EGU21-13599
https://doi.org/10.5194/egusphere-egu21-13599
EGU General Assembly 2021

Measurements of airborne particles and chemical identification of metal content in a public underground transport system

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In urban areas, a large number of people use public transport systems on a daily basis, and depending on the length of their commute, they spend a considerable amount of time in it. Part of the public transport system runs underground. Even though underground trains are powered by electric traction motors, the accumulation of airborne particles may be of concern due to limited air exchange in underground transport systems.

Initial measurements carried out in previous studies worldwide have shown that the air in a subway train station can be considerably more polluted with particulate matter than the air at a busy road junction. PM10 mass concentrations as high as 120 µg/m^3 have been measured at a subway train station in Stuttgart. This is more than double the daily average PM10 limit value of 50 µg/m^3 for outside air in Europe.

In order to study particulate matter concentrations in the underground transport system of Berlin (Germany) and potential particle sources, first semester students carried out preliminary measurements in a student project in January 2021. The students were equipped with handheld optical particle counters to study particulate matter levels at various locations of the underground transport system and at roadside station at street level for comparison. In additions, airborne particles were collected by using a single staged impactor, and subsequently analysed for their metal content using Total Reflection X-ray Fluorescence (TXRF) analysis.

The results indicate significantly elevated PM10 levels in underground train stations compared to street levels. Up to 35 times as much iron was found in the air of an underground train station compared to a busy street intersection at Potsdamer Platz. These high levels of iron suggest that a reason for the elevated concentrations of particulate matter in the underground system could be abrasion from wheels and rails.

This preliminary study sets the basis for a more comprehensive investigation of PM sources in public underground transport systems required to evaluate its effect on urban air quality.