Overview of the particulate matter composition in various regions of Switzerland

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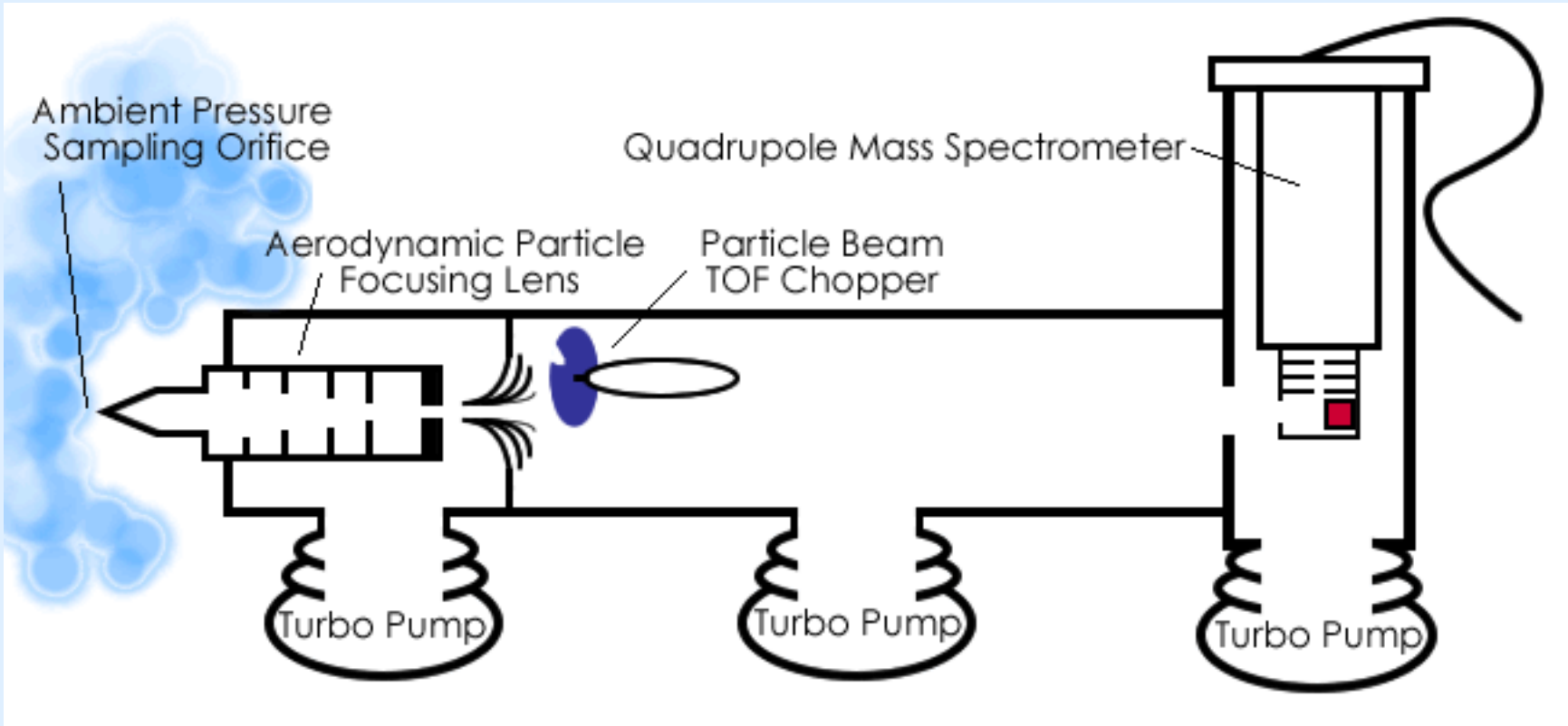
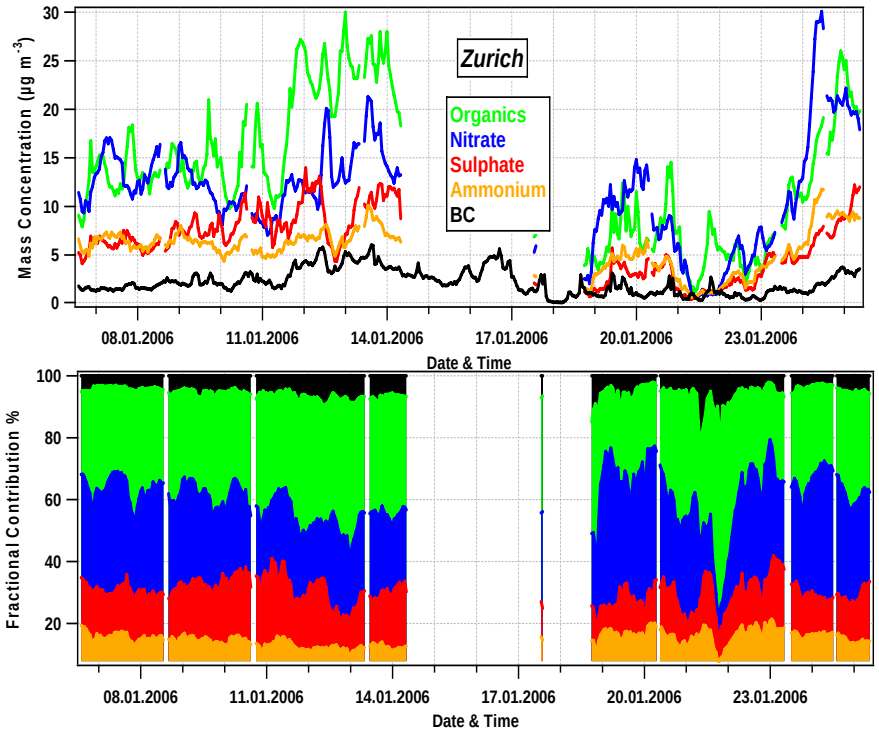
Outline

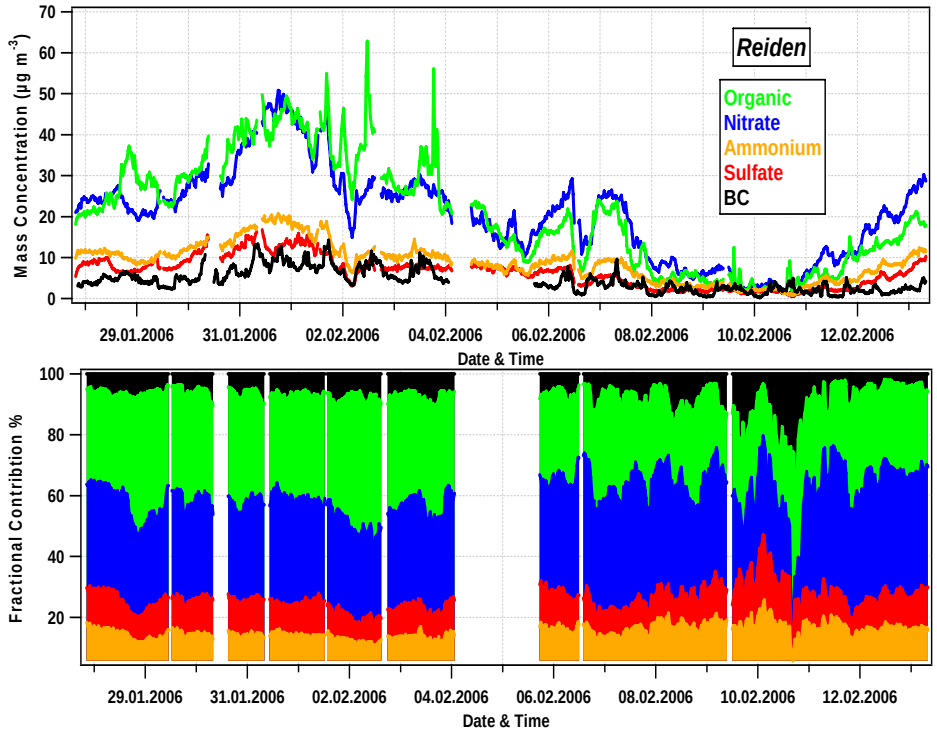
- Measurement principle of the Aerosol mass spectrometer
- Markers in mass spectra for source attribution
- Overview of the results concerning aerosol composition (PM1) (mostly nitrate (NO_3), ammonium (NH_4), sulfate (SO_4), black carbon (BC), some chloride and organic mass (OM) at monitoring sites
- Discussion of OM sources using mass spectral markers
- First results from recent mobile measurements
- Conclusions

The Aerodyne aerosol mass spectrometer



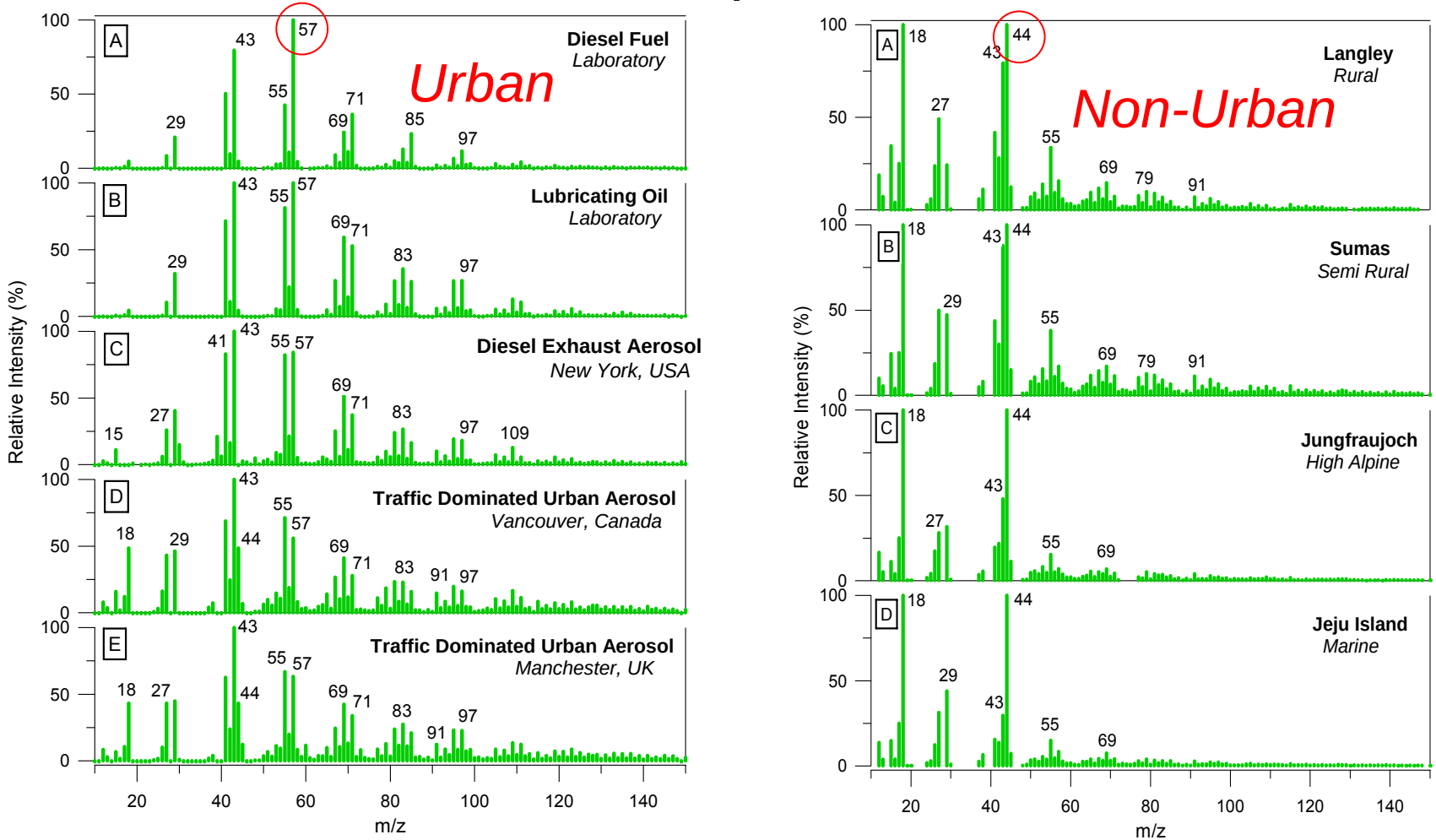
Example of Aerosol mass spectrometer measurements together with some black carbon measurements by an Aethalometer





Time resolution: minutes down to 6 seconds at low detection limits

Aerodyne aerosol mass spectrometer output: organic aerosol mass spectra



McFiggans, Alfarra et al., Faraday Discussions, 2005

Aerosol mass spectra of wood burning particles

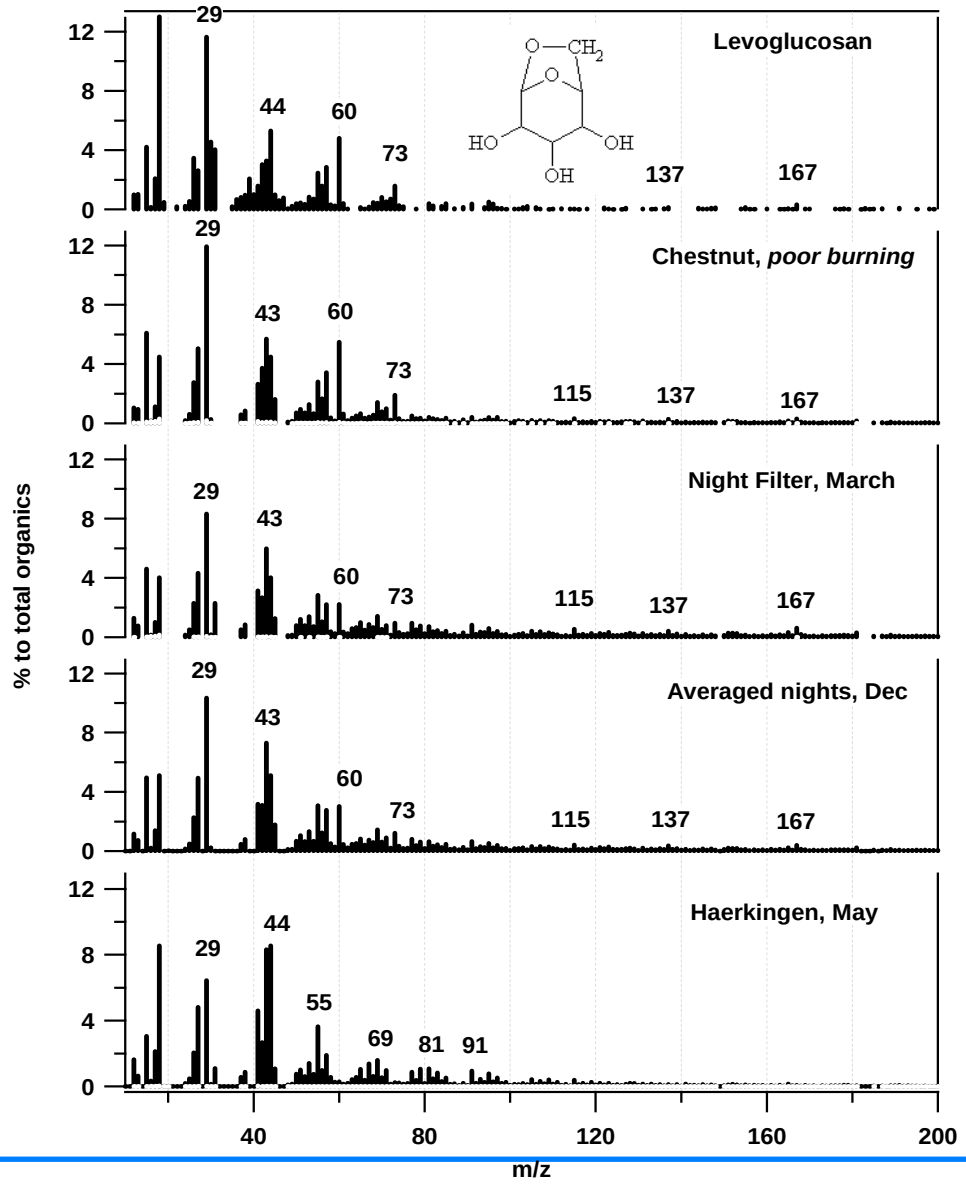
Levoglucosan

Wood burner (emissions) chestnut, very inefficient burning

Night period in Roveredo in March, more than 80% of OC non-fossil

Average in Roveredo over the whole December

Mass spectra from a Motorway site in May



Alfarra et al. ES&T (2007)

2006

Mass fragment markers for different sources

Original proposition (Alfarra et al., 2004):

- m/z 44 (mostly CO_2+) indicative for secondary organic aerosols (SOA)
- m/z 57 (mostly C_4H_9+) indicative for organic mass of **traffic** exhaust

New findings (Alfarra et al., 2007)

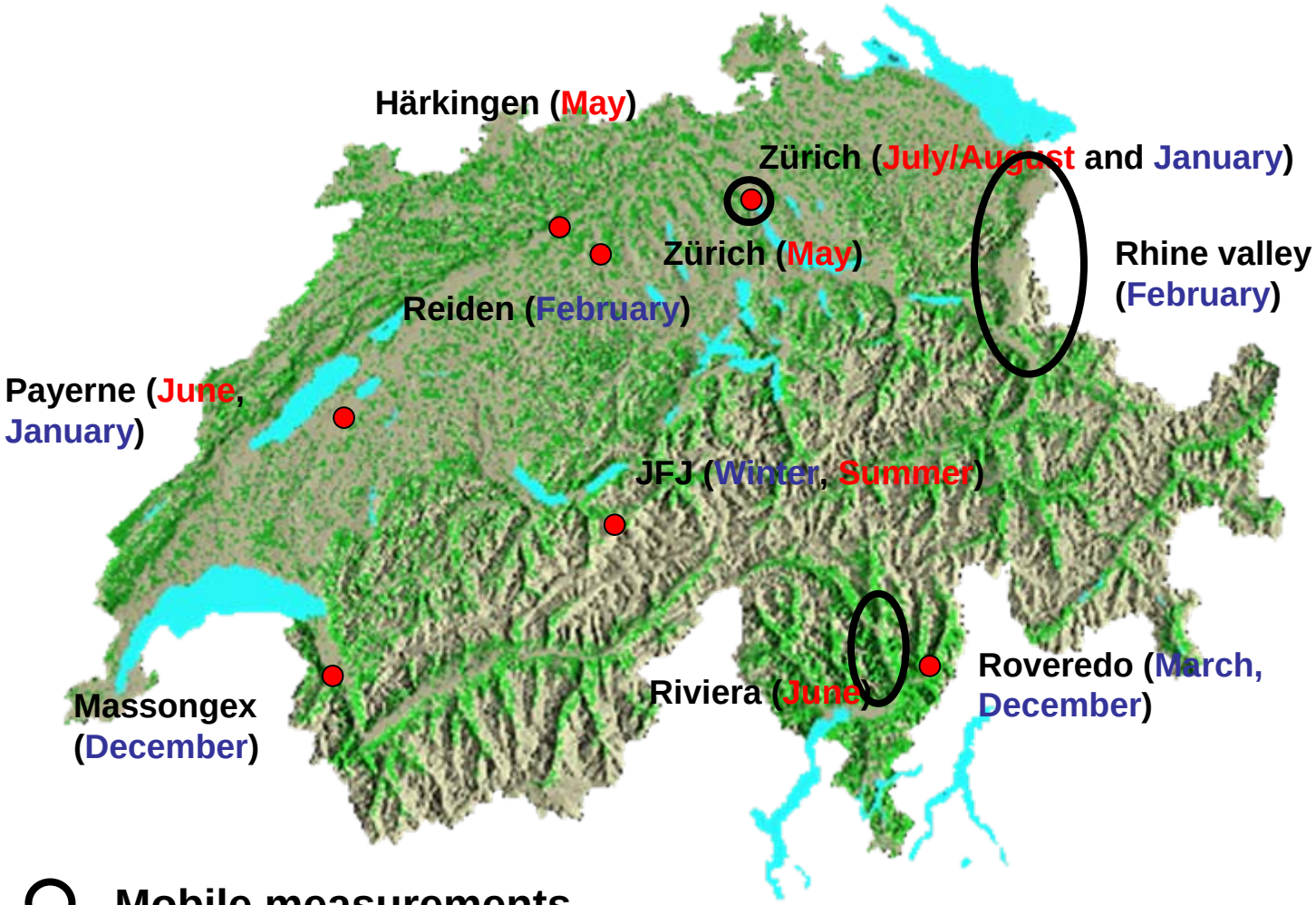
-m/z 60 (mostly ($C_2O_2H_4^+$) indicative for **biomass burning** (e.g. domestic wood burning)

- wood burning may also contribute to m/z44, and to m/z57

- in most cases: m/z57 from traffic is dominating (m/z 57 major peak); wood burning contribution might be taken into account in simple estimations

- the attribution of m/z44 must be done carefully if biomass burning sources are present

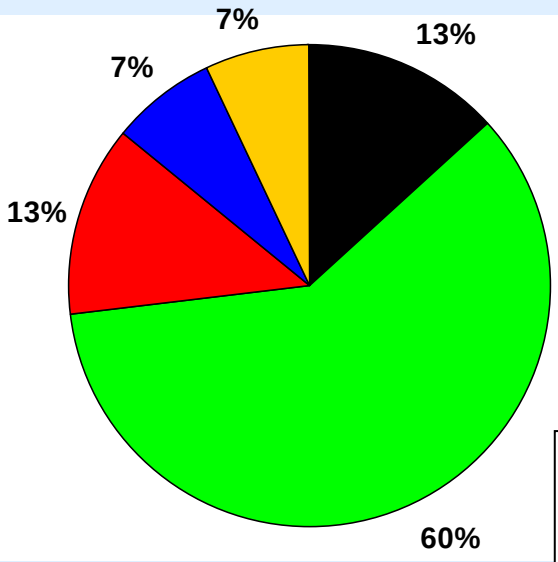
Locations with AMS Measurements



Mobile measurements

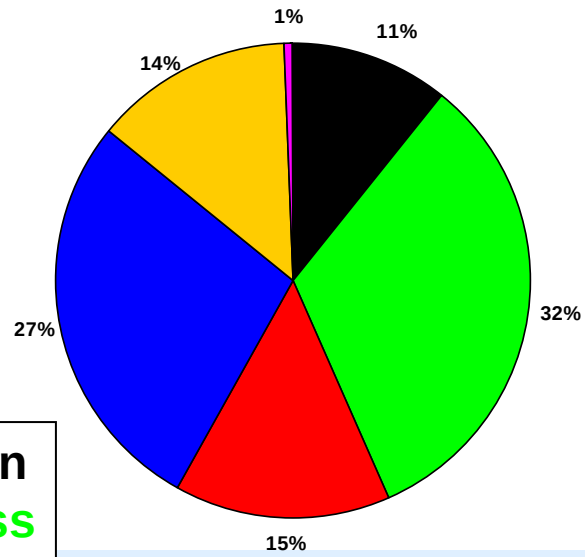
Milano (June)

Average composition in Zürich in summer and winter



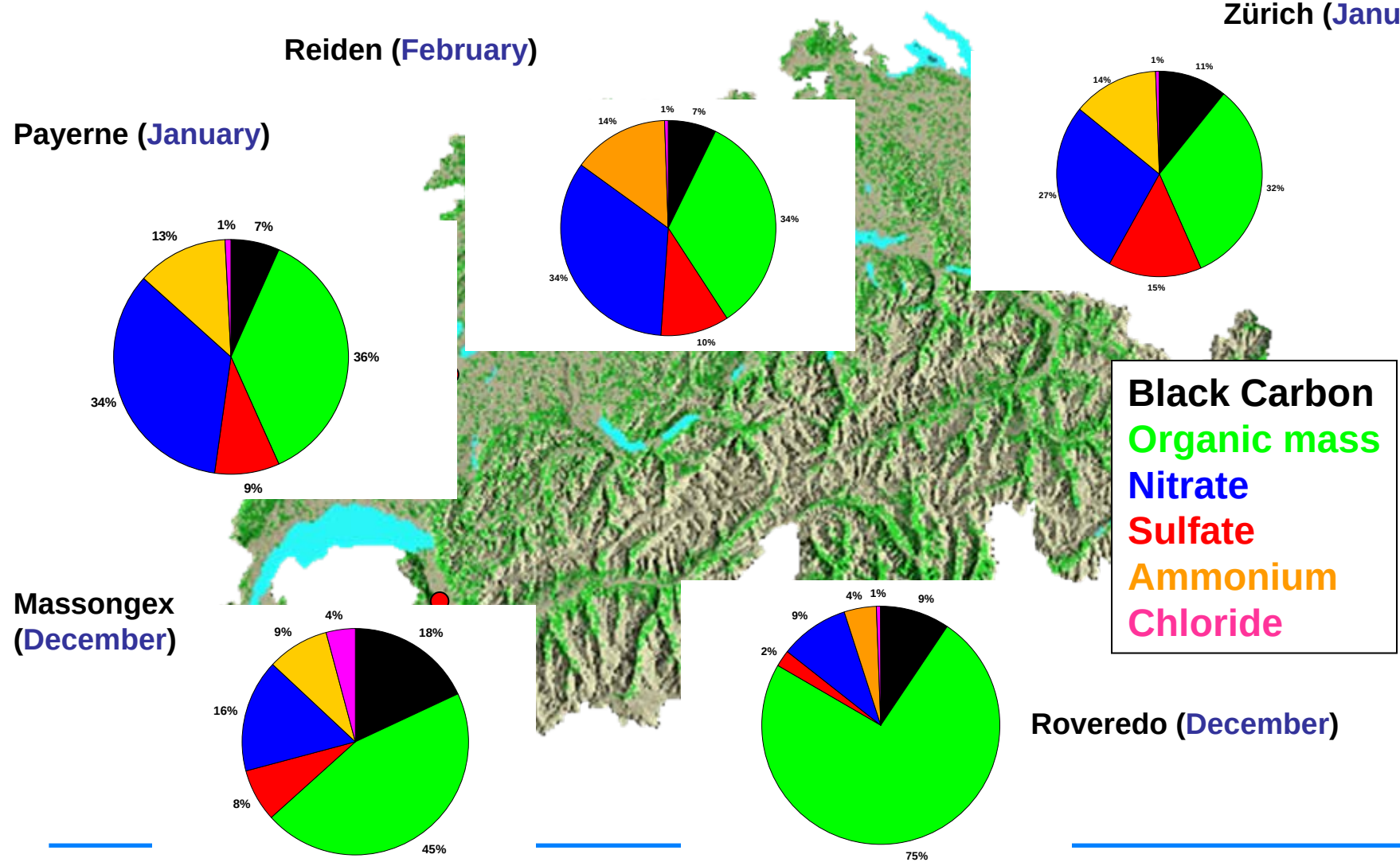
Zürich (July)

Black Carbon
Organic mass
Nitrate
Sulfate
Ammonium



Zürich (January)

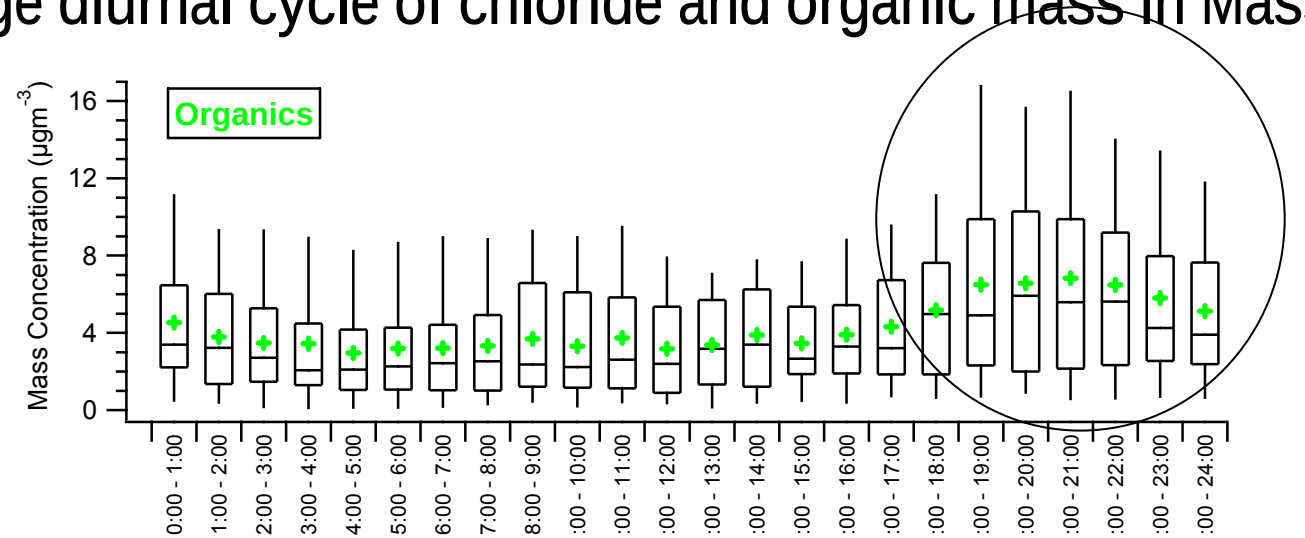
Average compositions in winter

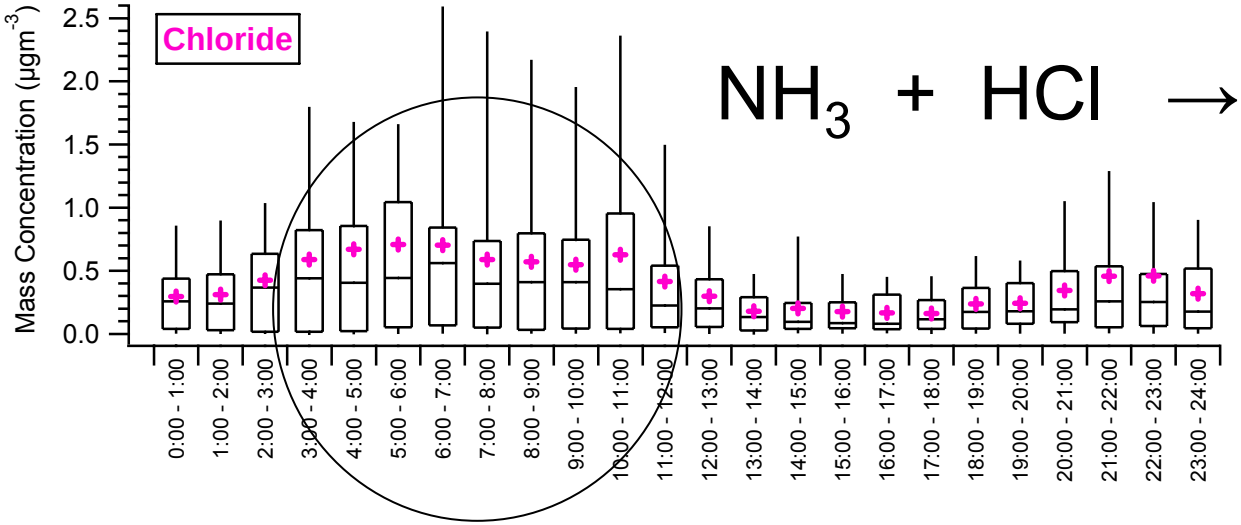


Simple estimations of wood burning and traffic contributions using marker/OM concentration ratios

Station (summer/winter)	Wood burning	traffic	Rest (mostly SOA)
Roveredo (Dec)	95%	5%	0%
Roveredo (March	47%	11%	42%
Zürich (Jan)	29%	14%	57%
Reiden (Feb)	32%	12%	56%
Massongex (Dec)	36%	12%	52%
Payerne (Jan)	32%	11%	57%
Zürich (July	14%	14%	72%
Härkingen(May)	11%	20%	69%
Payerne (July)	10%	10%	80%

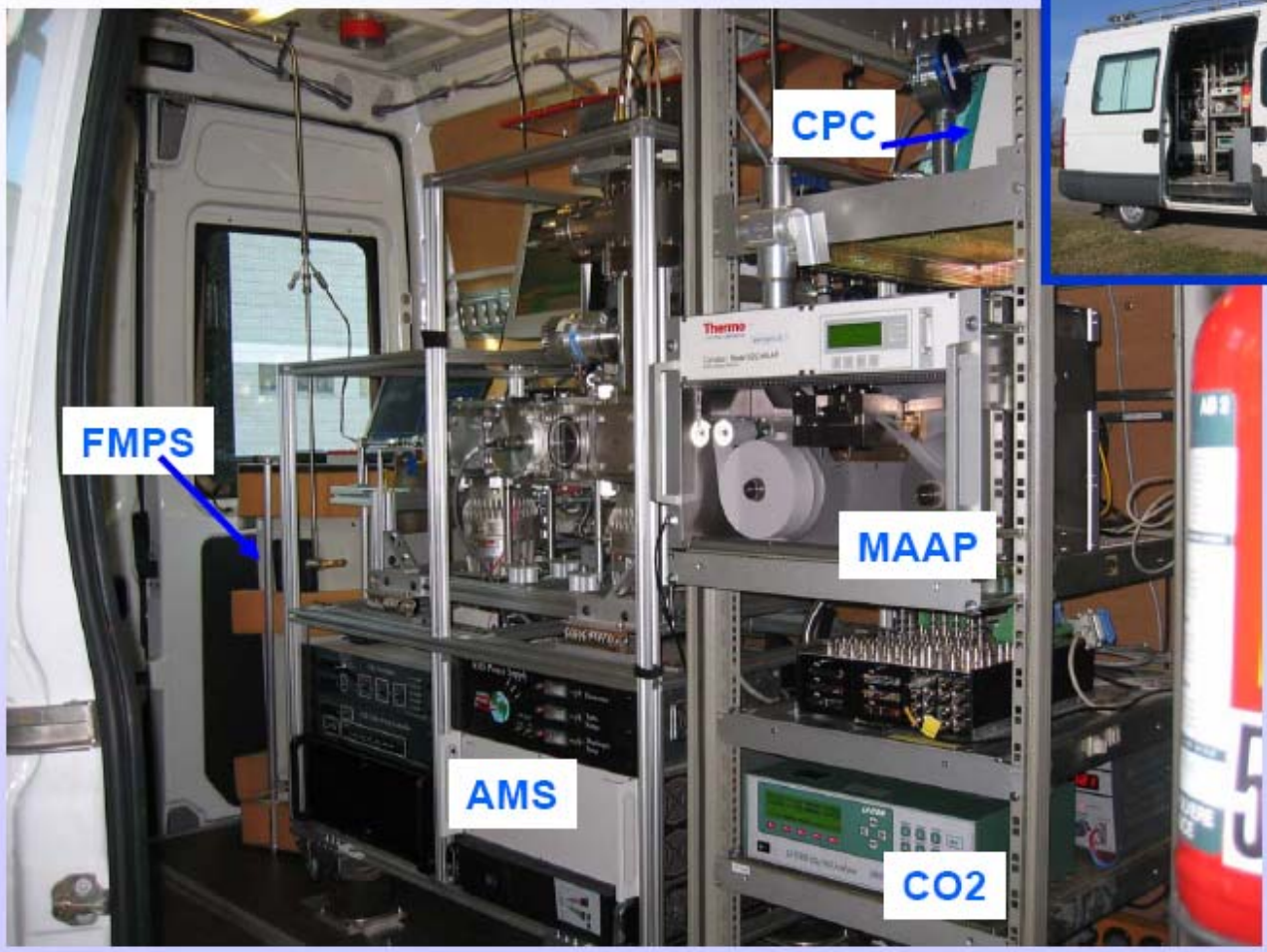
Average diurnal cycle of chloride and organic mass in Massongex



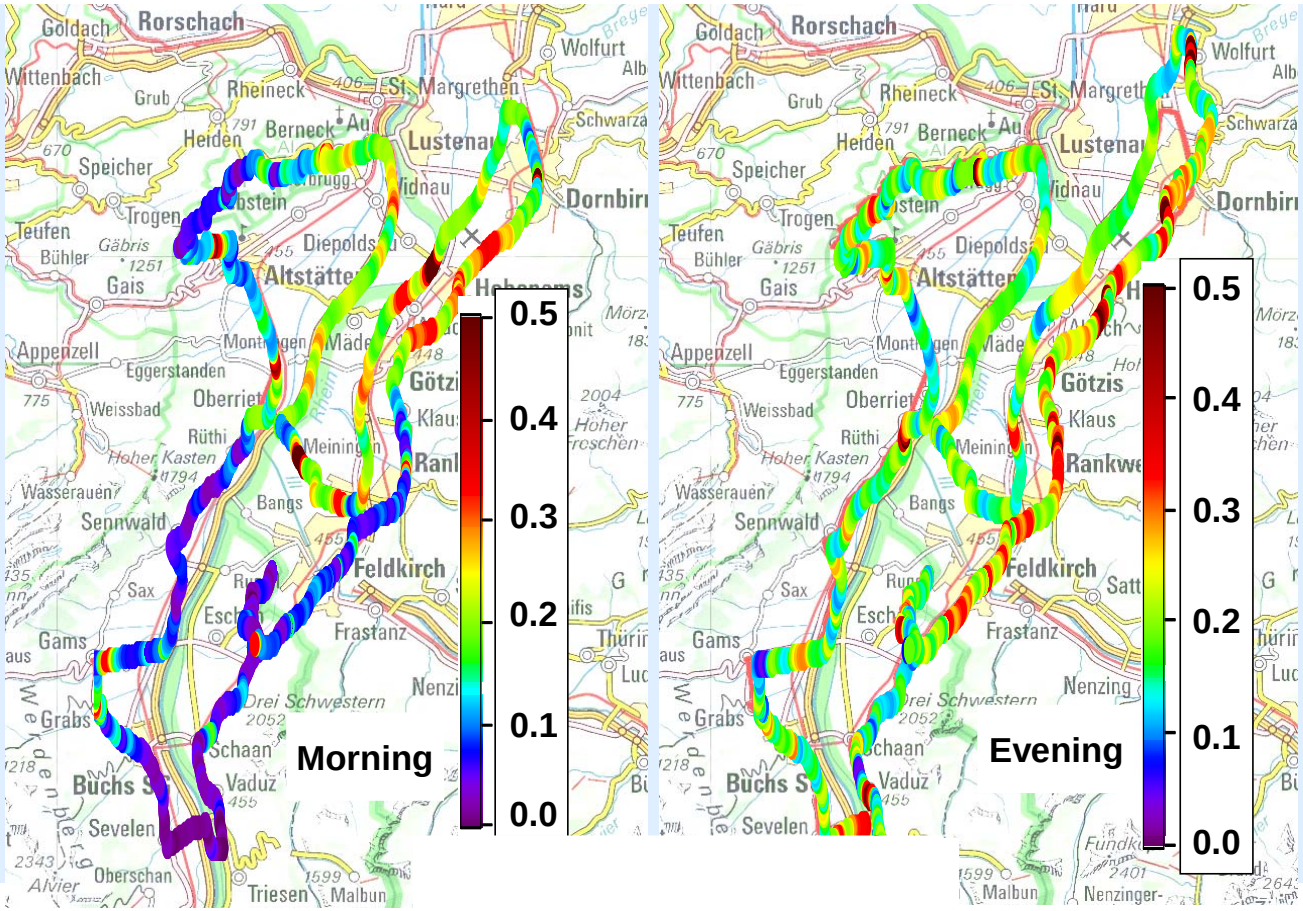


$$NH_3 + HCl \rightarrow NH_4Cl$$

PSI mobile laboratory



Estimation of wood burning contribution to OM as a function of location

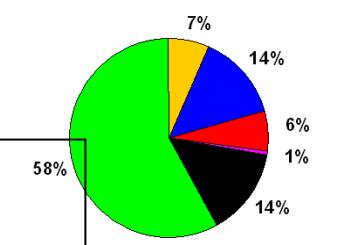


Average composition in the Rhine valley compared to Zürich and Reiden

Poster by Chirico, Weimer et al.

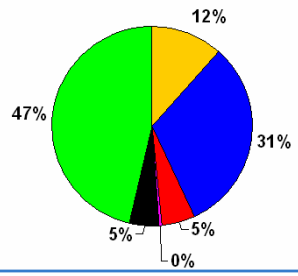
Black Carbon
Organic mass
Nitrate
Sulfate
Ammonium
Chloride

20-2-07-Morning



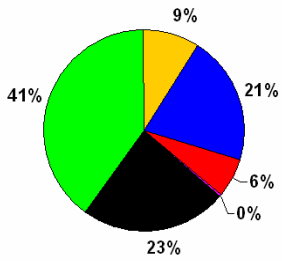
W.B. = 14.6% TRA = 41.3%

20-2-07-Evening



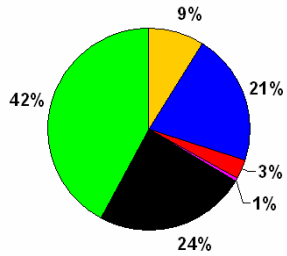
W.B. = 20.5% TRA = 20.9%

21-2-07-Morning



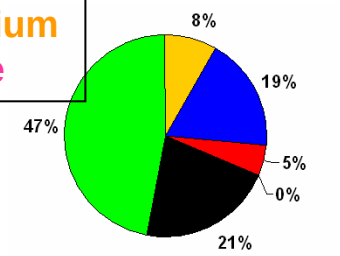
W.B. = 16.7% TRA = 27.0%

21-2-07-Evening



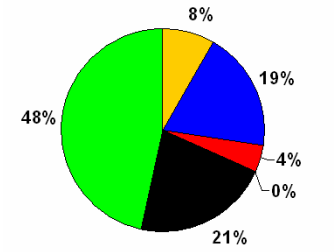
W.B. = 21.6% TRA = 30.4%

22-2-07-Morning



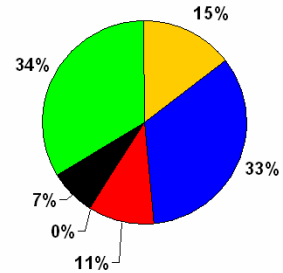
W.B. = 14.8% TRA = 38.8%

22-2-07-Evening



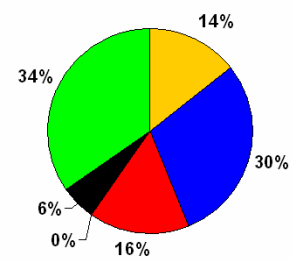
W.B. = 21.2% TRA = 36.8%

Reiden



W.B. = 32.4% TRA =12.2%

Zürich



W.B. = 28.8% TRA = 14.5%

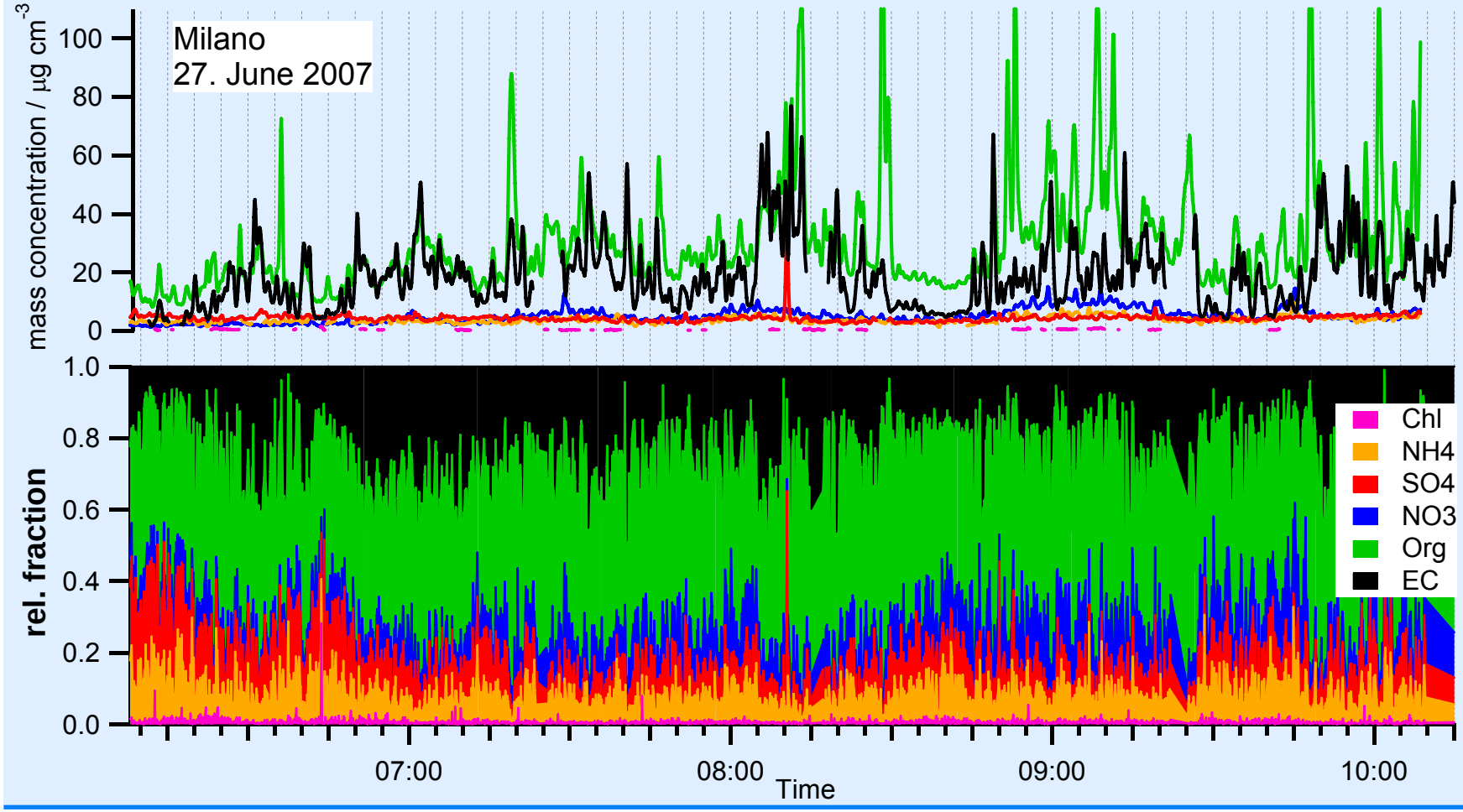
In Rhine valley relatively more EC and OM

Wood burning contribution Rhinevalley: 14-21%; Reiden/Zürich : 29-32%

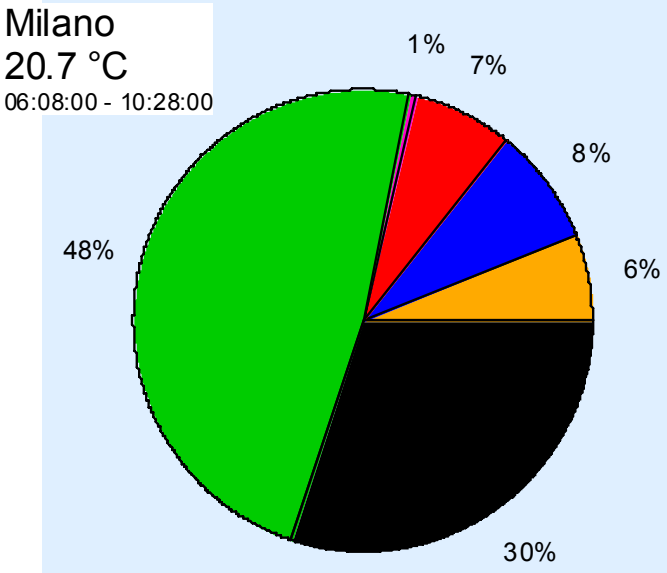
Traffic contribution: Rhinevalley: 20-41%; Reiden/Zürich : 12-14%

Mobile measurements in Milano

Mobile measurements in Milano



Average composition of aerosol in Milano in the morning of June 27, 2007



Black Carbon
Organic mass
Nitrate
Sulfate
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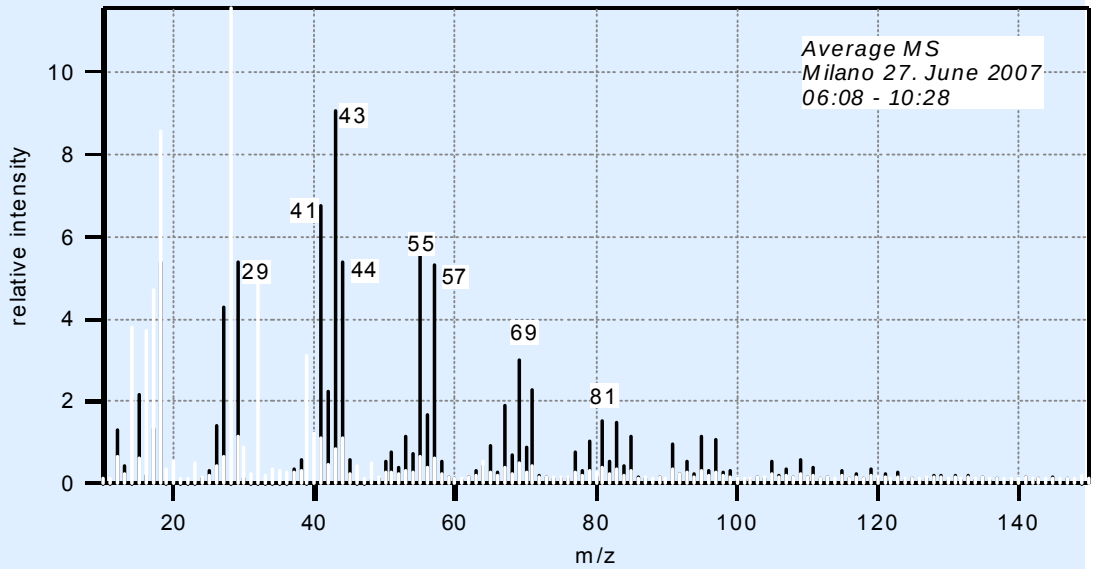
Chloride



Estimation of OM contributions:

Traffic: 64%

wood burning: 4%

Conclusions

• The Aerosol mass spectrometer is a powerful tool for the analysis of aerosol composition. Mobile measurements allow for new possibilities.

• Markers can be used to some extent to estimate sources for OM (wood burning, traffic, secondary organic aerosol). Better are sophisticated source apportionment methods (see next talk).

• Ammonium nitrate is very important in winter. The contribution of ammonium sulfate was highest in Zürich

• In summer, secondary organic aerosols are very important. But also in winter is the contribution typically 50% (except in some Alpine valleys)

• Wood burning is in winter always an important source

• The traffic contribution to OM at the monitoring stations was not very high. During the mobile measurements in the Rhine valley and especially in Milano, very high concentrations of EC and traffic contributions were found