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Wir schaffen Wissen – heute für morgen

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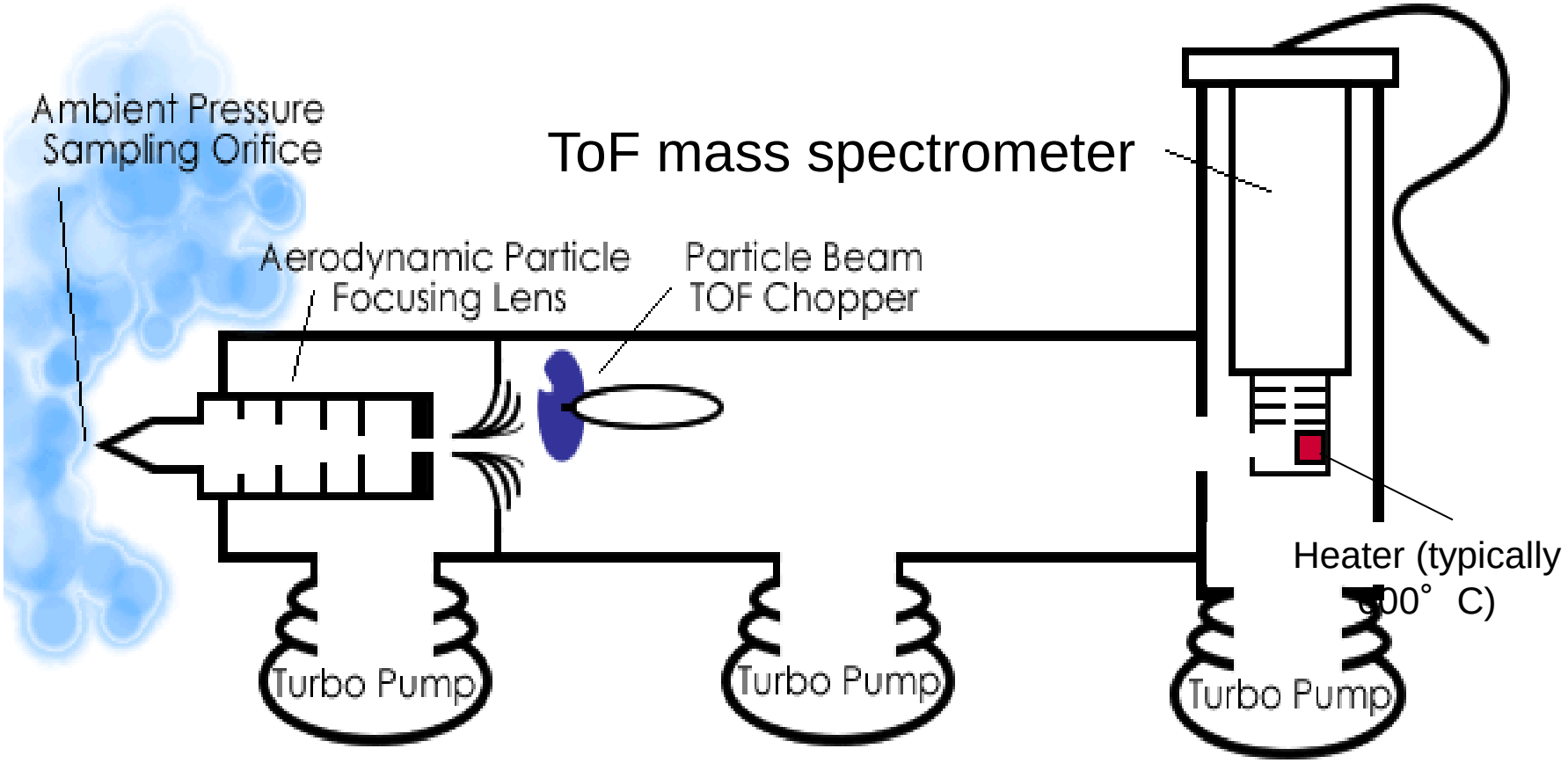
The potential of the Aerosol Chemical Speciation Monitor for Long-Term Monitoring

Thanks to BAFU, Empa for financial support and collaboration

Content

- Introduction
- Aerosol chemical speciation monitor versus Aerosol mass spectrometer
- First results
- Conclusions/Outlook

Research grade Aerosol mass spectrometer



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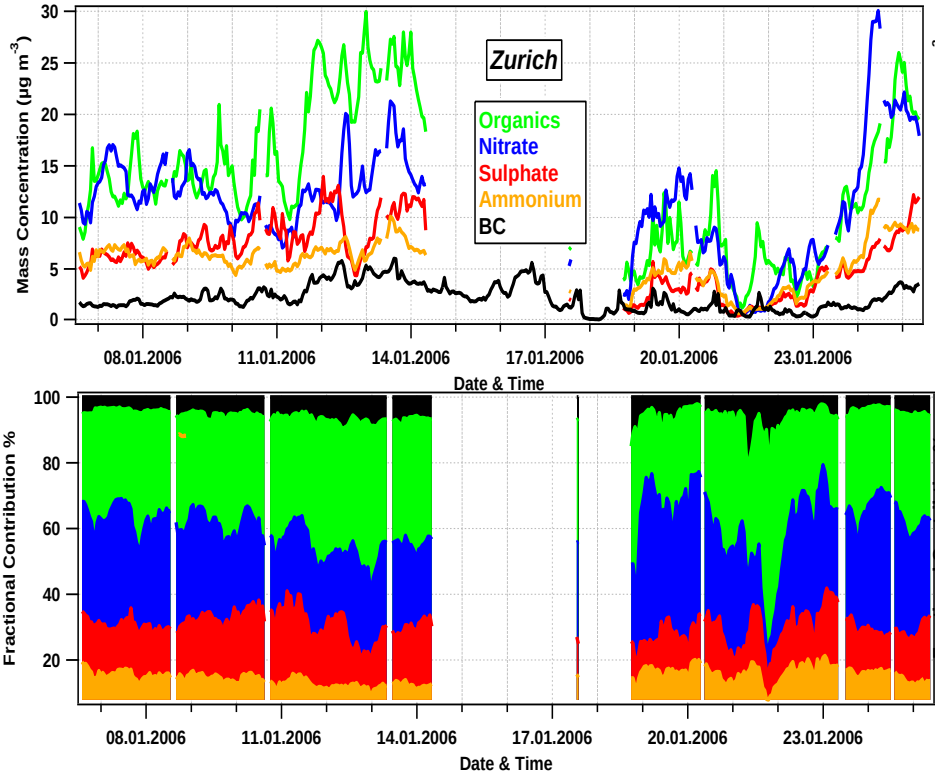
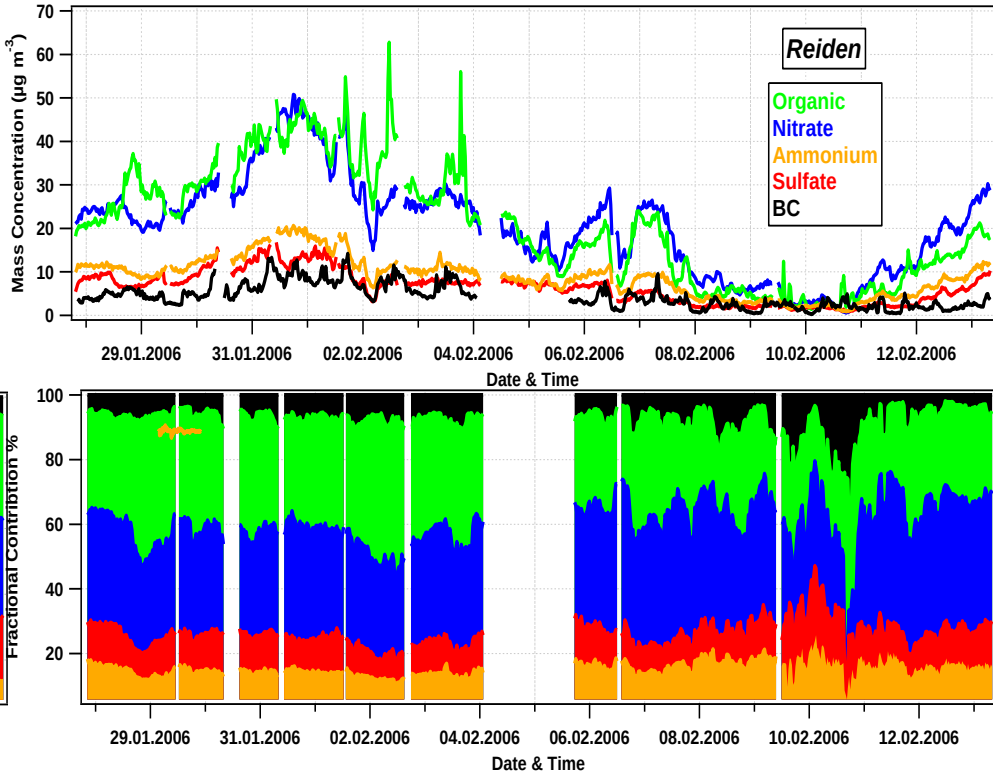
Time series (time resolution seconds to minutes) of PM1 (in the future also PM2.5 possible).

Black or elemental carbon or other refractory components must be measured by other instruments than AMS.



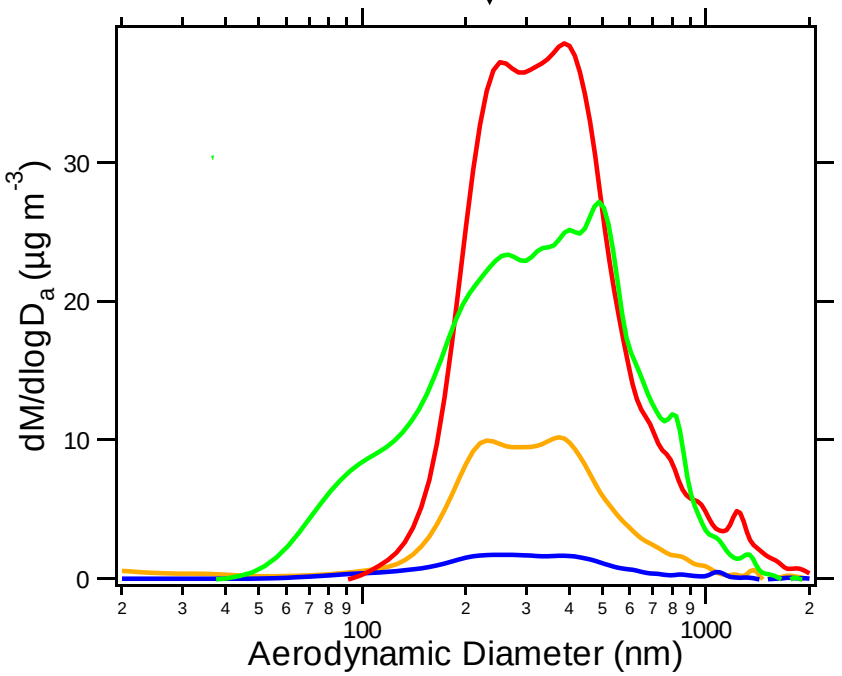


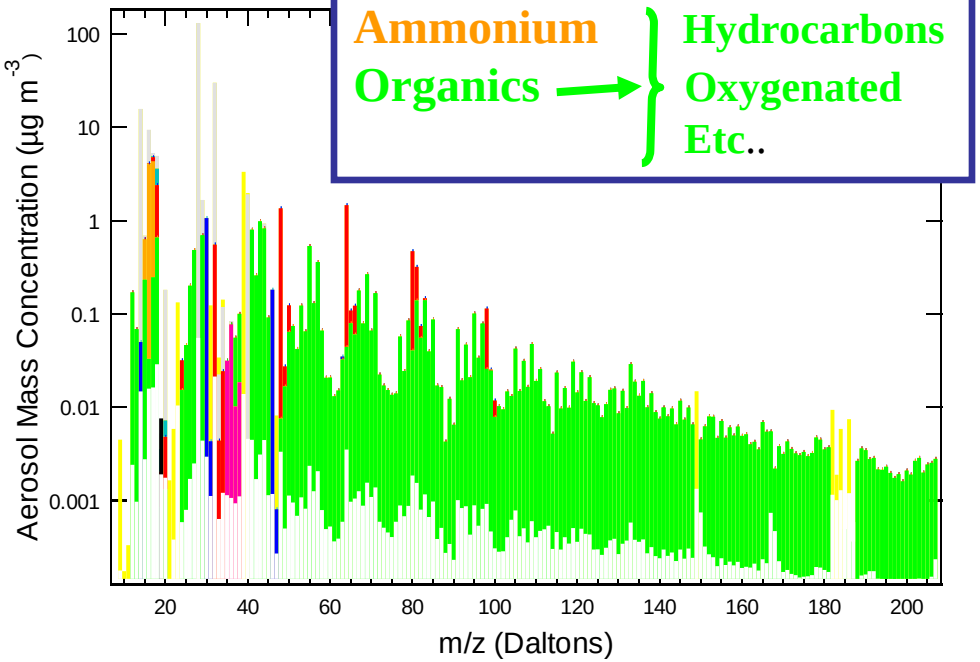
Real-time measurement of aerosol particles with the AMS

Aerosol Sampling

Real-time measurement → **AMS**

Nitrate
Sulphate
Ammonium
Organics → **Hydrocarbons**, **Oxygenated**, **Etc..**

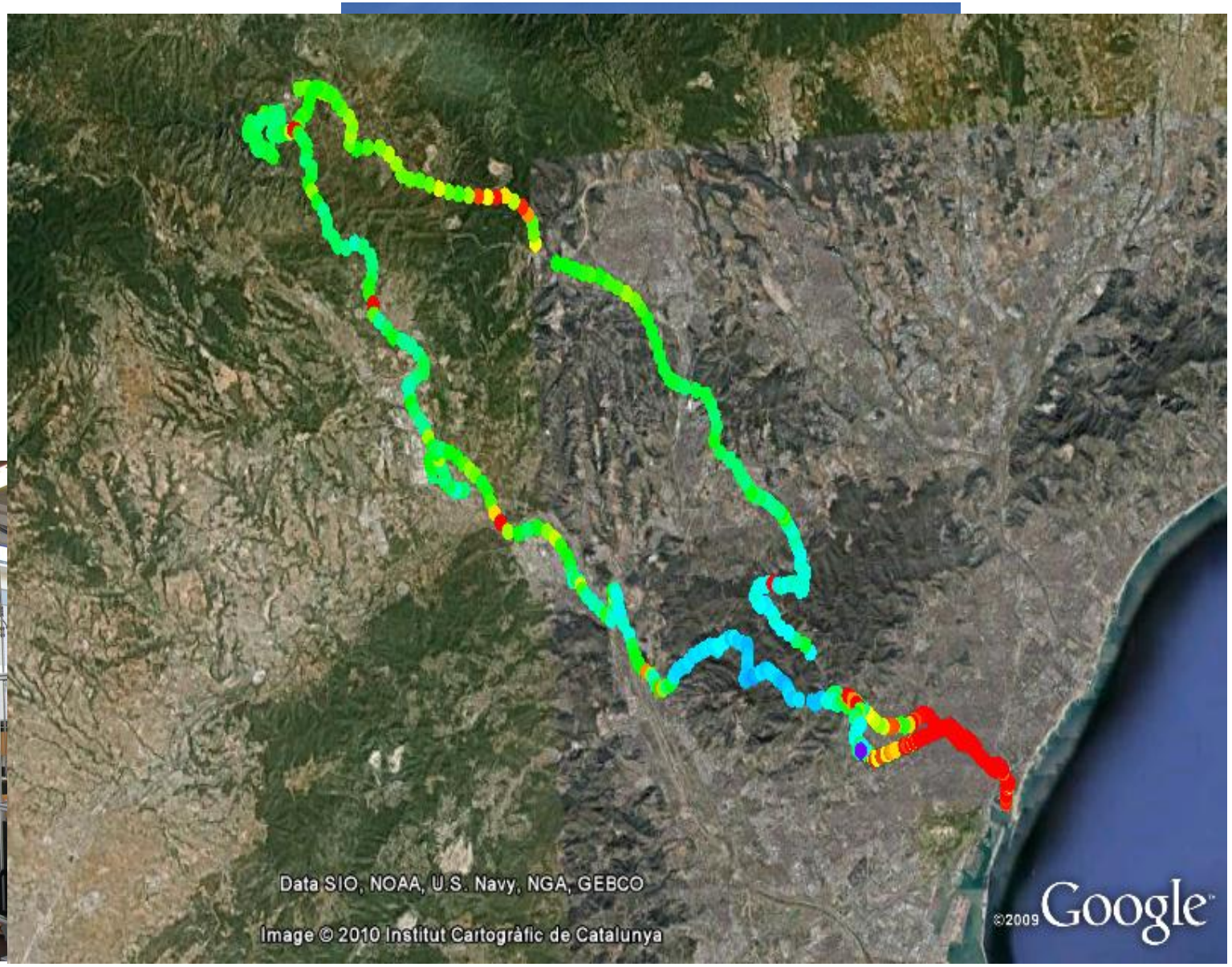




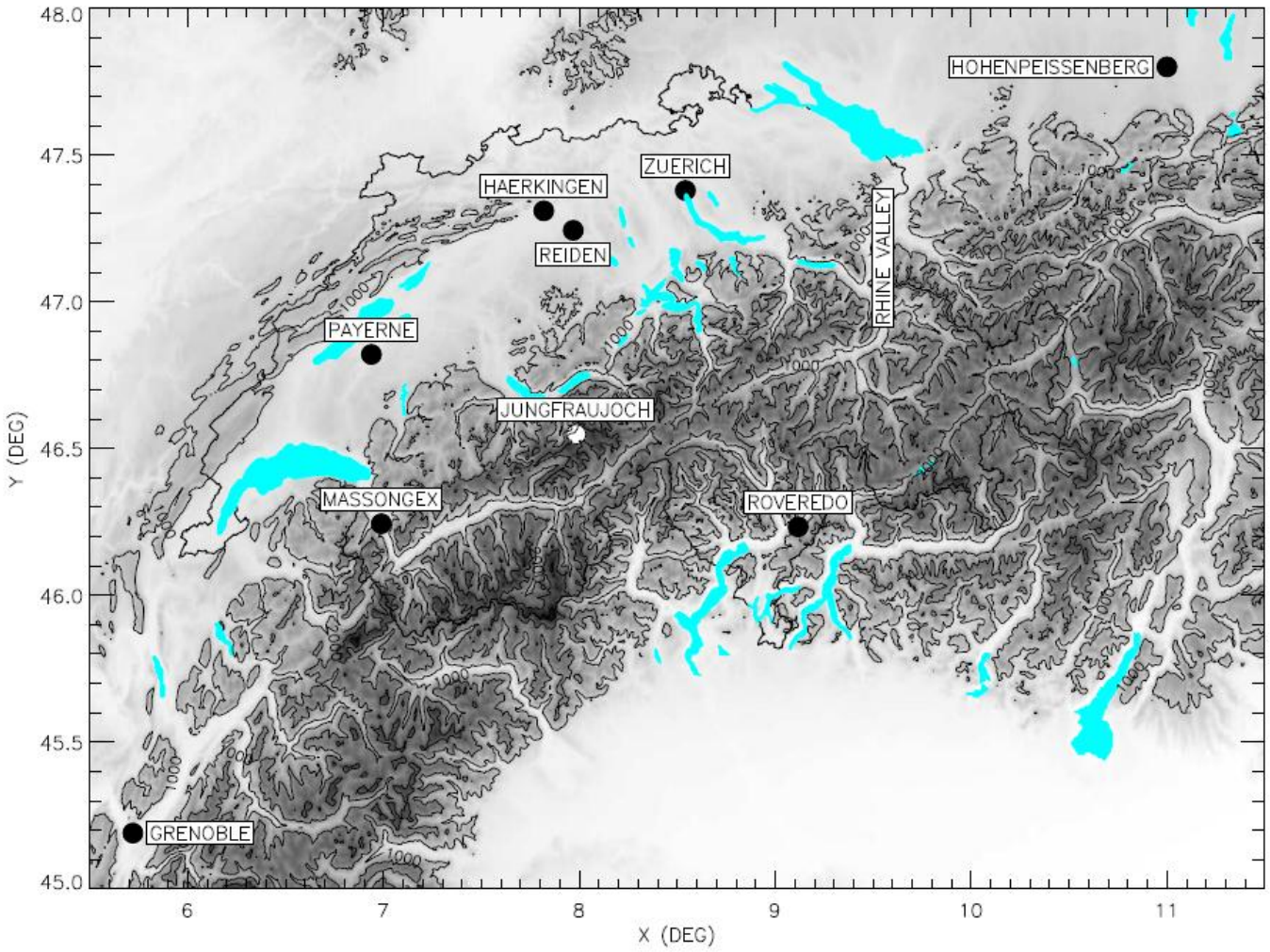
Mass Size distribution

Chemical composition

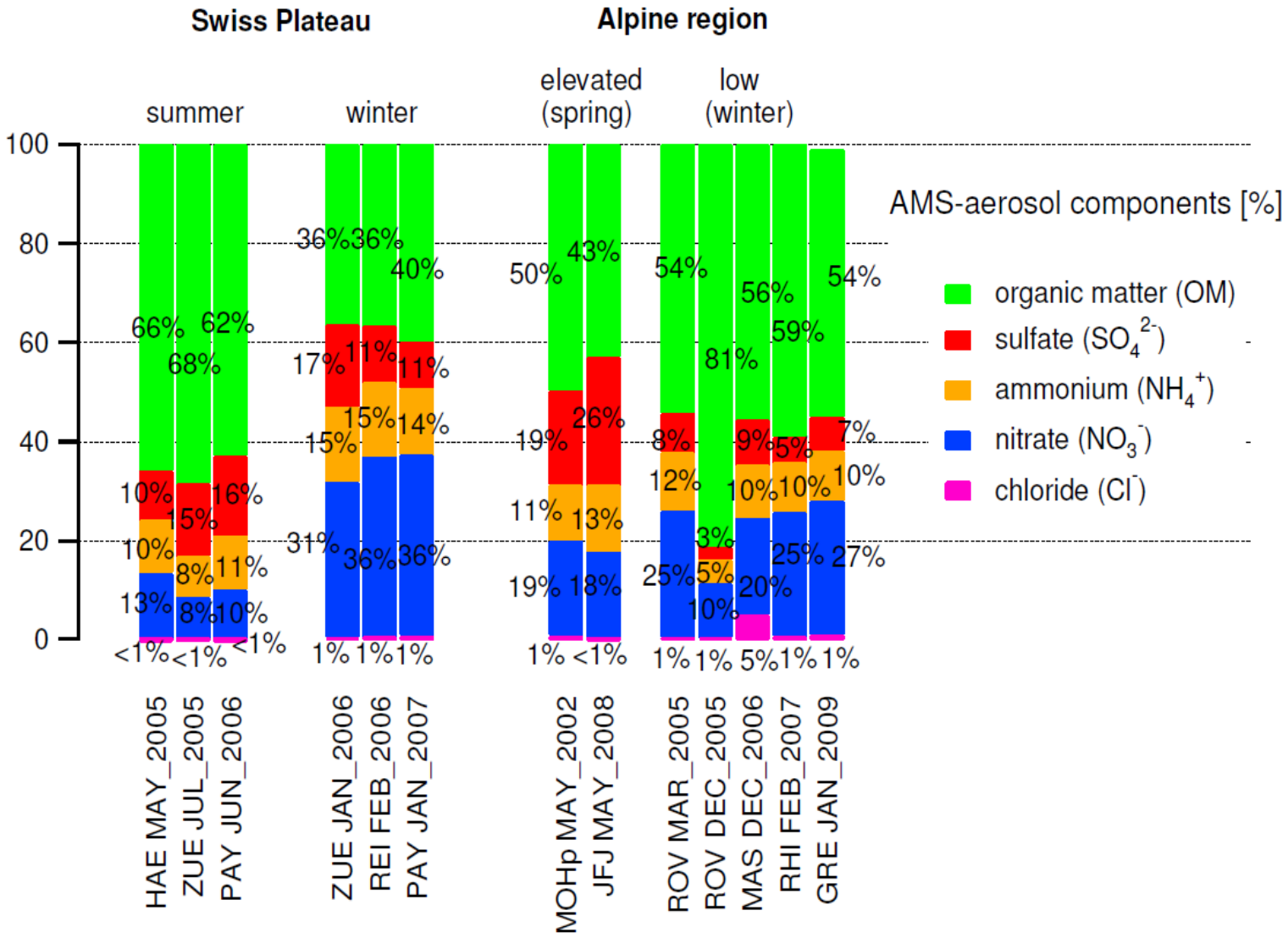
Mobile measurements possible



AMS measurements in and around Switzerland

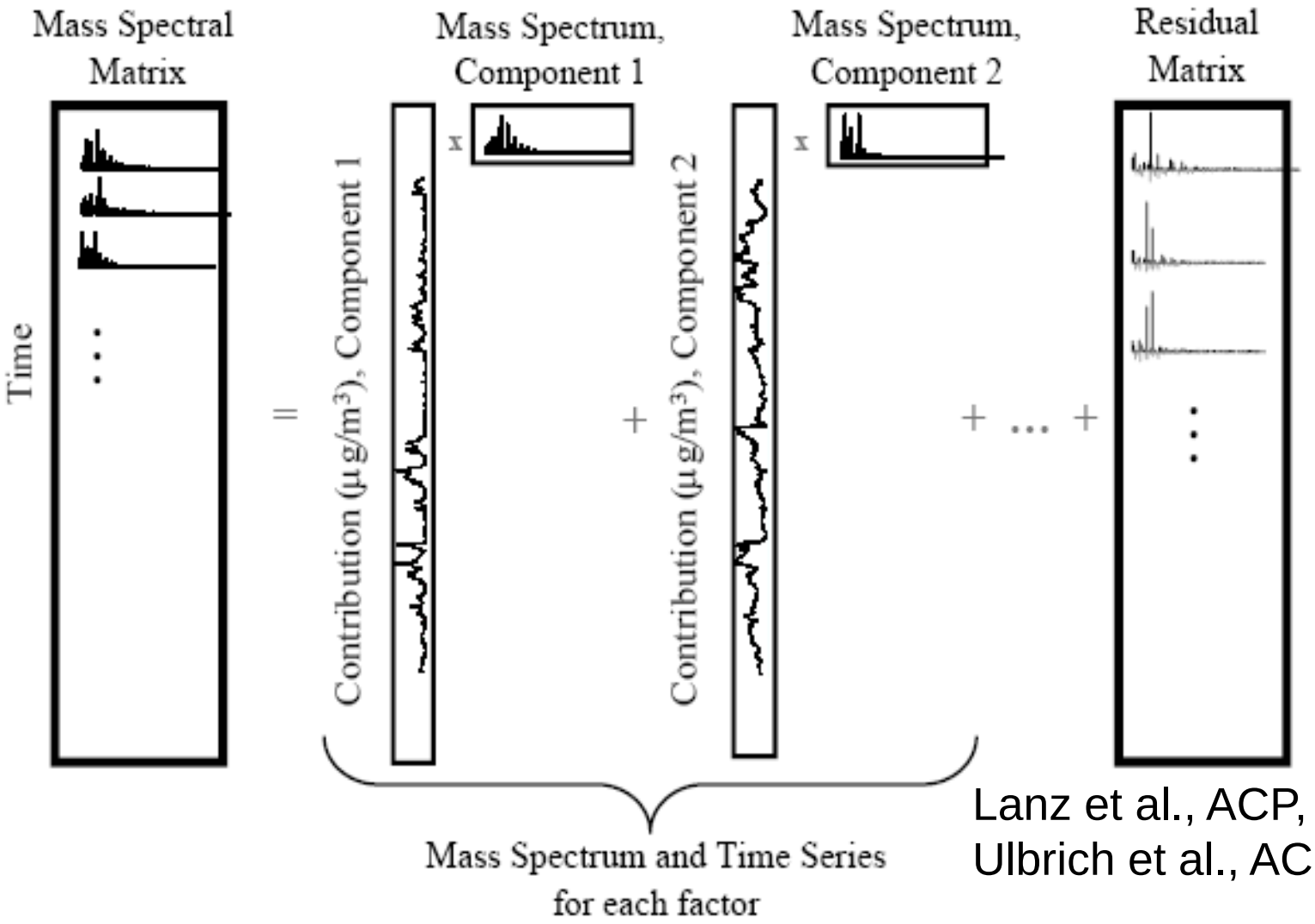


Chemical composition of PM1 without BC in Central Europe



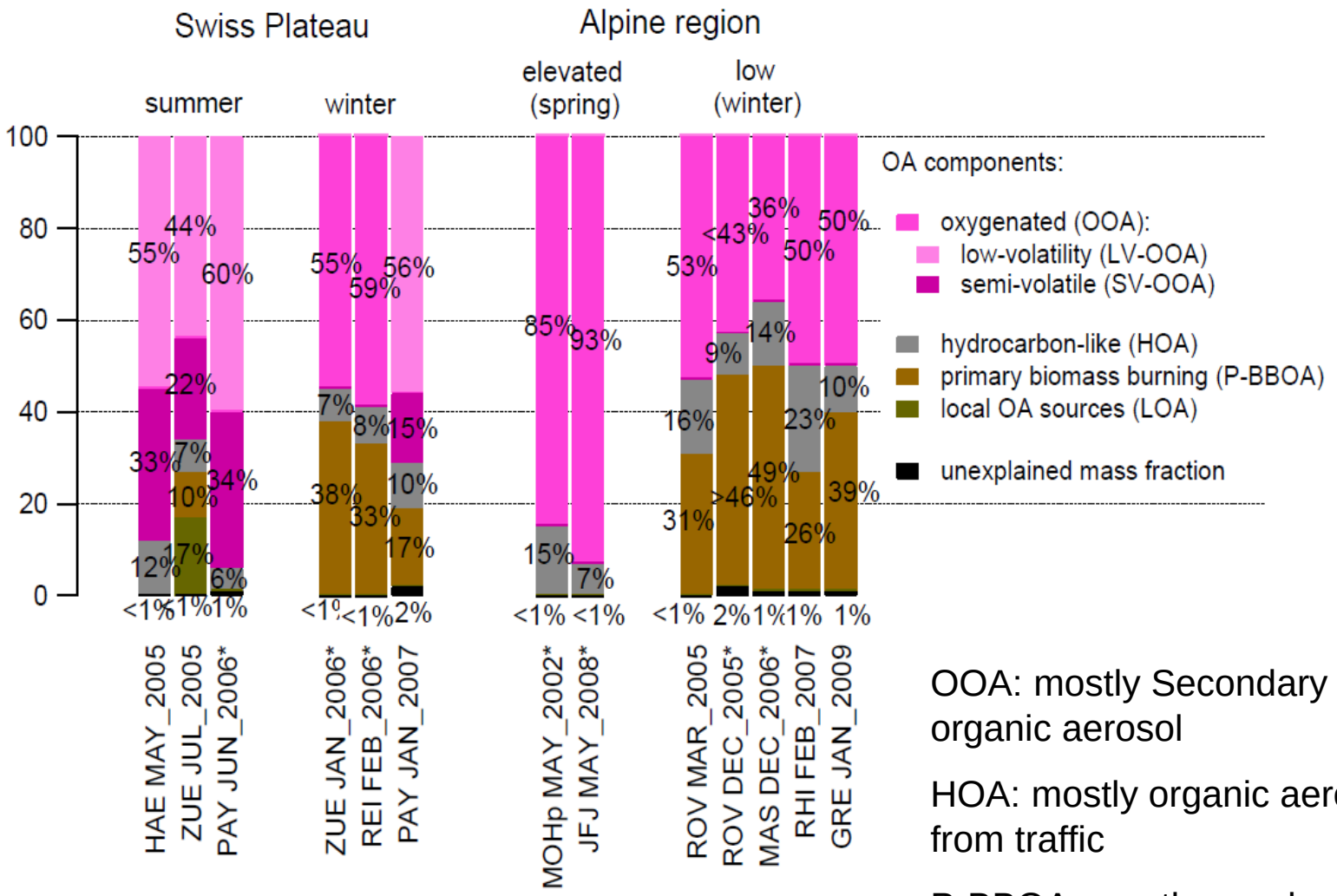
Lanz et al., ACP, 2010

Positive Matrix Factorization (PMF) of full OM spectrum for source identification and attribution



Lanz et al., ACP, 2007
Ulbrich et al., ACP 2009

Chemical components of organic aerosol



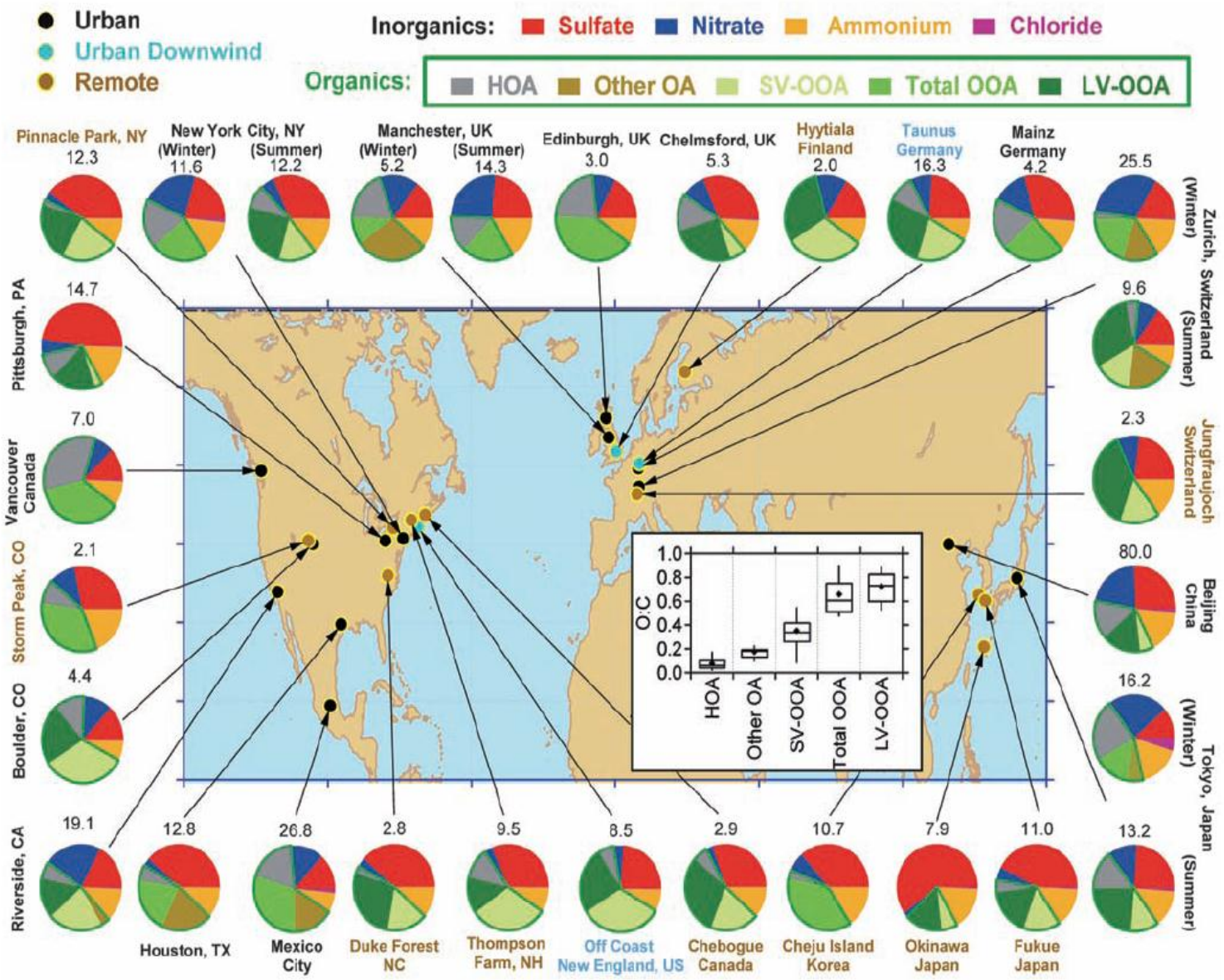
OOA: mostly Secondary organic aerosol

HOA: mostly organic aerosol from traffic

P-BBOA: mostly wood burning

Lanz et al., 2010

Composition and organic components in the northern hemisphere



HOA: mostly fossil combustion like traffic

OOA: mostly secondary

Other OA: e.g. wood burning, cooking

- **Data are based on campaigns of 3-5 weeks**

Jimenez, Prevot et al., Science, 2009

2. The ACSM instrument - Scheme

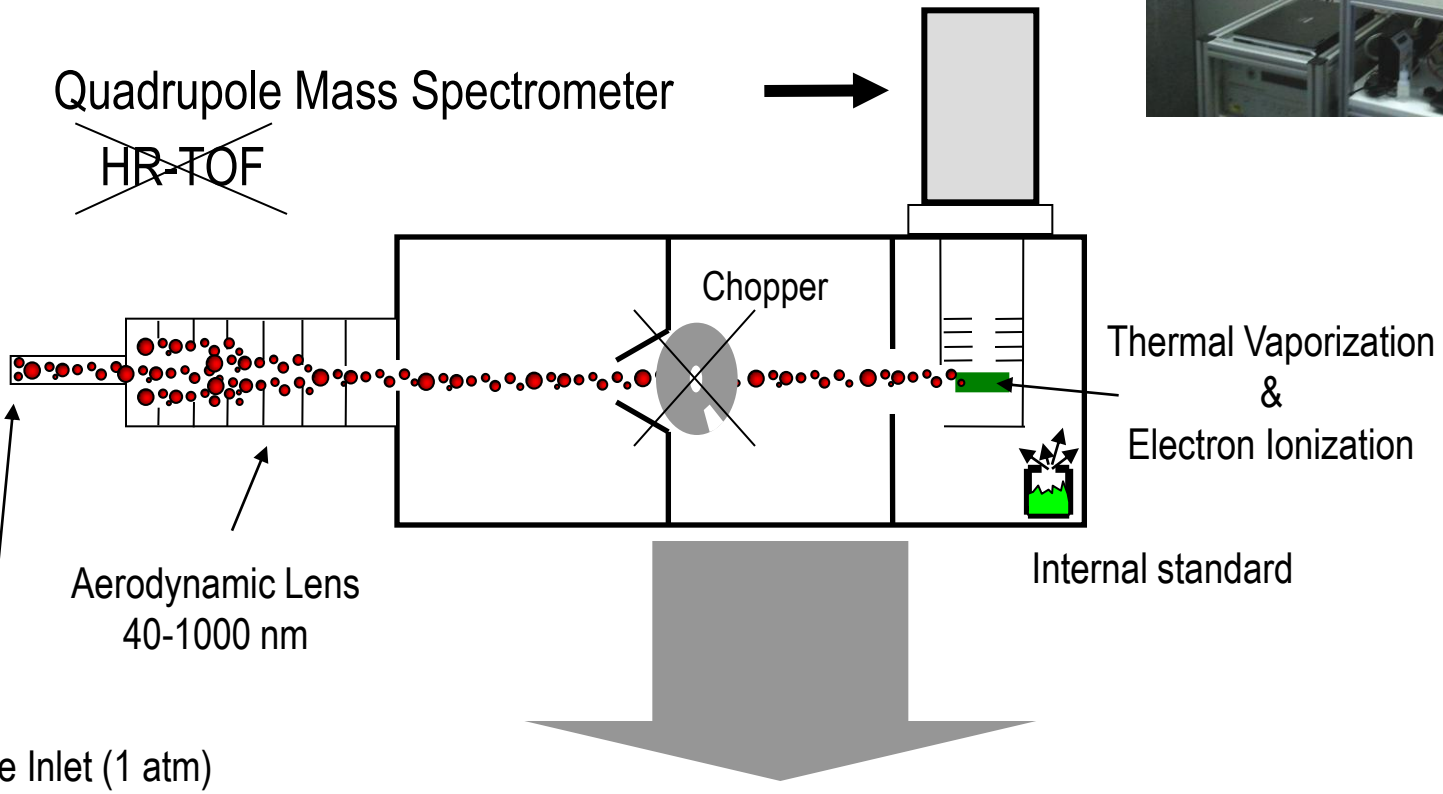
Particle Beam Generation

~~Particle Sizing~~

Particle Composition

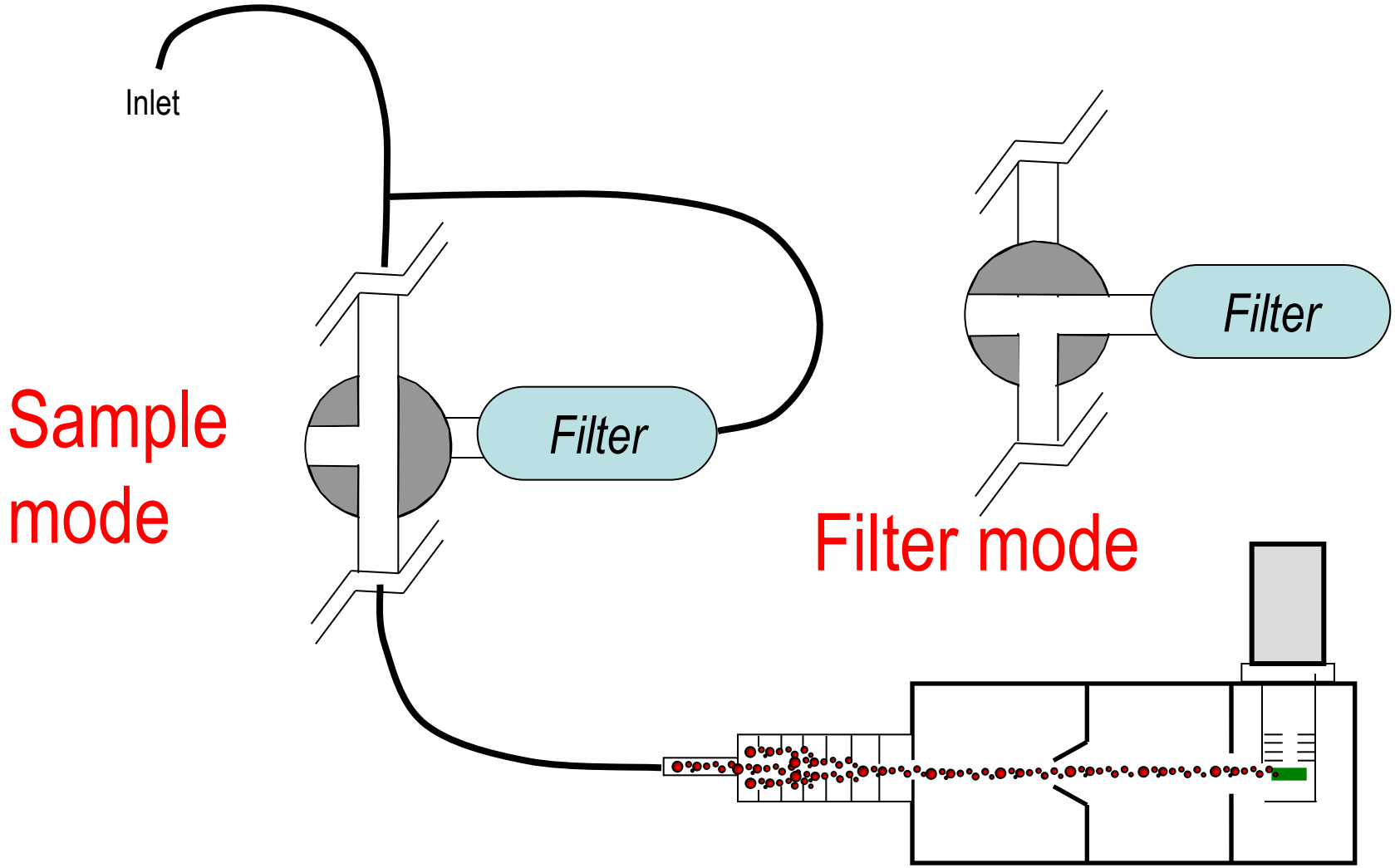
Quadrupole Mass Spectrometer

~~HR-TOF~~

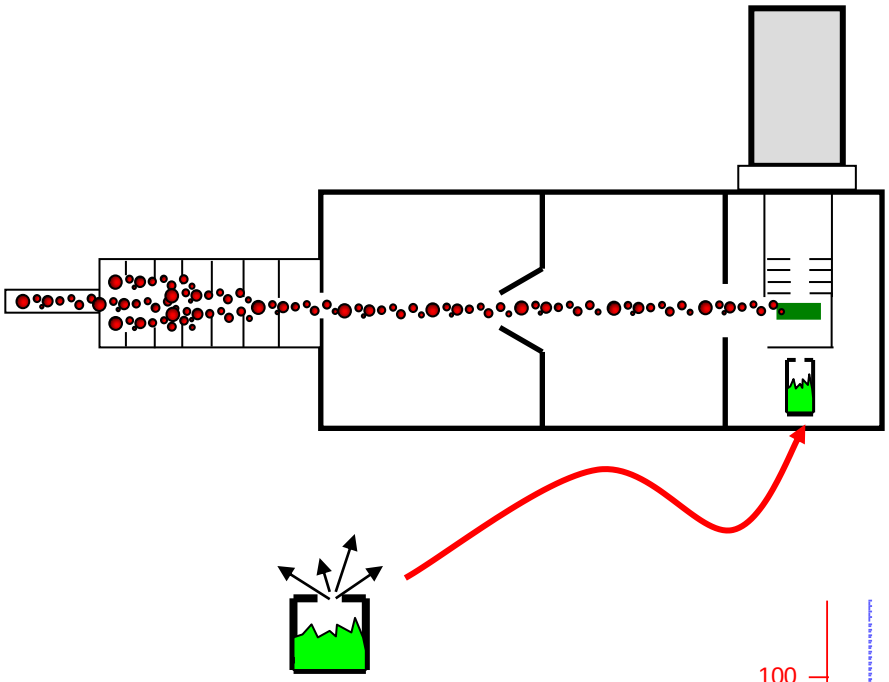


2. The ACSM instrument – Sampling mode

Aerosol mass is determined from difference of ‘Sample – Filter” mode

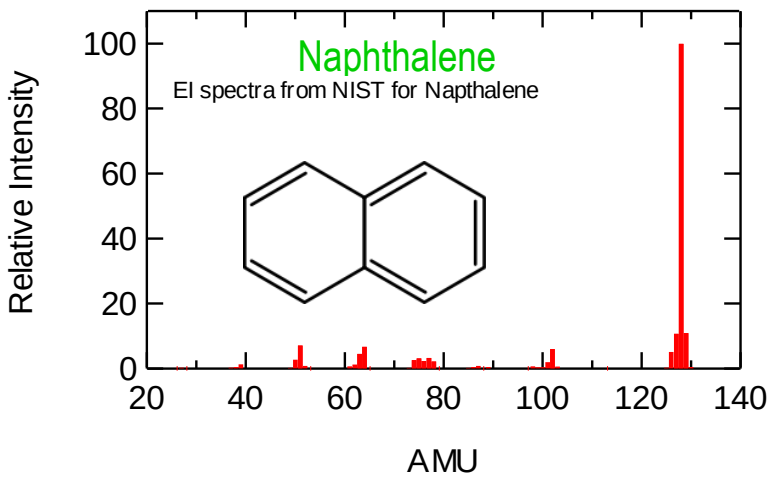


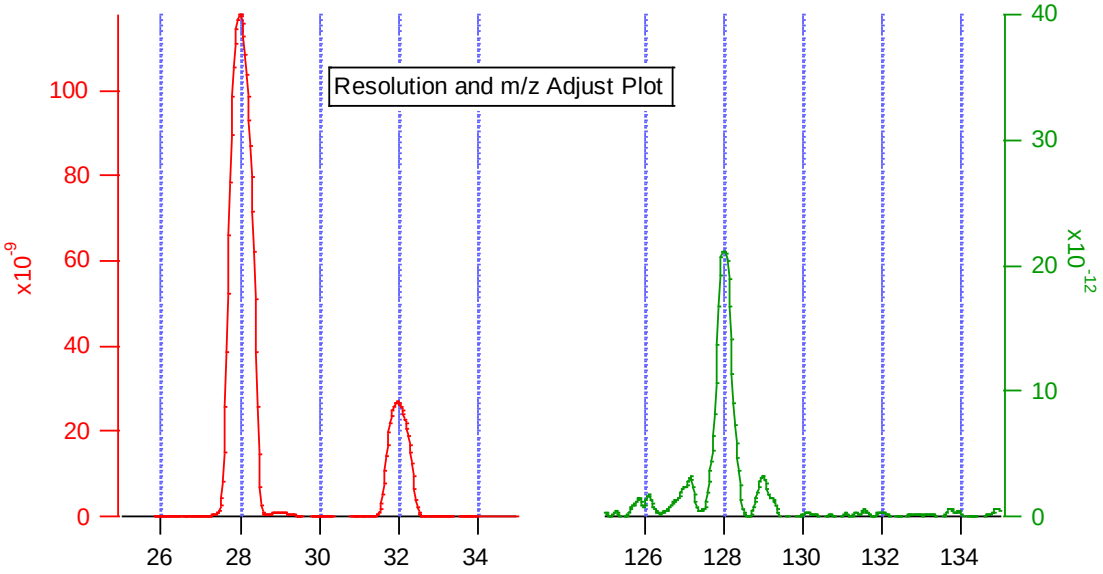
2. The ACSM instrument - Naphthalene



Naphthalene used for e.g.,

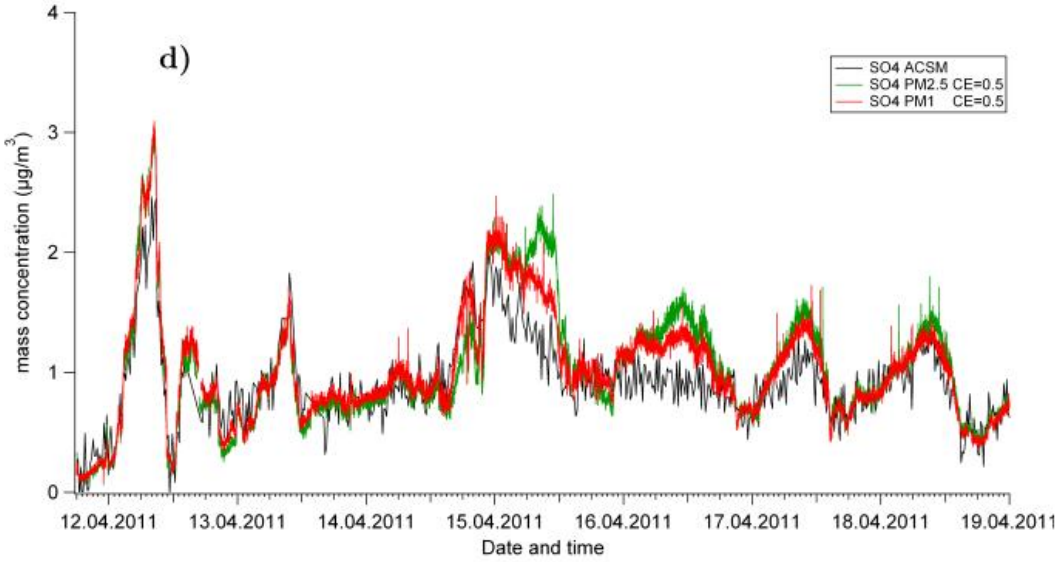
-m/z calibration



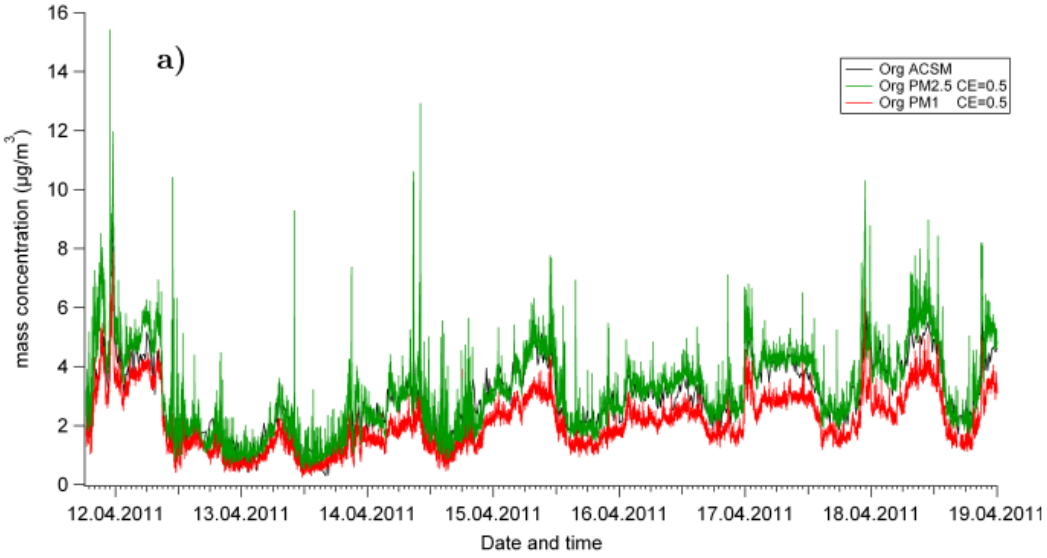


Example of comparison of time trends ACSM/AMS

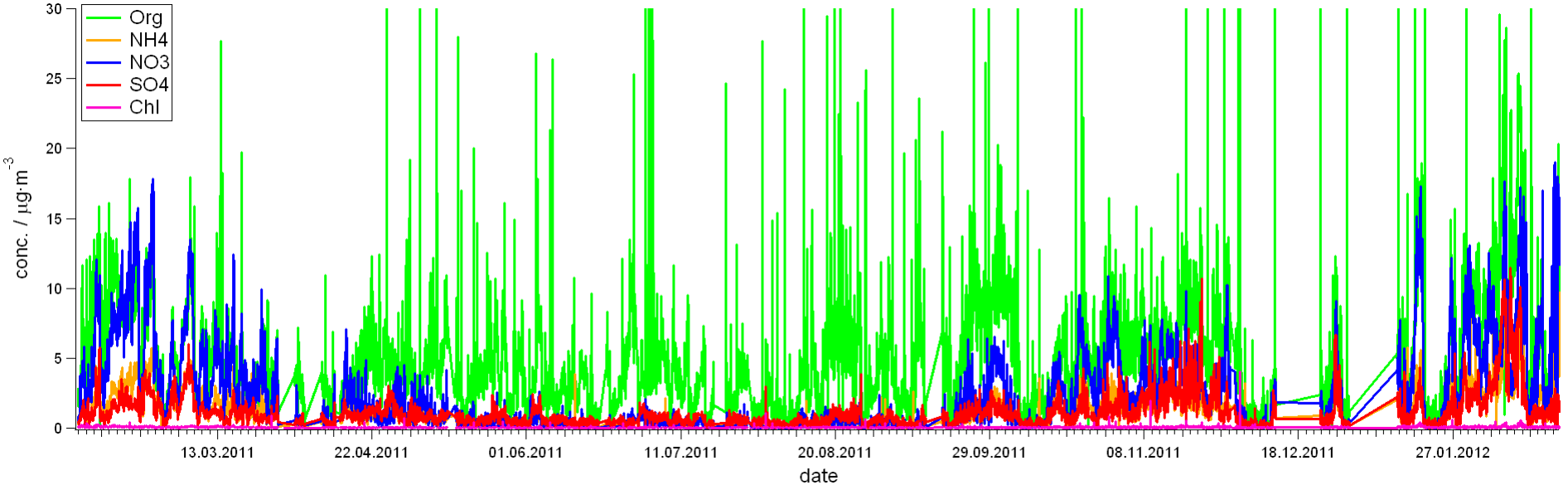
sulfate

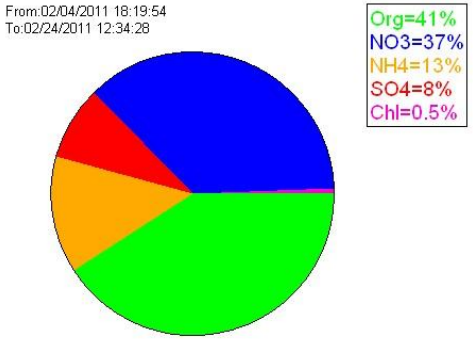


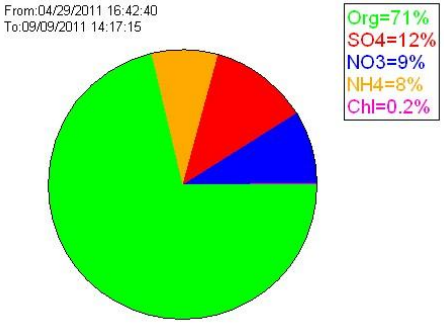
organics



ACSM in Zurich during one year
February 2011 – February 2012







- Data coverage very good
- Missing data due to some deliberate instrument tests but usually due to problems with inlet valve

Maintenance and issues

- Fixing the inlet valve a few times
- Calibration once a month seems to be sufficient
- Data analysis. The assessment of the collection efficiency (mostly bounce off the heater) is one of the most important issues in AMS (this is true for all AMS). Measurements of PM_1 or $PM_{2.5}$ in the future is highly recommended

Aerosol mass spectra

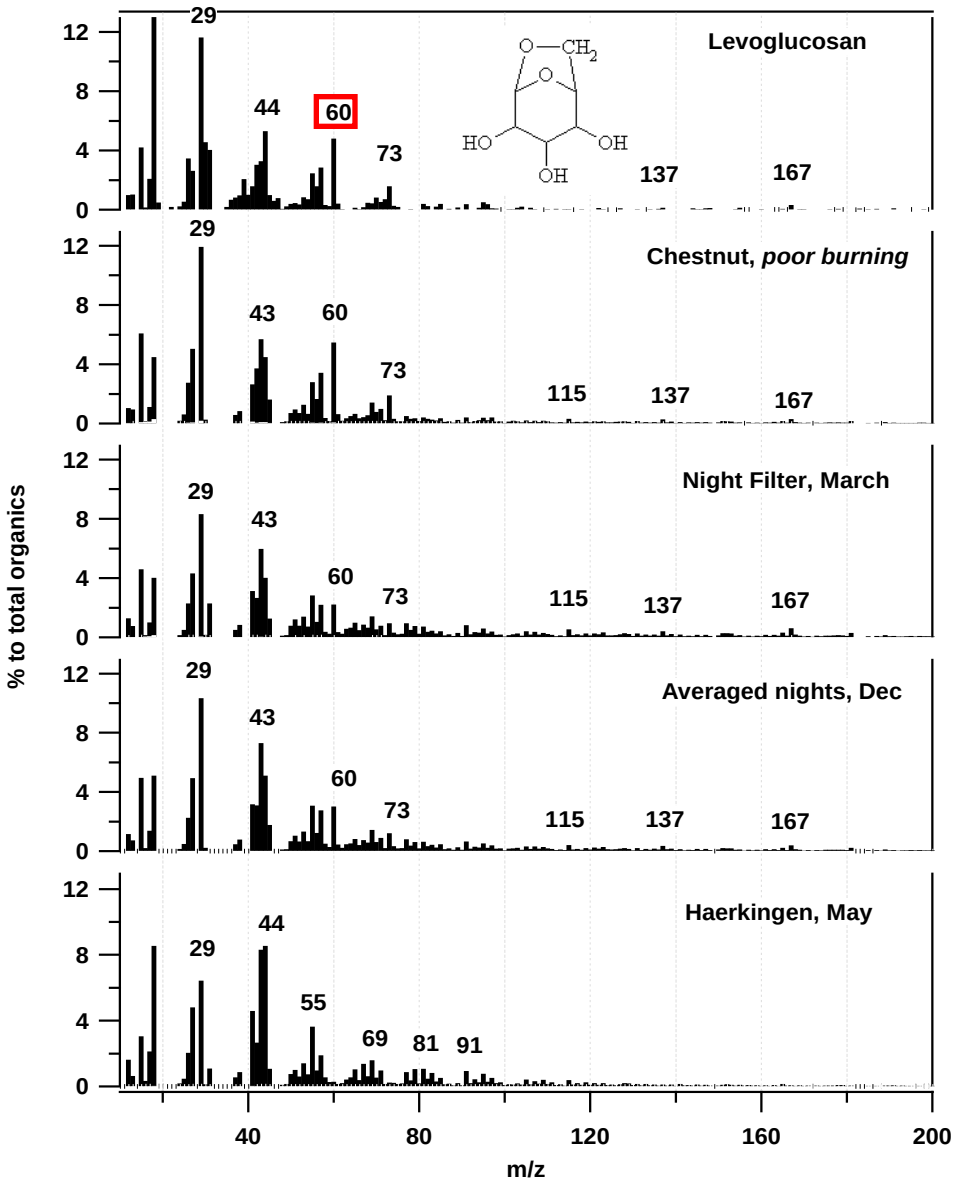
Levoglucosan

Wood burner (emissions) chestnut, very inefficient burning

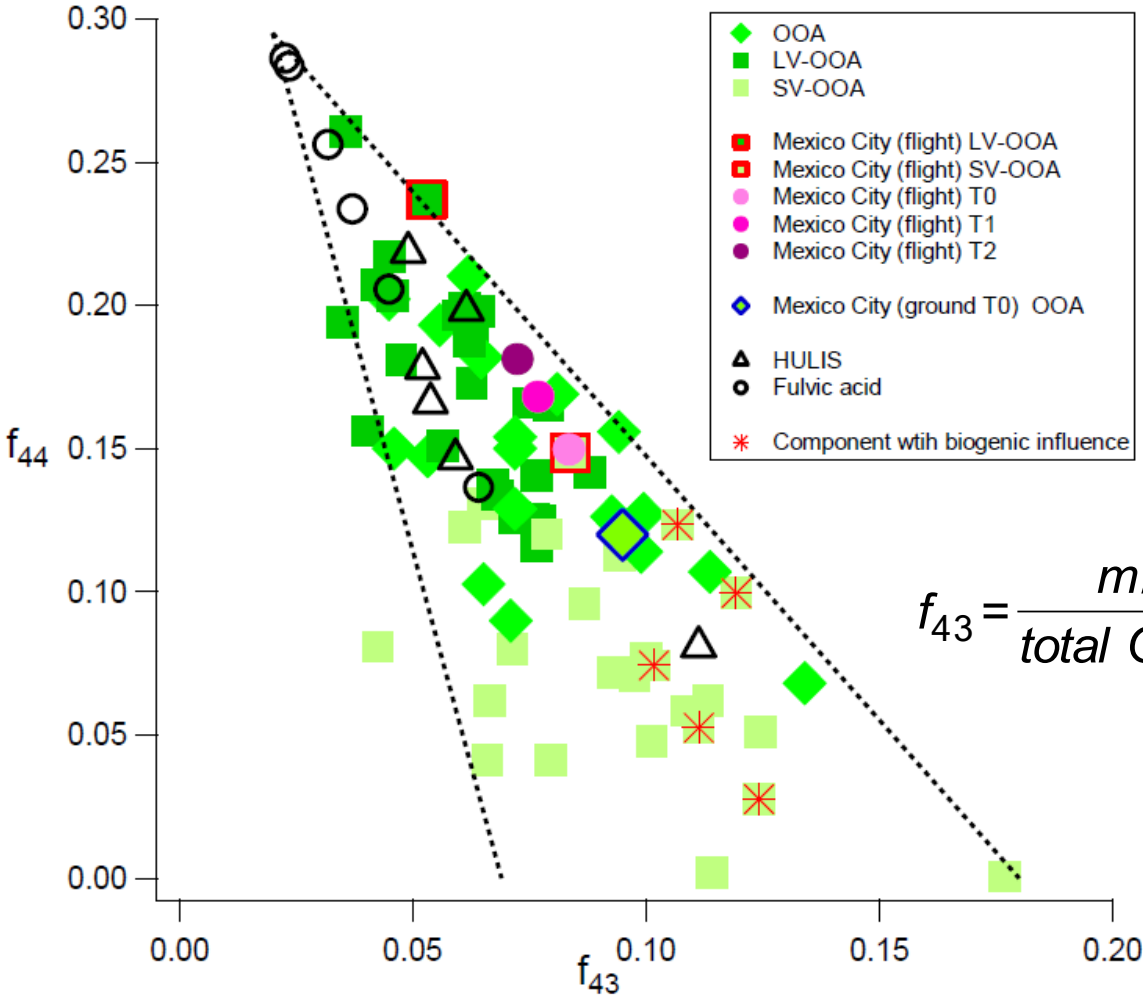
Night period in Roveredo in March, more than 80% of OC non-fossil

Average in Roveredo over the whole December

Mass spectra from a Motorway site in May



Oxidation characteristics : former studies



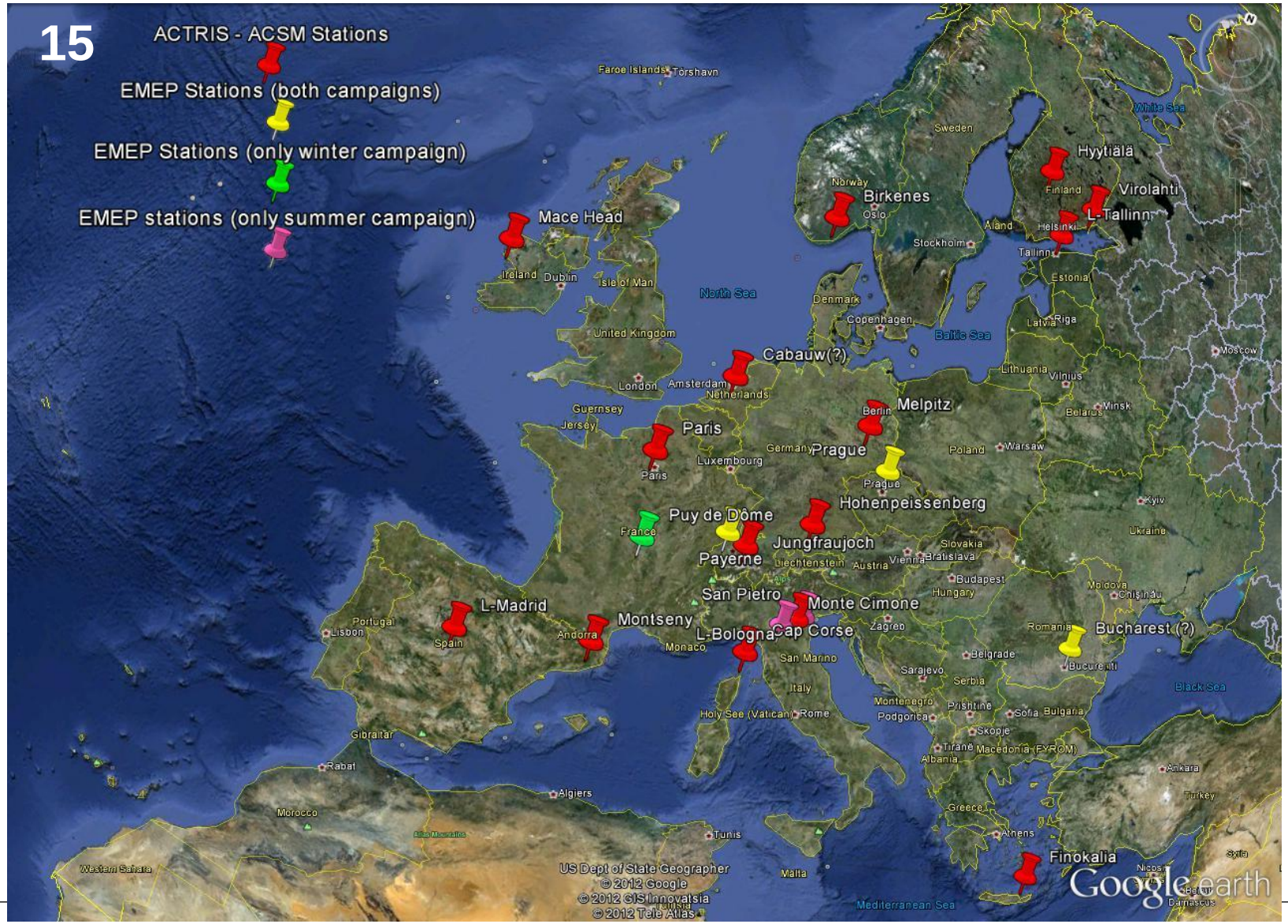
$$f_{43} = \frac{m/z\ 43}{total\ Organics} \qquad f_{44} = \frac{m/z\ 44}{total\ Organics}$$

f_{43} mostly the oxidized ($C_2H_3O^+$) ion mostly from non-acidic functional groups

f_{44} marker for oxidation => (CO_2^+) mostly from carboxylic groups *(Ng et al., 2010)*

ACTRIS one-year campaign starting June 2012

EMEP special observation periods: June 8 – July 17; January 15 – February 15



Conclusions / Outlook

- The ACSM is an instrument that can be used researchers but also by the authorities. There were rumours that the French government planned to buy 40 ACSMs. There are projects for several ACSMs in Sweden, several ACSMs around Lyon…
- Within 2012, around 15 (soon likely many more) ACSMs will be operational in Europe
- Goal: Characterization of composition of PM1 (later years probably PM2.5). Quantification of sources or organic aerosols (traffic, wood burning, cooking, secondary organics) over a whole year
- The combination of the ACSM with the multi-wavelength light absorption measurment (e.g. new Aethalometer) is recommendable to provide source apportionment of BC as well
- Value of monthly campaigns strongly enhanced if embedded in year-long measurements
- New ACSM (ToF-ACSM) maybe becomes available in 2012 (even smaller). Tests will be performed at Jungfraujoch
- AMS measurements also possible off-line from Hi-Vol-filters (Very similar spectra can be obtained)