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Emission factors and source apportionment for abrasion particles produced by road traffic

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Particle emissions of road traffic are generally associated with fresh exhaust emissions only. However, recent studies identified a clear contribution of non-exhaust emissions to the PM10 load of the ambient air. These emissions consist of particles produced by abrasion from brakes, road wear, tire wear, as well as resuspension of deposited road dust. For many urban environments, quantitative information about the contributions of the individual abrasion processes is still scarce. For effective PM10 reduction scenarios it is of particular interest to know whether road wear, resuspension or fresh abrasion from vehicles is dominating the non-exhaust PM10 contribution.
In Switzerland, the emissions of road traffic abrasion particles into the ambient air were characterized in the project APART (Abrasion Particles produced by Road Traffic). The project aimed at finding the contribution of the non-exhaust sources to total traffic-related PM10 and PM2.5 for different traffic conditions, by determining specific elemental fingerprint signatures for the various sources. This was achieved by hourly elemental mass concentration measurements in three size classes (2.5-10, 1-2.5 and 0.1-1 micrometers) with a rotating drum impactor (RDI) and subsequent synchrotron radiation X-ray fluorescence spectrometry (SR-XRF). The elemental fingerprint measurements were embedded into a large set of aerosol, gas phase, meteorological and traffic count measurements. To identify traffic related emissions, measurements were performed upwind and downwind of selected roads. For a better investigation of road wear, a road wear simulator was applied in additional experiments.
This allows for the identification and quantification of the different source contributions by means of source-receptor modeling, and for the calculation of real-world emission factors for the individual abrasion sources. The preliminary analysis of hourly resolved trace element measurements in a street canyon in Zürich showed that Fe, Cu, Mo, Sn, Sb and Ba were clearly correlated with hourly traffic counts and were attributable to brake abrasion. It was estimated that more than 80% of the emissions of these elements originated from fresh brake abrasion rather than from resuspended PM10 road dust. The contribution of brake abrasion to the total traffic related PM10 emission in the street canyon was found to be approx. 15%. Furthermore, the road wear simulator experiments showed that resuspension of deposited road dust was dominating fresh road wear. The diurnal variation of the resuspended particles is not directly correlated to traffic counts but is rather driven by the local air mass circulation.