Fact sheet for the PM10 characterization and determination of dust origin

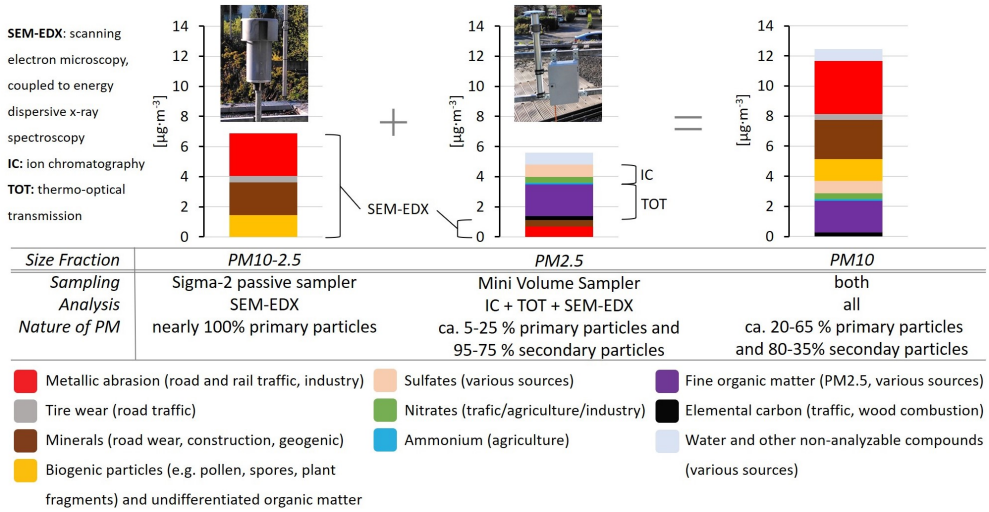

Figure 1: Sampling, analysis and results of a PM10 characterization and determination of dust origin for one period of 14 days near the metro station M2 Délices, VD. *Source: Measurement campaign on behalf of DGE-ARC of the canton of Vaud, 2019.*

Applications

Characterization, monitoring and determination of the origin of airborne PM10 dust. Understanding the origin of the PM10 and PM2.5 size fractions is crucial due to their health relevance. In addition, a detailed PM10 differentiation is a powerful tool to take the right measures to reduce concentrations and comply with the prescribed limit values. Owing to the combination of various targeted methods (SEM/EDX, IC and TOT), one can achieve a nearly complete PM10 characterization, and therefore a monitoring covering a wide variety of possible dust sources .

Description of the measurement technique

As is visible from Fig. 1, the PM10 quantification and differentiation consists of 3 individual analyses, whose results are combined thereafter. For the description of the SEM-EDX single particle analysis on Sigma-2 samples of coarse-mode dust (PM10-2.5), please refer to the fact sheet available through the following clickable link. To complement the coarse-mode measurement, PM2.5 is actively sampled onto filters which are subsequently analyzed with ion chromatography (IC) for the quantification of ammonium, nitrates and sulfates, as well as with thermo-optical transmission (TOT) for the quantification of fine organic matter and elemental carbon content. Non-volatile components of PM2.5 that are not accounted for by IC and TOT, i.e. metallic abrasion and minerals can also be quantified via SEM-EDX single particle analysis on a separate filter, if desired. This will decrease the amount of undifferentiated substances. By subsequently merging the PM10-2.5 and the PM2.5 data, one can obtain a full PM10 characterization.

What particle classes?

The morpho-chemical classifier used for the primary particles that are measured with SEM-EDX was trained with over 100'000 particles from more than 40 locations and distinguishes between the following 5 classes. Metallic particles, tire abrasion particles, minerals, biogenic-organic particles and salt particles. These have further subgroups, which are mainly based on morphological criteria (e.g. metallic spheres). TOT and IC allows for the determination of fine organic matter and elemental carbon and sulfates, nitrates and ammonium, respectively.

Quality of the measurement?

For the accuracy of the SEM-EDX single particle analysis on Sigma-2 samples of airborne coarse-mode dust (PM10-2.5), please refer to the fact sheet available through the following clickable link. For IC & TOT, an analytical error of up to approx. 20 wt.% can be expected (IC: ISO-9001 certified partner lab, which passed the EMEP interlaboratory test of NILU. TOT: Karanasiou et al. 2015 – doi:10.5194/amtd-8-9649-2015) . The sum of the different particle groups can result in up to 25 wt.% unaccounted mass among PM10, which corresponds to water and other non-analyzable compounds. This value lays in the range of reported values (Putaud et al. 2004 – doi:10.1016/j.atmosenv.2004.01.041).

Advantages of this measurement technique?

The sampling devices are easy to install, handily sized and do only require access to electricity for the active sampling device (Mini Volume Sampler). They can easily be mounted in open fields, on railings or posts. Since all particles belonging to the coarse-mode as well as the metals and minerals belonging to the PM2.5 are measured individually and divided into classes, it can be assessed, for example, whether a particular chemical element is contributed by only a single particle class or by several thereof. The efficient processing of the SEM-EDX data sets by means of a machine-learning based particle classifier also allows for a more direct and accurate determination of the origin of primary airborne dust, which is then optimally complemented by bulk techniques mainly dedicated to the quantification of secondary particles.