

Name of research institute or organization:

Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

Title of project:

Highly time resolved chemical composition measurements of non-refractory PM1 with a ToF-ACSM

Project leader and team:

Dr. André Prévôt, project leader

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Project description:

In the framework of this project, which started in summer 2012, more than one year of data of the chemical composition of the non-refractory (PM1) aerosol at the high altitude research station at Jungfraujoch was collected with a time resolution of 10 minutes.

For this purpose, a new prototype instrument, the time-of-flight aerosol chemical speciation monitor (ToF-ACSM), developed by the Thun based company Tofwerk, was installed at the site (see Fig. 1). Compared to the previous version, the Q-ACSM, the ToF-ACSM provides much better sensitivity and resolution, a prerequisite for the operation in very clean environments like the Jungfraujoch. This was the first field deployment of the new instrument and in addition to the scientific output the successful operation of the device was crucial for its chances of success on the market.



Figure 1. Transport of the prototype ToF-ACSM to the measurement site.

The measurements at the well-equipped Jungfraujoch research station facilitated a thorough characterization of the device and showed good correlations to co-located instrumentation. The results were published in Fröhlich et al. (2013).

The long-term monitoring of the chemical composition is embedded in the framework of the European FP7 project ACTRIS (Aerosols, Clouds, and Trace Gases Research InfraStructure Network) ACSM network, which encompasses more than a dozen measurement stations all over Europe and which will produce an unparalleled long-term aerosol composition database with high time resolution. Fig. 2 shows the measured PM1 aerosol concentrations in $\mu\text{g}/\text{m}^3$ from the start of the measurements in summer 2012 to fall 2013. The different chemical species are separated by colors (green: organics, red: sulfate, blue: nitrate, orange: ammonium).

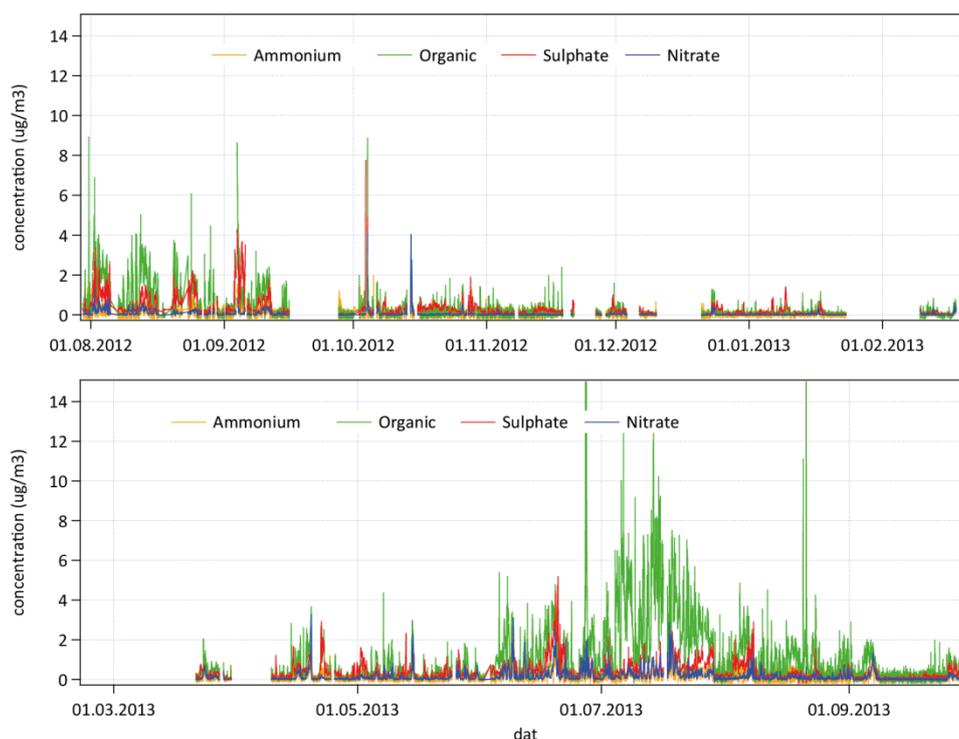


Figure 2. Mass concentration time series measured with the ToF-ACSM between August 2012 and October 2013.

In general, concentrations of all species are low at the Jungfraujoch but there are significant differences between winter and summer. In winter, concentrations are relatively constant below $1 \mu\text{g}/\text{m}^3$ while in summer higher concentrations and a typical diurnal cycle are observed. On warm summer afternoons there is a significant updraft of polluted boundary layer air. Organics and sulfate are the major chemical species in the aerosol with sulfate becoming more important in winter. Additionally, the mass spectra which are recorded with the ToF-ACSM (see example spectrum in Fig. 3) contain more information about the sources and chemical oxidation state of the organic fraction of the aerosol. For example the fraction of the $m/Q = 44$ Th fragment (CO_2^+) in the organic aerosol at the Jungfraujoch is usually high compared to other sites which is indicative of highly aged (oxidized) air masses. This is expected due to the absence of major local sources close to the research station. An in-depth investigation of the dataset, containing also a PMF/ME2 source apportionment factor analysis is currently underway and a publication can be expected in 2014.

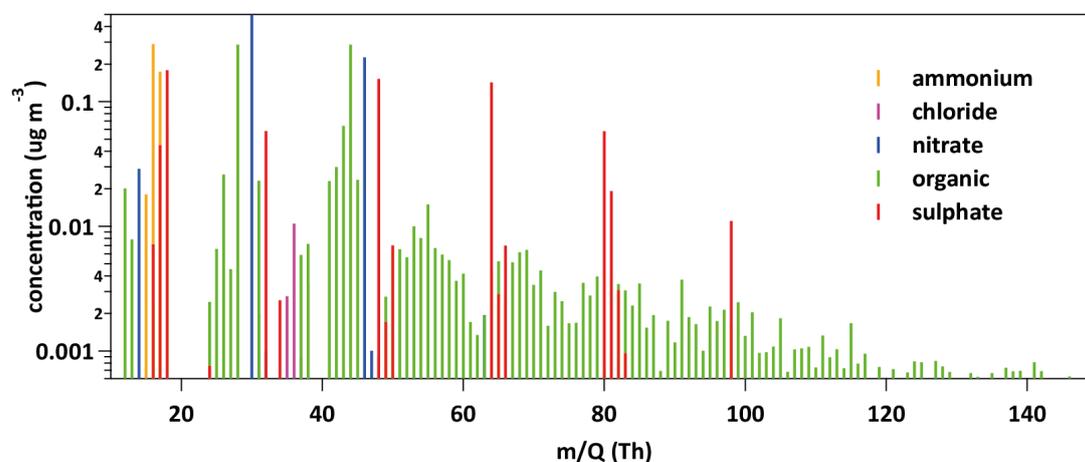


Figure 3. Example unit mass resolution spectrum measured with the ToF-ACSM (Average spectrum on the 6th of September 2013).

Key words:

ACSM, ToF, chemical composition, PMF, ME2, mass concentration, mass spectrum, mass spectrometer, PM1, organics

Internet data bases:

<http://www.psi.ch/lac/>
<http://www.psi.ch/acsm-stations/>
<http://www.actris.net/>

Collaborating partners/networks:

Tofwerk AG, CH-3600 Thun, Switzerland
European FP7 project ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network)
Aerodyne Research, Inc., Billerica, MA-01821, United States

Scientific publications and public outreach 2013:

Refereed journal articles and their internet access

Fröhlich, R., Cubison, M. J., Slowik, J. G., Bukowiecki, N., Prévôt, A. S. H., Baltensperger, U., Schneider, J., Kimmel, J. R., Gonin, M., Rohner, U., Worsnop, D. R., Jayne, J. T., The ToF-ACSM: a portable aerosol chemical speciation monitor with TOFMS detection, *Atmos. Meas. Tech.*, **6**, 3225-3241, doi: 10.5194/amt-6-3225-2013, 2013.

www.atmos-meas-tech.net/6/3225/2013/

Conference papers

Fröhlich, R., Cubison, M. J., Slowik, J. G., Prévôt, A. S. H., Baltensperger, U., Kimmel, J. R., Gonin, M., Rohner, U., Worsnop, D. R., Jayne, J. T., Year-round measurement of pm1 chemical composition in the Swiss Alps using a Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM), European Aerosol Conference (EAC), Prague, Czech Republic, September 2-6, 2013.

Fröhlich, R., Coordinated ACSM measurements in the framework of ACTRIS (+ source apportionment), 3rd ACTRIS WP3 Workshop, Athens, Greece, October 7-11, 2013.

Fröhlich, R., Slowik, J., Prévôt, A. S. H., Baltensperger, U., Q-ACSM on the Jungfrauoch 13.06.12-14.11.12, 14th EMEP Task Force on Measurements and Modelling (TFMM), Zagreb, Croatia, May 5-8, 2013.

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