne there are hardly any open places where food is sold, such as hot-dog-stands. In addition, the majority of restaurant kitchens are equipped with filters and these facts presumably prevent the identification of a cooking factor at this site in winter. Allan et al. (2010), supplementary material, noted that "... if a solution set with a given number of factors was deemed unreliable, those with greater than this number also failed." This was also found in this study.

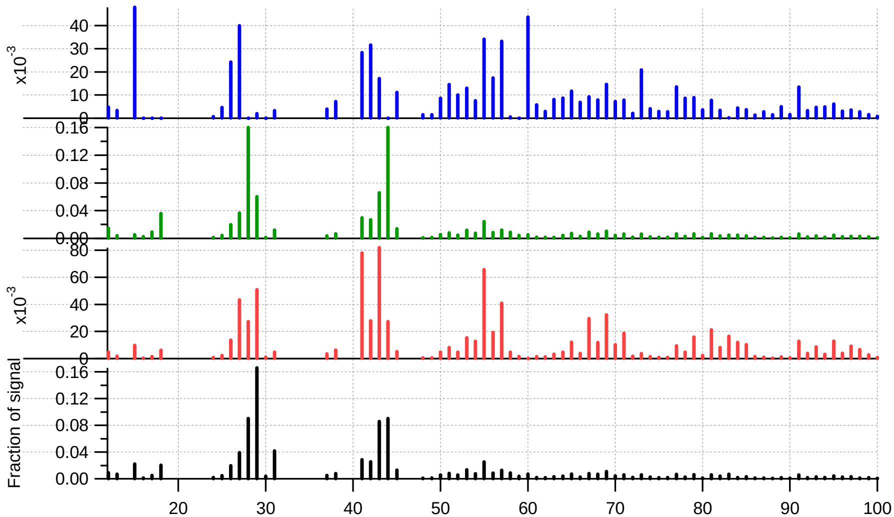

Fig. 12. *Supplementary*: Factor profiles for the 4-factor solution of AMS compounds: BBOA (blue), first OOA (green), HOA (red) and the second OOA (black) factor.

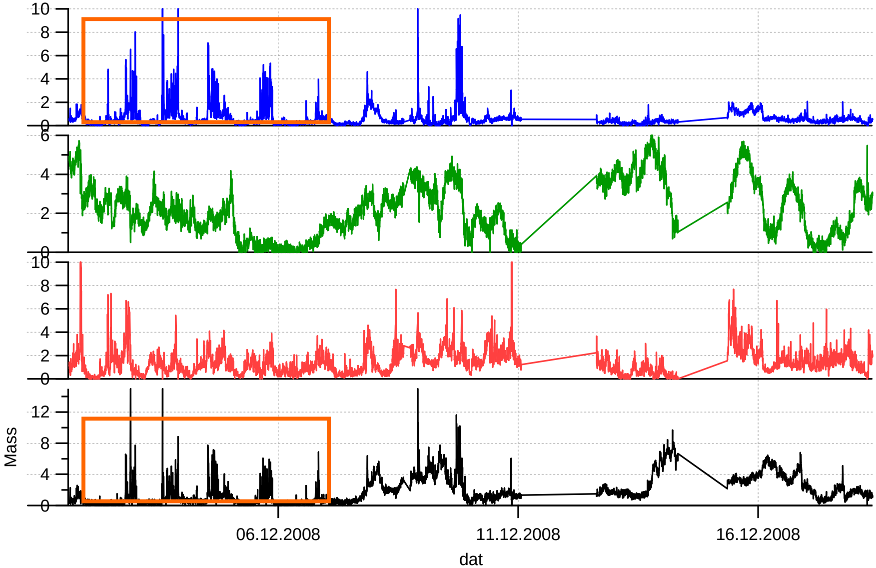

Fig. 13. *Supplementary*: Time series of 4-factor solution of AMS compounds: BBOA (blue), first OOA (green), HOA (red) and the second OOA (black) factor.

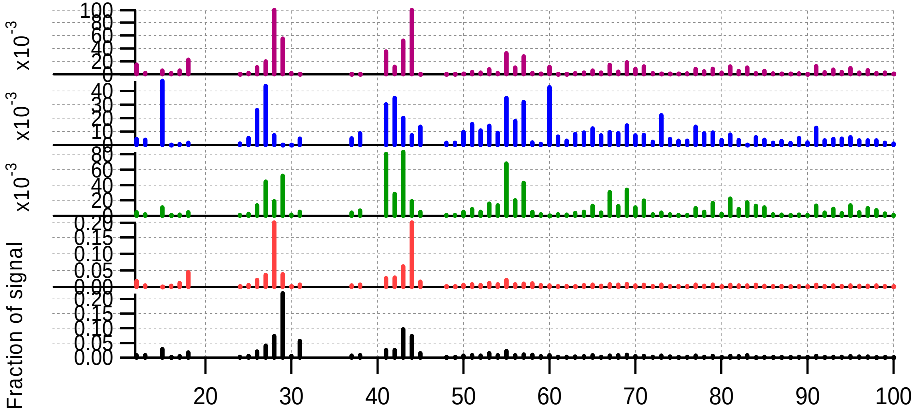

Fig. 14. *Supplementary*: Profiles of 5-factor solution of AMS compounds.

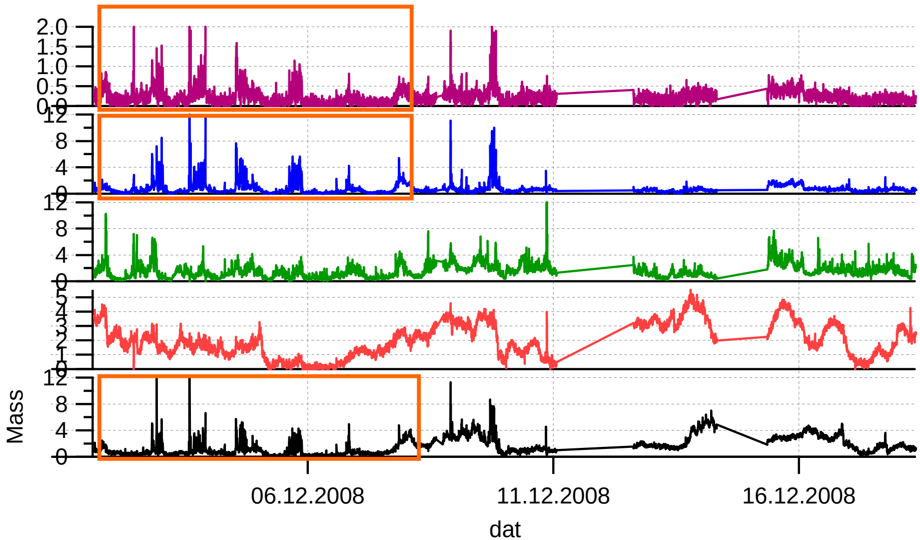

Fig. 15. *Supplementary*: Time series of 5-factor solution of AMS compounds.