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Near-real-time trace element measurements in a rural, traffic-influenced environment with some fireworks

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Aerosol-bound trace elements can affect the environment in significant ways especially when they are toxic. Characterizing the trace element spatial and temporal variability is a prerequisite for human exposure studies. The requirement for high time resolution and consequently the low sample masses asked for analysis methods not easily accessible, such as synchrotron radiation-induced X-ray fluorescence spectrometry (SR-XRF). In recent years, instrumentation that samples and analyzes airborne particulate matter with time resolutions of less than an hour in near real time has entered the market. We present the results of a three-week campaign in a rural environment close to a freeway. The measurement period included the fireworks of the Swiss National Day.

The XRF instrument was set up at the monitoring station Härkingen of the Swiss Monitoring Network for Air Pollution (NABEL). It was configured to sample and analyze ambient PM_{10} aerosols in 1-hour intervals. Sample analysis with XRF was performed by the instrument immediately after collection, i.e. during the next sampling interval. 24 elements were analyzed and quantified (Si, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Cd, Sn, Sb, Ba, Pt, Hg, Pb, Bi). The element concentrations obtained by the XRF instrument were compared to those determined by ICP-AES and ICP-MS in PM_{10} samples collected by NABEL high volume samplers.

The results demonstrate the capability of the instrument to measure over a wide range of concentrations, from a few ng m^{-3} to μg m^{-3}, under ambient conditions. The time resolution allows for the characterization of diurnal variations of element concentrations, which provides information on the contribution of emission sources, such as road traffic, soil, or fireworks. Some elements (V, Co, As, Pt) were below their detection limit during most of the time, but As could be quantified during the fireworks. Transition metals Cr, Mn, Fe, Cu, Zn could be attributed to freeway traffic. K, S, Ba, and Bi were strongly linked to the fireworks.

The field test provided good evidence for the applicability and ease of use of the instrument. It provided also an idea on the sensitivity of the method in realistic, ambient conditions, although the 3-week period was too short for a thorough assessment, e.g. for different weather conditions.