Investigation of sources of ambient submicron aerosol using AMS mobile and stationary data

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ETH-Conference on combustion generated nanoparticles
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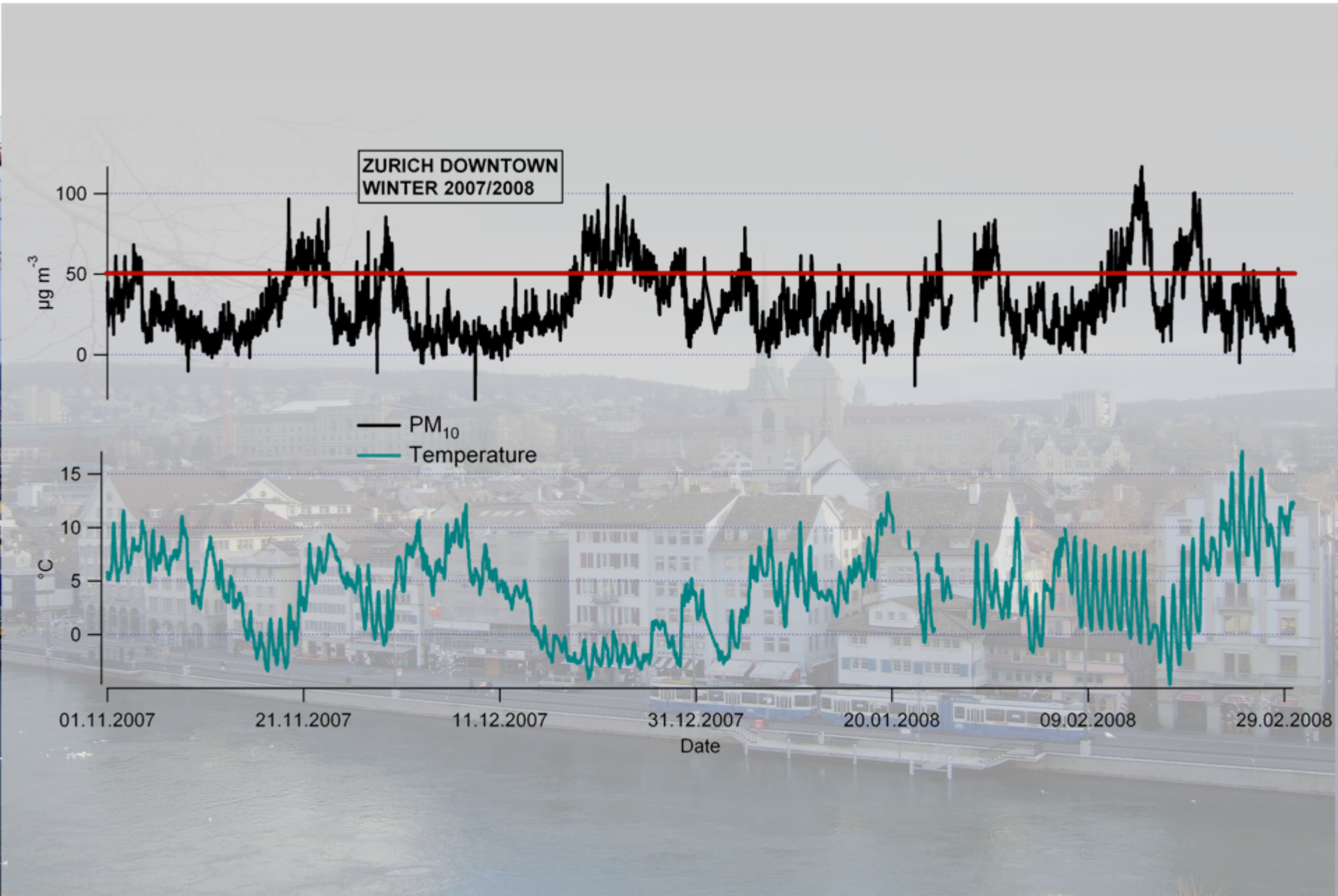
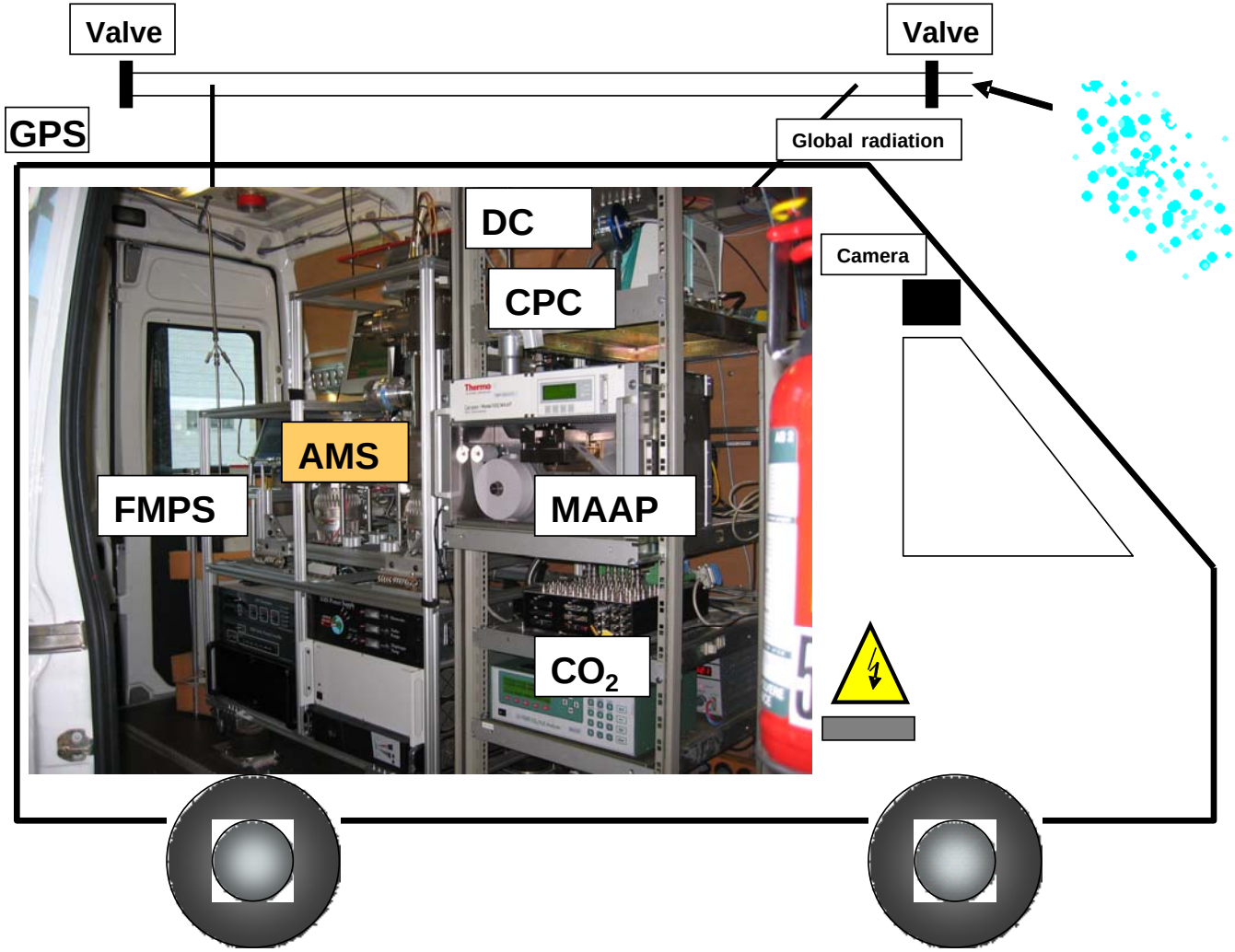
ETH Zürich

Motivation

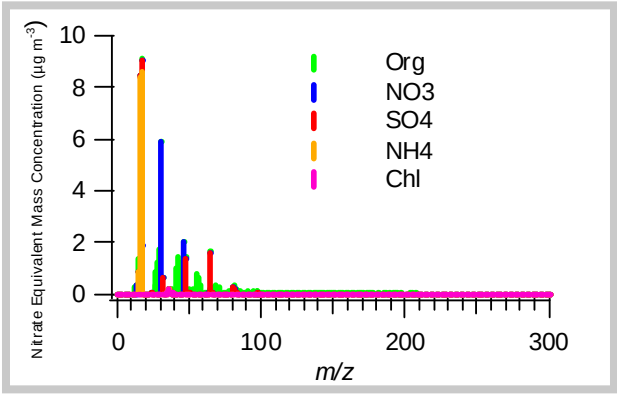

ZURICH DOWNTOWN
WINTER 2007/2008
100
50
0
µg m-3
PM10
Temperature
15
10
5
0
°C
01.11.2007
21.11.2007
11.12.2007
31.12.2007
20.01.2008
09.02.2008
29.02.2008
Date

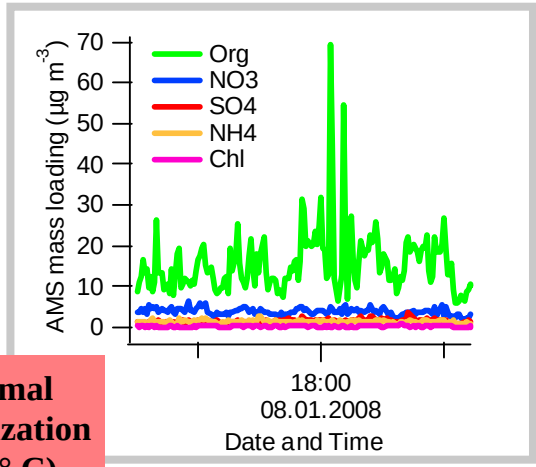
The PSI mobile laboratory

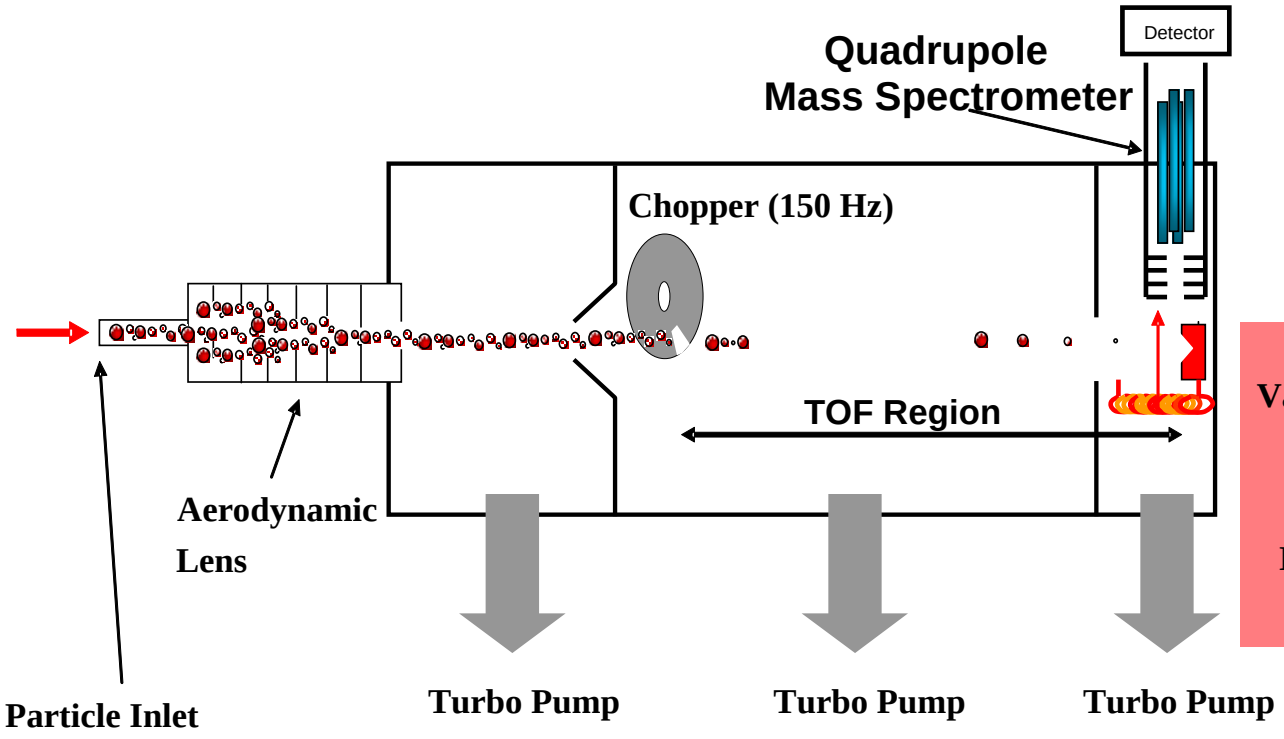


Aerodyne Aerosol Mass Spectrometer (AMS)

- Chemical composition of non-refractory PM1







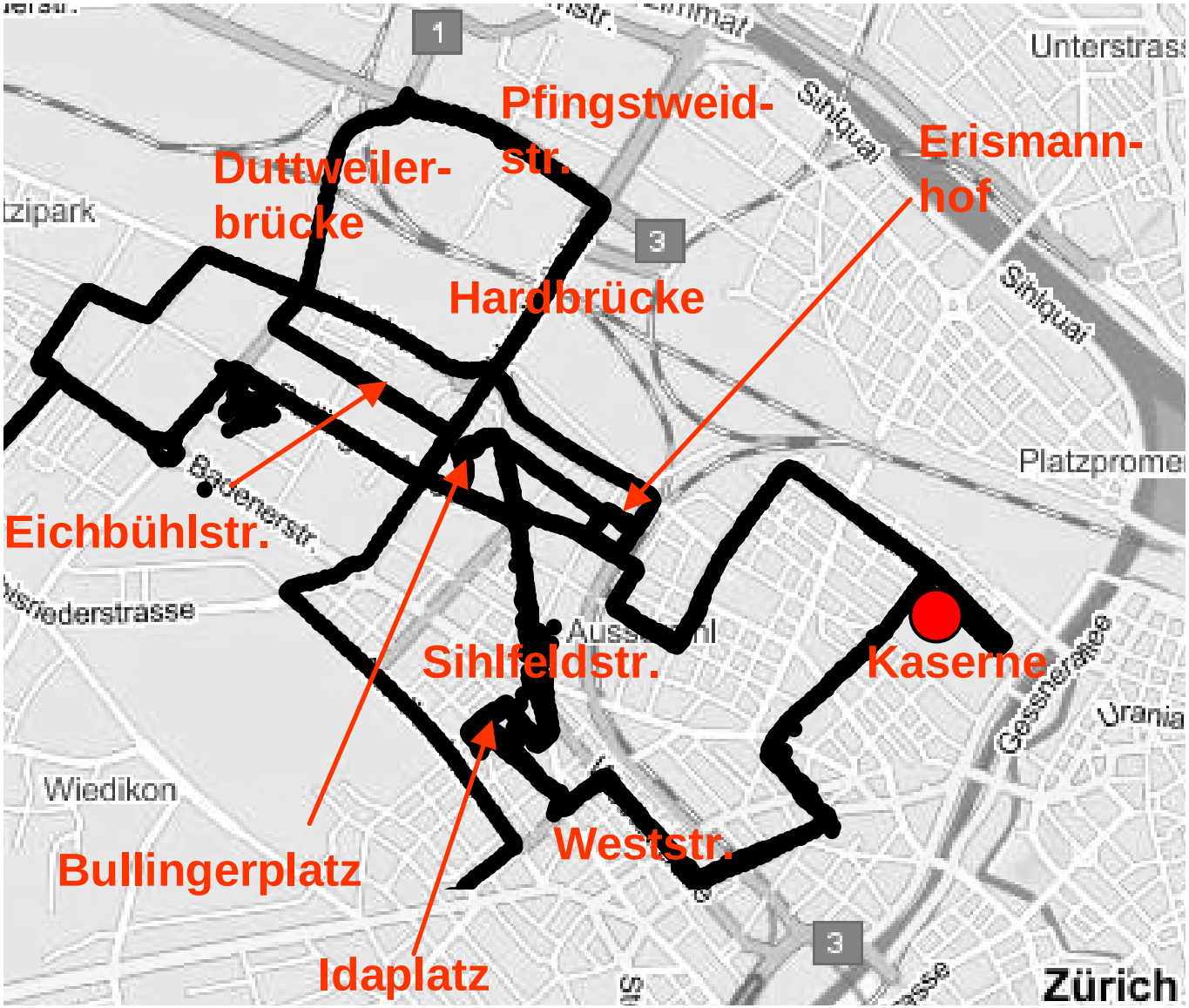
Thermal Vaporization (600° C) and Electron Ionization (70 eV)

(Jayne et al., 2000)

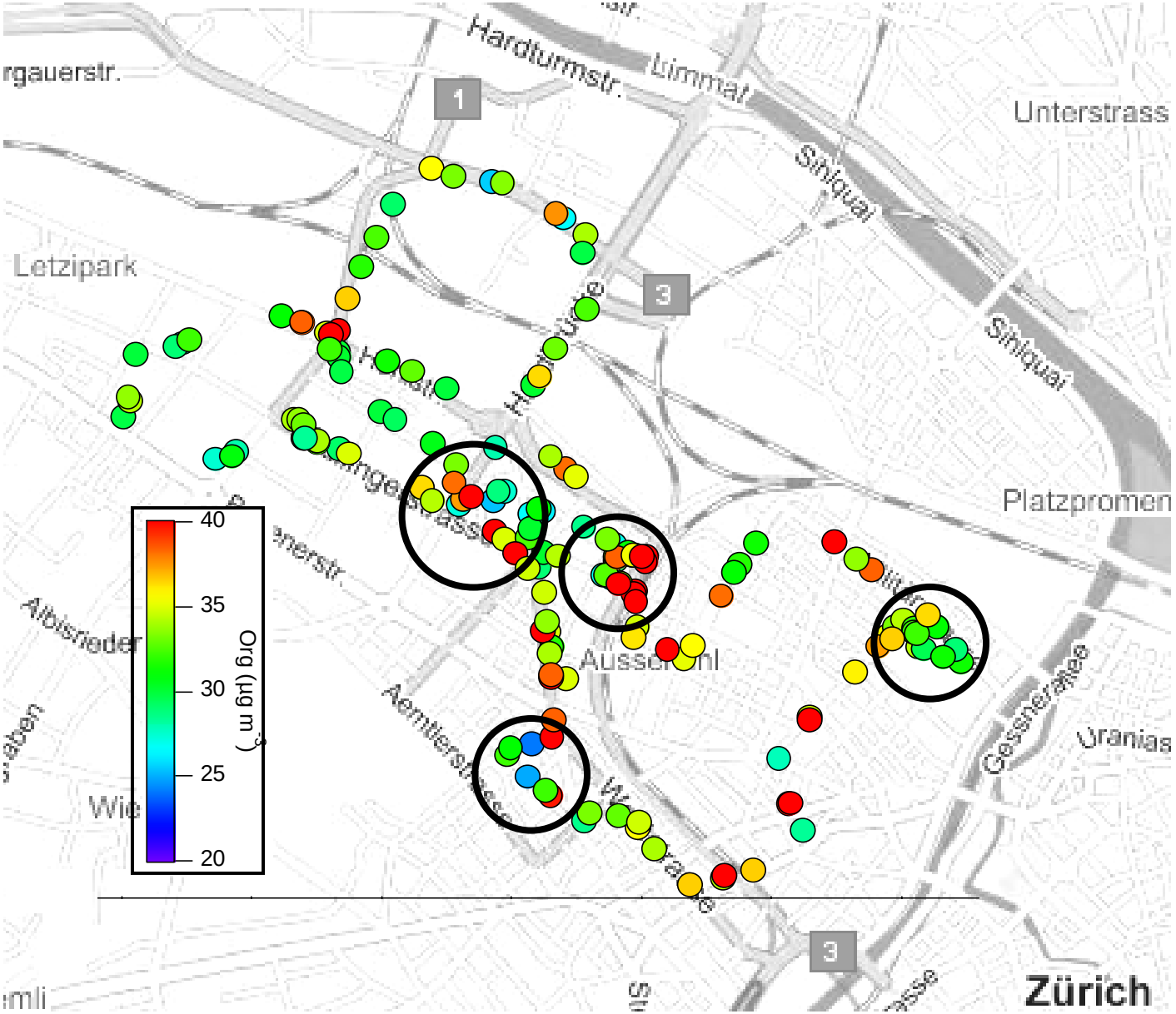
Mobile measurement route

ZÜRICH

Winter 2007/2008, 13 drives



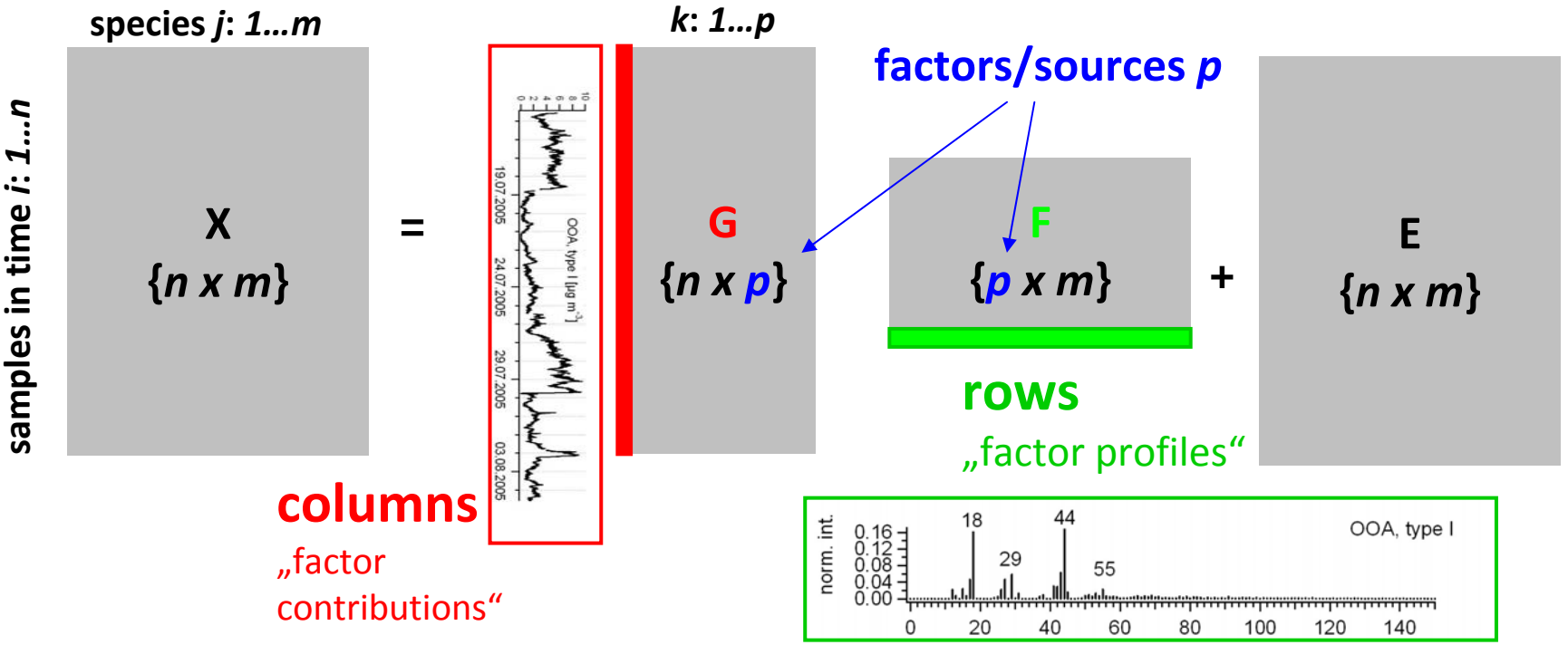
Organic mass: Spatial variation



Drive: 28.11.2007, evening

Source apportionment of organic mass fraction

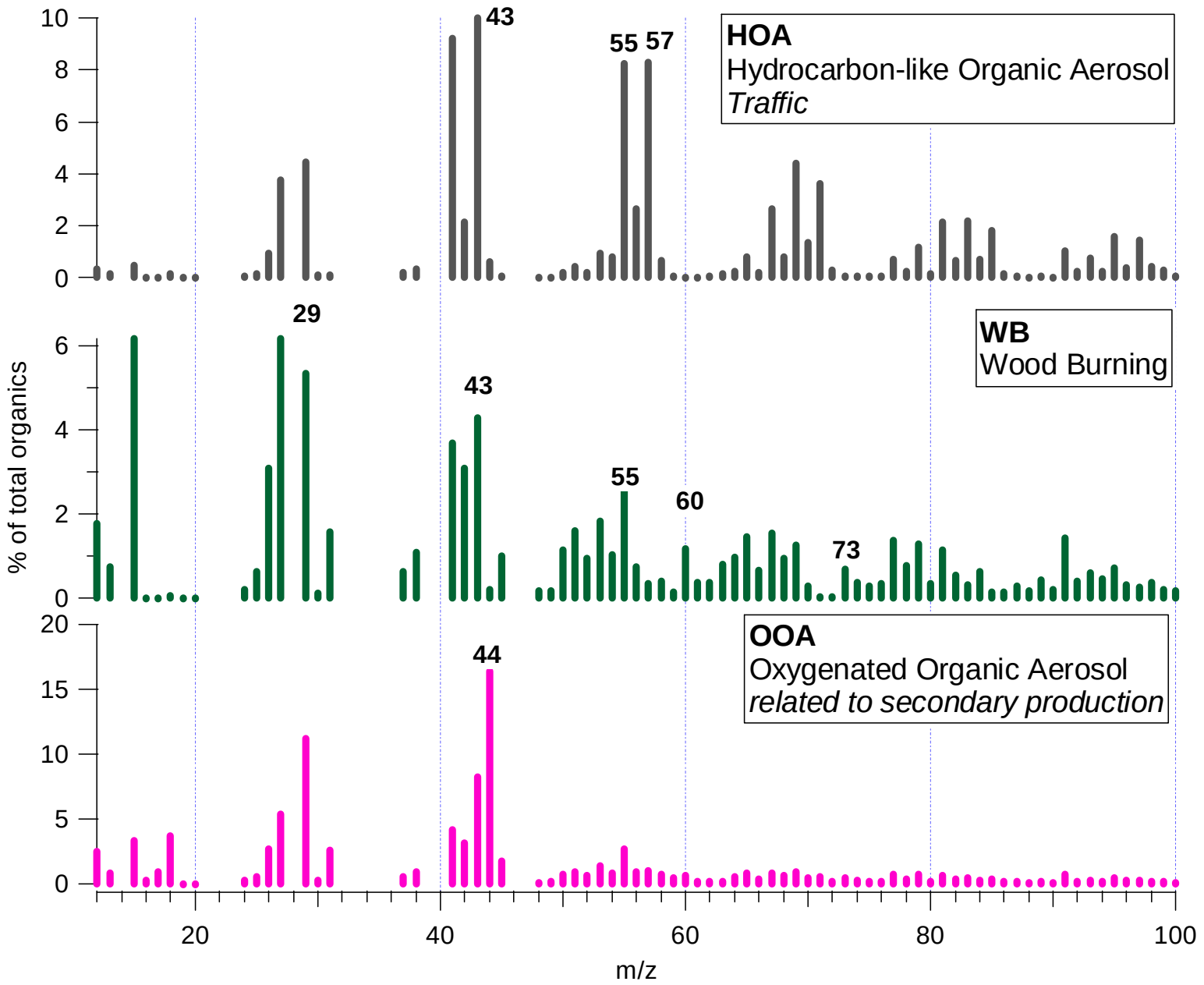
- Positive Matrix Factorization PMF



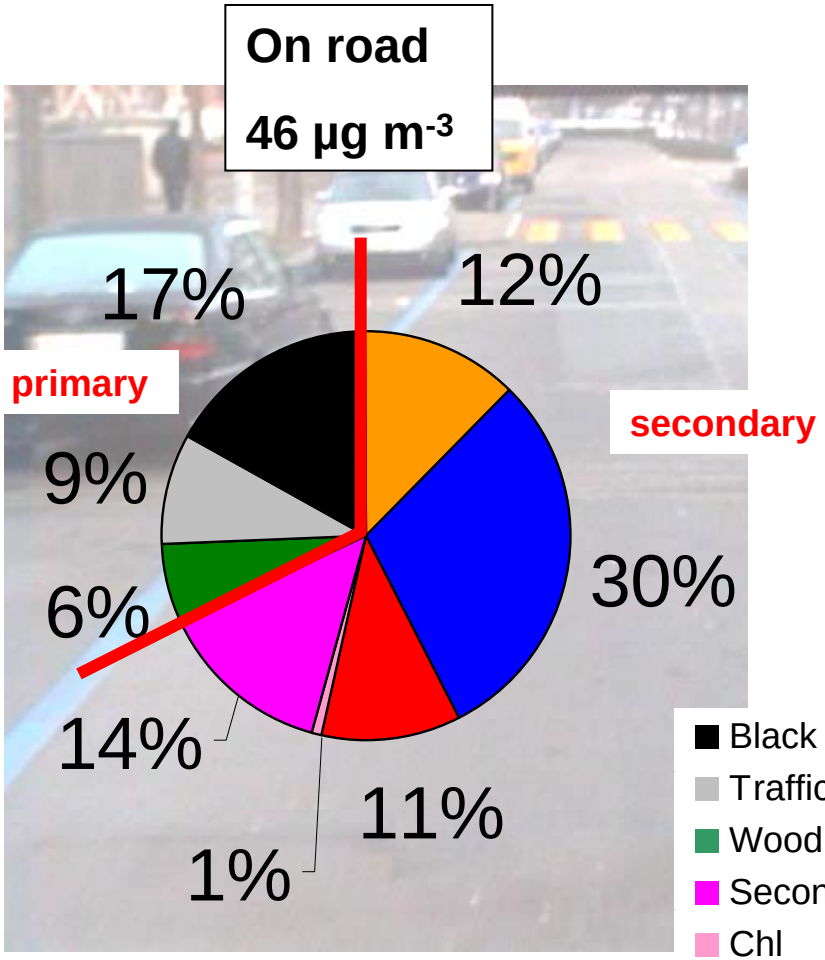
X measured by AMS:

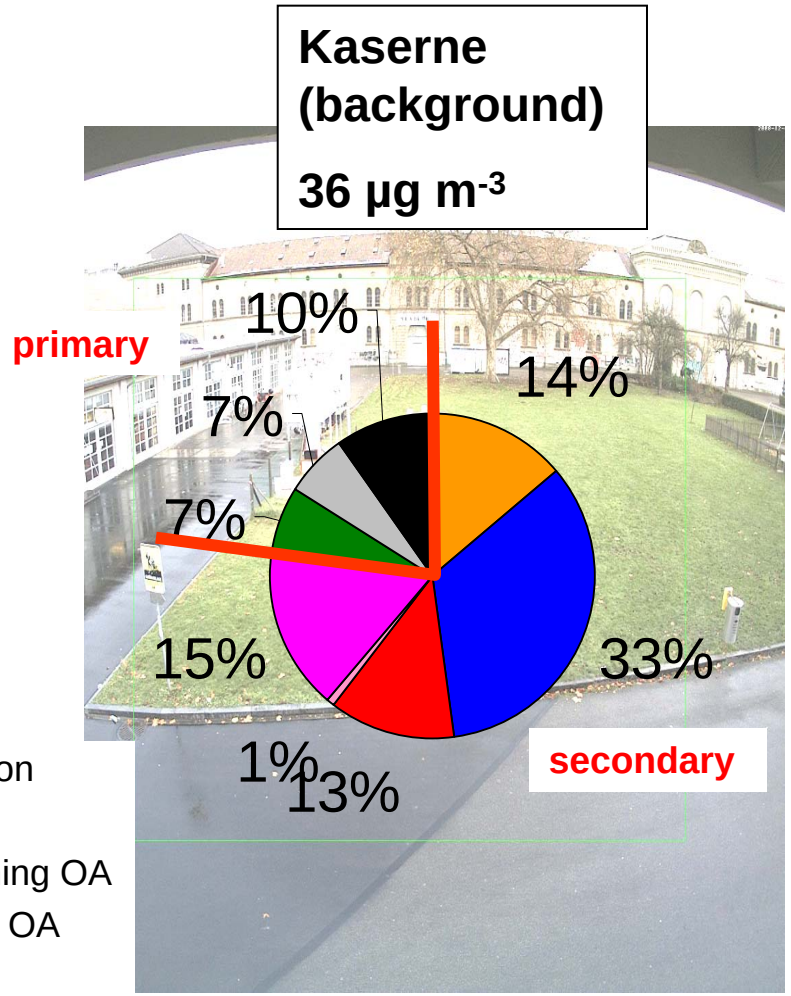
Organic matrix, n spectra comprised of m species

PMF results: Factors/sources for Zurich



Downtown Zurich: PM1 chemical composition





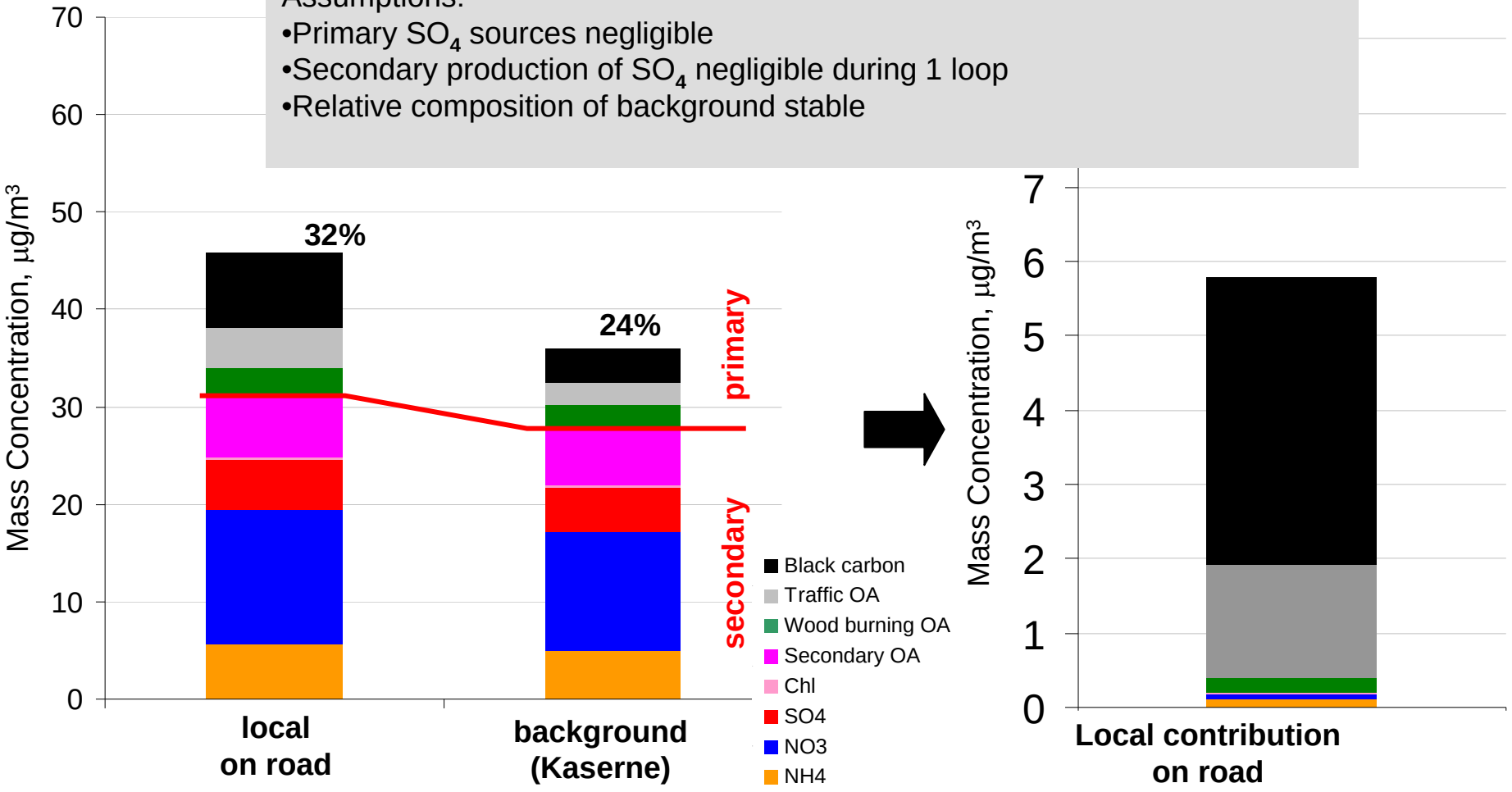
- Black carbon
- Traffic OA
- Wood burning OA
- Secondary OA
- Chl
- SO4
- NO3
- NH4

Local contribution versus background

Correction of local meteorology

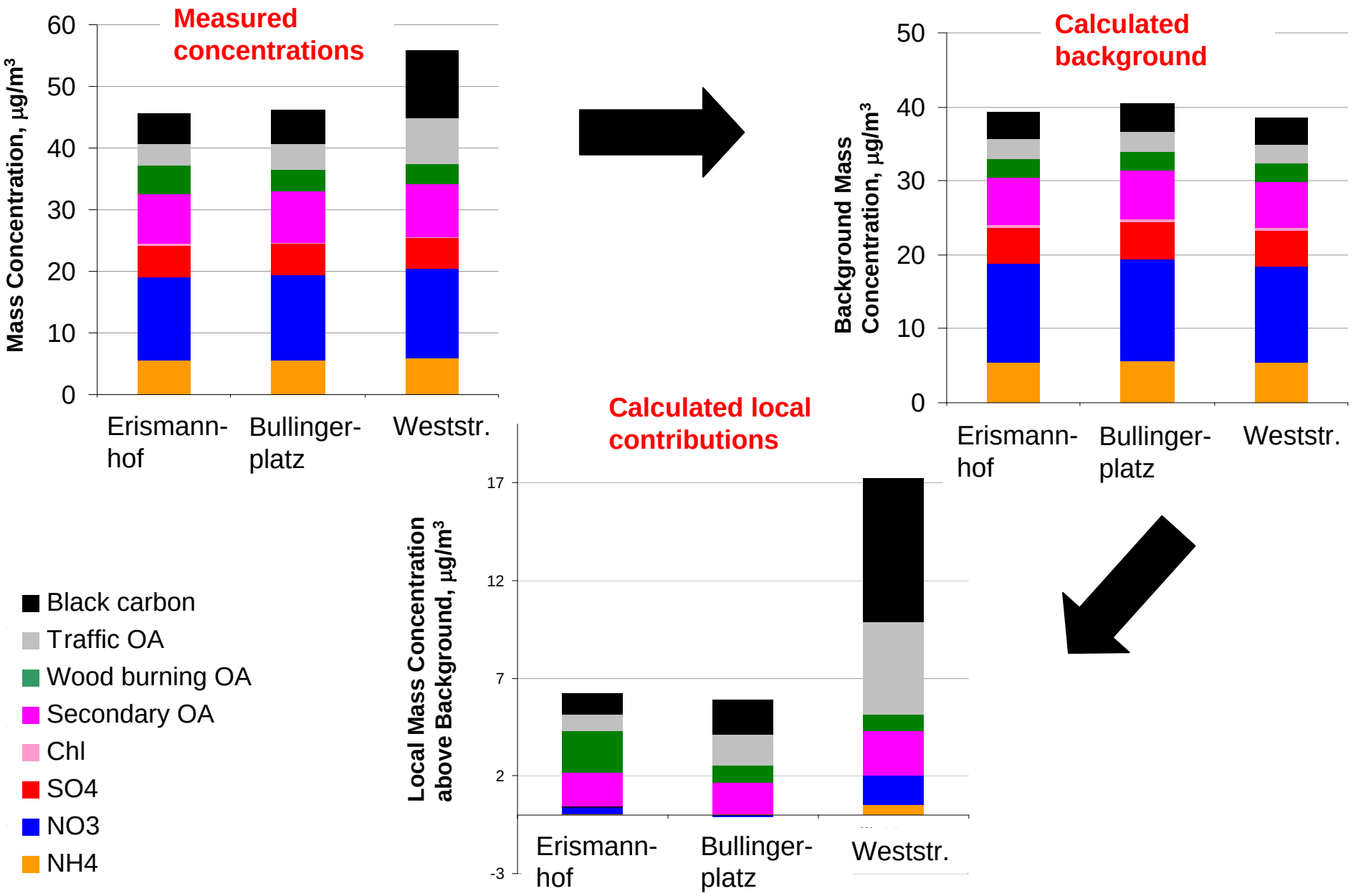
Local contribution =
Ambient concentration – background based on sulphate ratio

Assumptions:
- Primary SO_4 sources negligible
- Secondary production of SO_4 negligible during 1 loop
- Relative composition of background stable



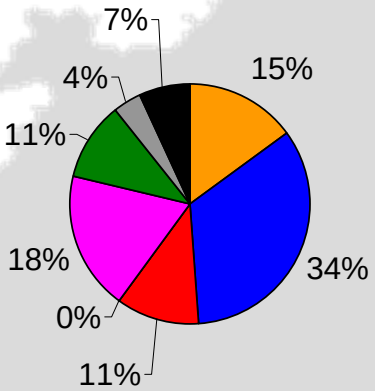
Local contributions: Various sites downtown Zurich

Downtown Zurich: PM1 local contributions, various sites

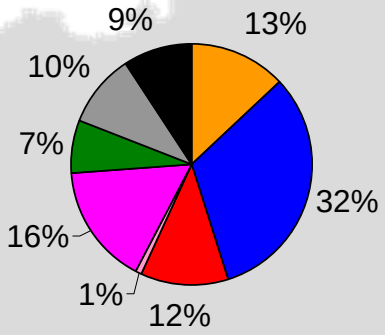


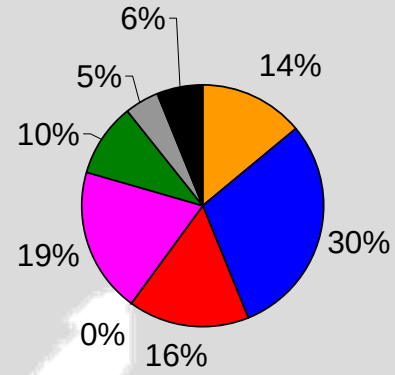
Swiss plateau: PM1 chemical composition

Reiden, Winter 2006
Total concentration: 60 µg m^{-3}

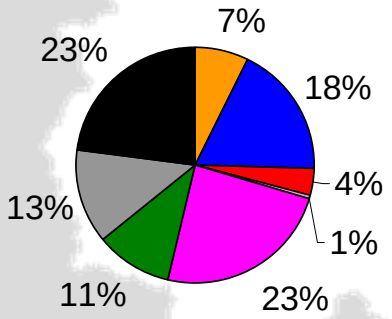


Zurich, Winter 2007/08
Total concentration: 38 µg m^{-3}





Zurich, Winter 2006
Total concentration: 40 µg m^{-3}



Rheintal, Winter 2007/08
Total concentration: 35 µg m^{-3}

- Black carbon
- Traffic OA
- Wood burning OA
- Secondary OA
- Chl
- SO4
- NO3
- NH4

Summary and conclusions

- Mobile measurements give information on spatial distribution of parameters of interest

- PMF retrieved sources of organic aerosol (PM1) in downtown Zurich:
  - Traffic
  - Wood burning
  - Secondary production

- Chemical composition on road vs background: Higher influence of primary emissions

- Local contributions to measured concentrations can be estimated using sulphate normalization
  - Local differences due to traffic or wood burning emissions
  - Local contributions generally small, regional background dominates

Thanks to…

- Ostluft, Cantons Graubünden, St. Gallen, Zürich, Stadt Zürich, Fürstentum Liechtenstein and Vorarlberg (A)
- BAFU
- IMBALANCE
- IVECO
- PSI

Classification

PMF vs. PCA

1. Principal Component Analysis (PCA) is not an (air quality) model (technique of dimensionality reduction)

2. In contrast to standard PCA-based models, PMF….

…constraints factor profiles (**F**)/ factor time series (**G**) to non-negative values…
…weights individual data points in data matrix **X** by analytical uncertainty…
…and, therefore, PMF yields more realistic factors than PCA.
…no orthogonality imposed on **F**…

3. PMF-results are not unique, whereas PCs are unique.