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*Supplement of*

## **Primary to secondary organic aerosol: evolution of organic emissions from mobile combustion sources**

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## **Supplemental Information**

### **List of acronyms**

AMS – Aerosol Mass Spectrometer

HOA – Hydrocarbon-like Organic Aerosol

LV-OOA – Low Volatility Oxidized Organic Aerosol

OOA – Oxidized Organic Aerosol

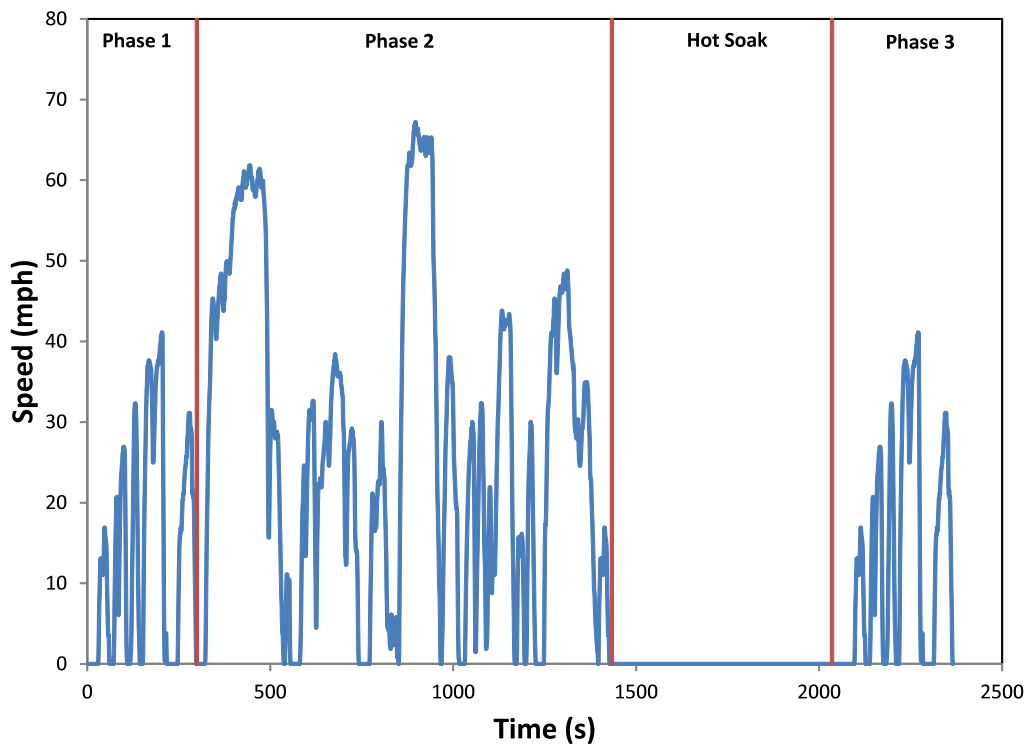
PMF – Positive matrix factorization

POA – Primary Organic Aerosol

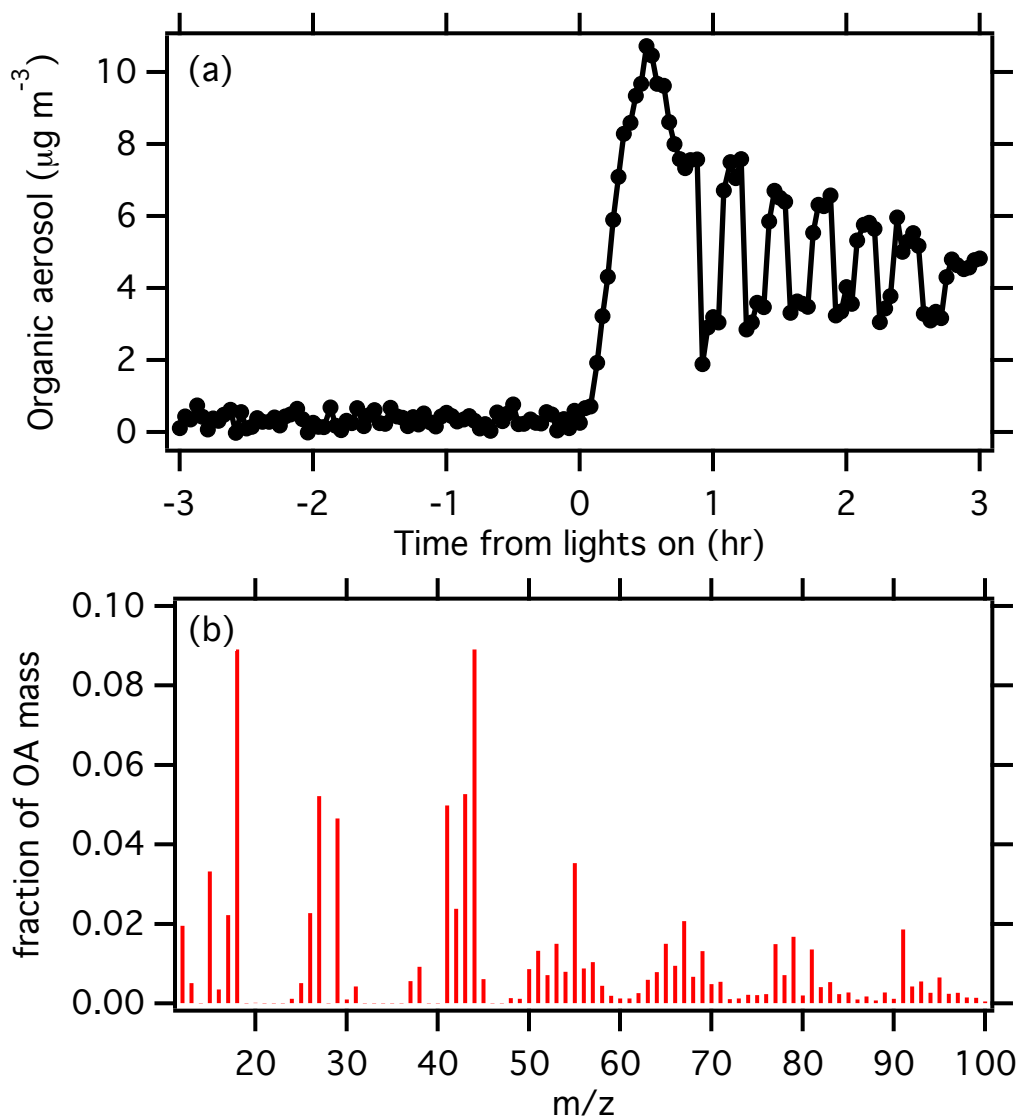
SOA – Secondary Organic Aerosol

SV-OOA – Semi-Volatile Oxidized Organic Aerosol

UC – Unified Cycle

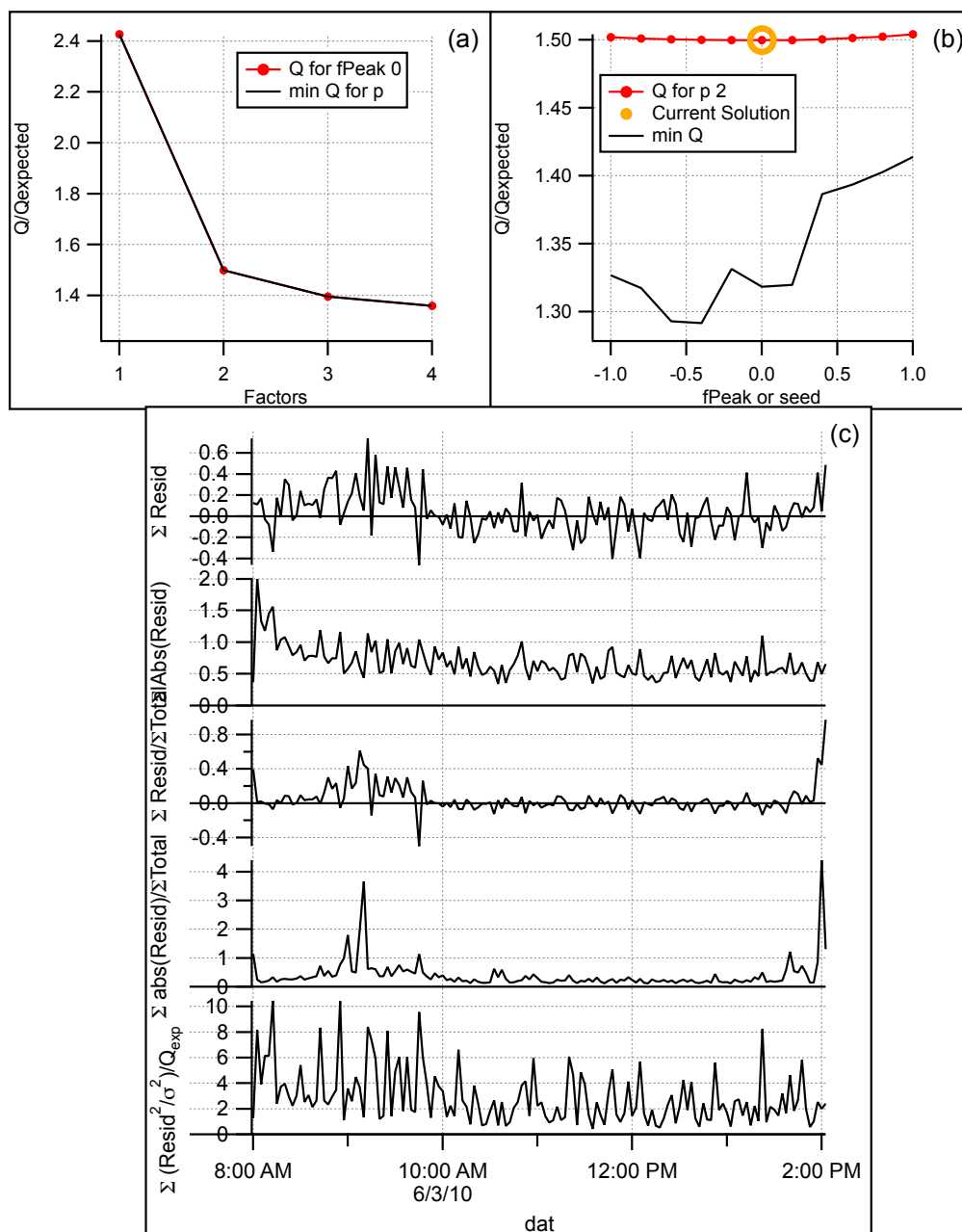


**Figure S1** Driving speed and duration for Unified Cycle. The complete test cycle is divided into three phases with a hot soak (engine off during hot soak). Composite samples were collected over all three phases, but not during the hot soak.



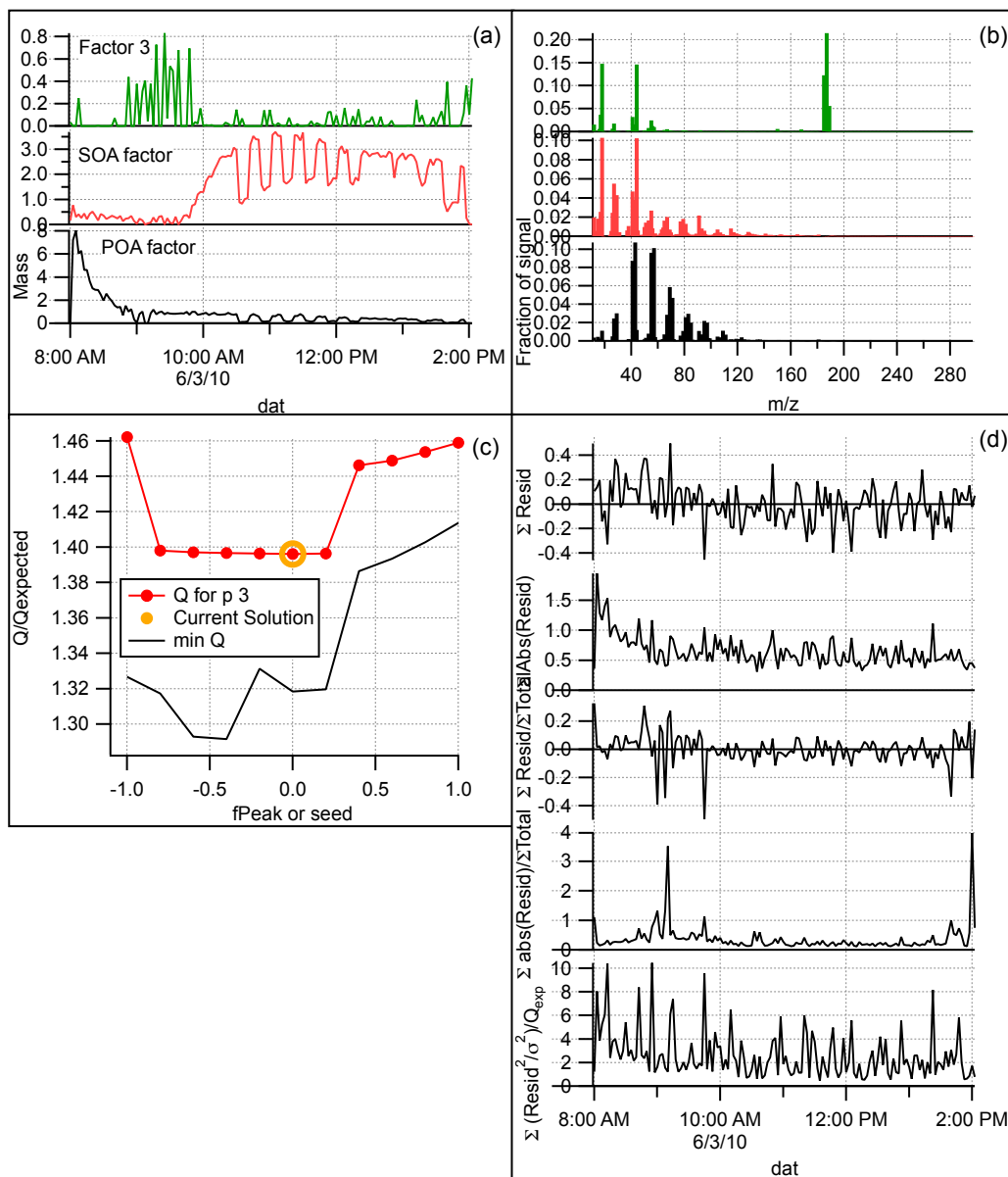
**Figure S2** (a) Time series for a “pure SOA” experiment (LEV2-1.2). There is no evidence of POA entering the chamber when filling with diluted exhaust (filling started at  $t \sim -1$  hr), and rapid formation of SOA with the start of photo-oxidation. (b) Mass spectrum of the SOA formed in this experiment is similar to the SOA factor identified for experiment LEV1-5.2 in Figure 2 of the manuscript.

### LEV1-5.2 2 factor solution

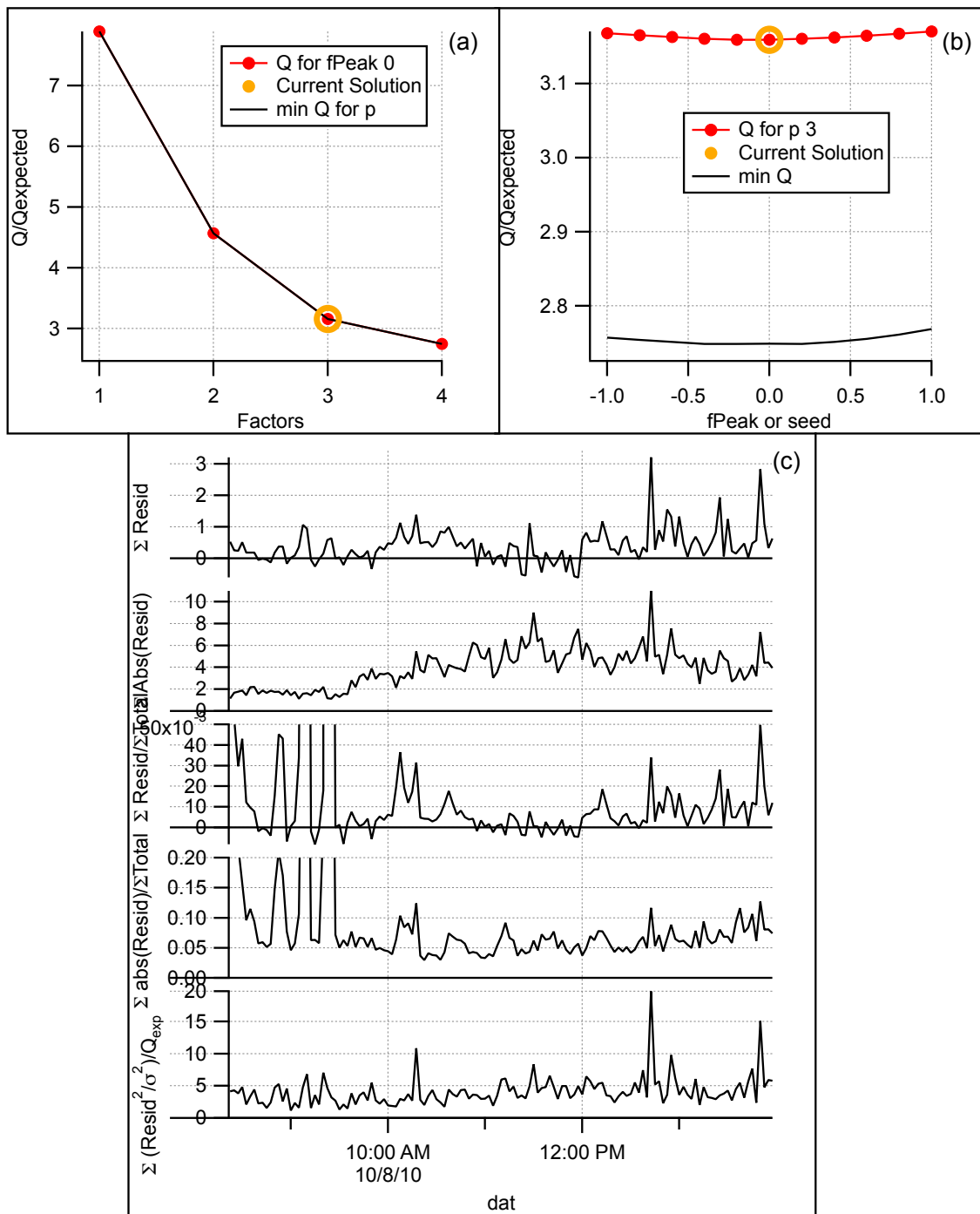


**Figure S3** Diagnostic plots for experiment LEV1-5.2. The two-factor solution for this experiment is shown in Figures 1 and 4 in the manuscript. Panel (a) shows  $Q/Q_{\text{exp}}$  versus the number of factors in the PMF solution, (b) shows  $Q/Q_{\text{exp}}$  versus FPEAK for the 2-factor solution, and panel (c) shows the residual time series plots for the 2-factor solution. The diagnostic plots contain data from AMS scans when the OA was sampled through a thermodenuder (TD), and these scans cause many of the “spikes” in the residual time series. TD scans have been removed from the corresponding figures in the manuscript.

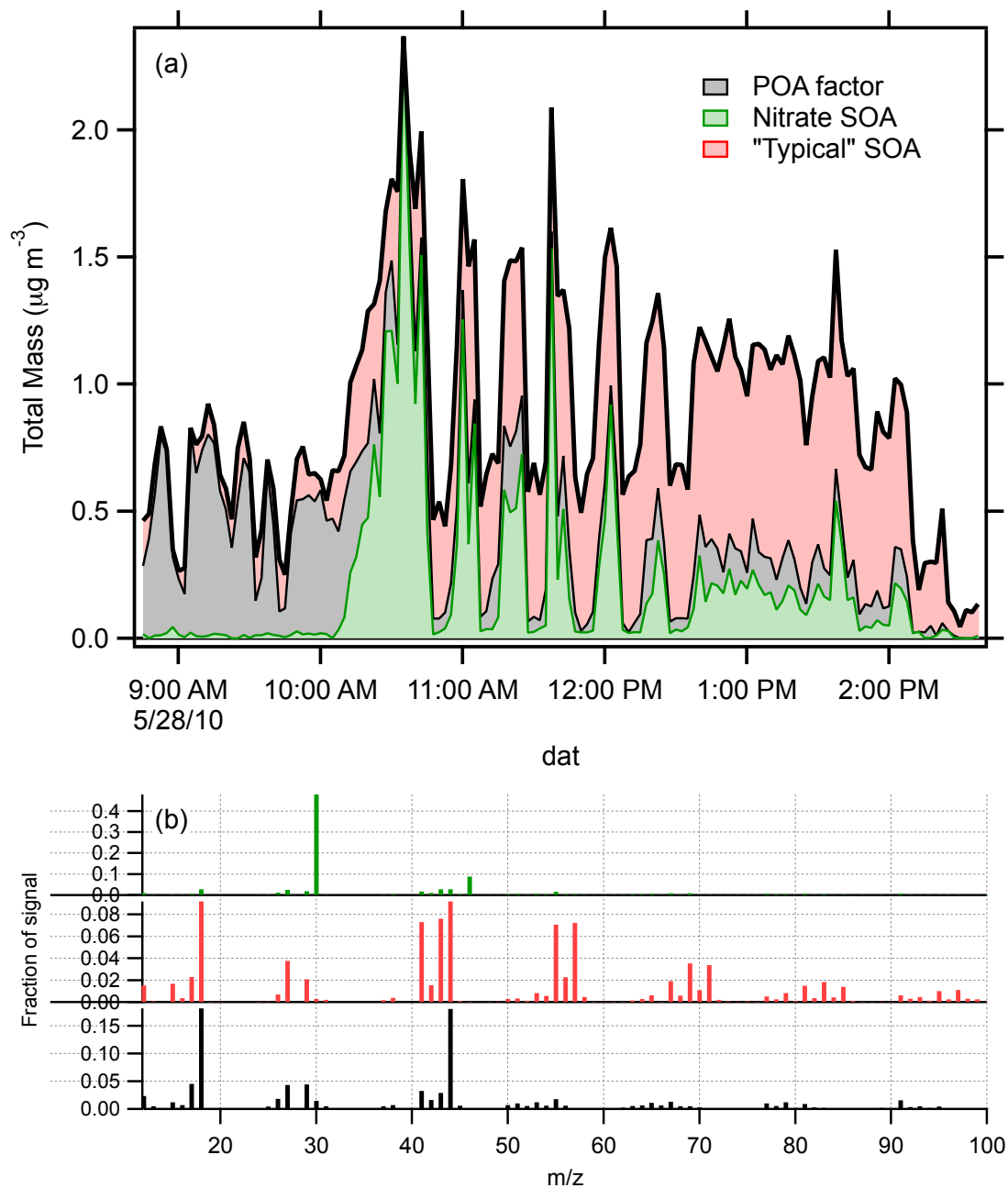
### LEV1-5.2 3 factor solution



**Figure S4** Diagnostic plots of the 3-factor PMF solution for experiment LEV1-5.2. Panel (a) shows the time series of the 3 factors. One POA factor, one SOA factor, and one unidentified factor (“Factor 3”) are present in the solution. The concentration of Factor 3 does not align with any major events in the experiment such as the addition of dilute exhaust or the onset of photo-oxidation. The mass spectra of the factors are shown in (b); the MS of Factor 3 is not well aligned with known SOA or POA mass spectra. Panel (c) shows  $O/Q_{exp}$  as a function of FPEAK for the 3-factor solution, and panel (d) shows the time series of the residuals. The diagnostic plots contain data from AMS scans when the OA was sampled through a thermodenuder (TD), and these scans cause many of the “spikes” in the residual time series. TD scans have been removed from the corresponding figures in the manuscript.

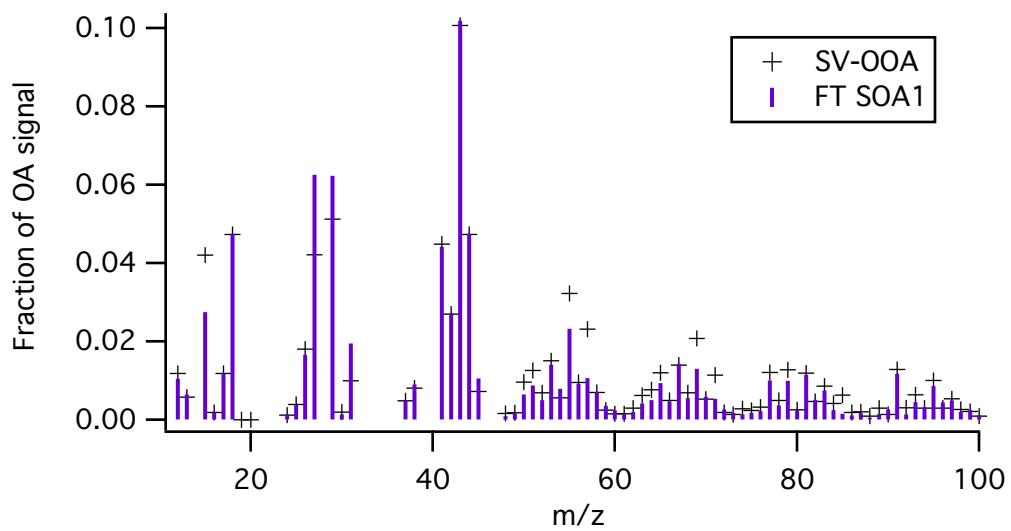


**Figure S5** PMF diagnostic plots for experiment T63-1. Panel (a) shows  $Q/Q_{\text{exp}}$  versus the number of factors in the PMF solution, (b) shows  $Q/Q_{\text{exp}}$  versus FPEAK for the 3-factor solution, and (c) shows time series plots of the residual. The diagnostic plots contain data from AMS scans when the OA was sampled through the TD.



**Figure S6** Time series of the 3-factor PMF solution for experiment LEV1-6.1, including data when the OA was sampled through the TD (a), and mass spectra of the factors (b). This was the only of the gasoline and diesel experiments to require more than two factors. In this case, the green color indicates a high nitrate SOA factor that is formed early in the photo-oxidation phase of the experiment. Later in the experiment the high nitrate SOA is overwhelmed by a more typical SOA factor.





**Figure S7** Mass spectrum of the SOA 1 factor determined for the FT fuel experiments with the T63 engine and comparison to the average ambient SV-OOA mass spectrum.