Survey of the Small-scale Variability of Aerosols and Validation of Low-cost Sensors by Mobile Measurements

Jan Bendl [1], Mohamed Khedr [1], Xiansheng Liu [1], and Jürgen Schnelle-Kreis [1]

1 Helmholtz-Zentrum München (HMGU), Cooperation Group of Comprehensive Molecular Analytics, München, Germany, E-mail: jan.bendl@helmholtz-muenchen.de

According to EEA, more than 400.000 premature deaths in Europe per year are linked to PM2.5 exposure (in Germany around 66.000) while polycyclic aromatic hydrocarbons (PAHs) bonded on these particles are probably most responsible for the cancer development due to polluted air. Nowadays, urban air quality is quite well monitored by stationary measurements, however, the measuring networks are usually not enough dense so we have a lack of information about concentrations within the micro-scale level. The aerosol spatial distribution varies significantly in the small scale depending mainly on sources, geomorphology (closed valleys, street canyons) and meteorology (temperature inversions). The low-cost PM sensors which are under development could increase the density of these networks, however, their precision and reliability are needed to be intensively tested and improved.

Therefore, we developed 3 identical strollers for comprehensive aerosol measurements during walking. Using this equipment, a 11.4 km (3:40 h) long route across the city of Augsburg was repeated several times during the two 28 h long Intensive Observation Campaigns of the SmartAQnet project [1]. For higher temporal variability observation, we conducted overlapping walks starting almost every hour together with 5-10 minutes stops at the LfU LÜB-stations for instrument collocations. PM10, PM2.5, PM1 (using DustTrak DRX, TSI, 1 second time resolution), particle number concentration (PTrak, TSI, 1 sec), aerosol particle size distribution (11E Mini LAS, Grimm, 6 sec / OPS, TSI, 1 sec), black carbon and brown carbon (MA200, AetheLabs, 10 sec) were measured continuously and photos were taken every 5 seconds (Olympus TG-Tracker) for better source identification. GPS and temperature were recorded (Garmin 64s with external temperature sensor, 1 sec). During the walks, the PM2.5 fraction was sampled on a SIOUTAS impactor for later chemical ultra-trace analysis (IDTD-TOF-GC-MS, Orasche et al. 2011 [2]) focused mainly on PAHs and combustion markers.

Air pollution hot spots were identified by plotting the data into maps and by comparison with photos and notes, however, a detailed analysis is still in progress.

Low-cost sensor validations were conducted by placing 3 identical PM10 and PM2.5 sensors (SDS011) and one optical particle counter (OPC-N2, Alphasense) at each stroller for comparisons between each other and with professional instruments during the real urban conditions.

Moreover, all measured data are available for our project partners for their further studies, such as air quality model validation.

References

[1] Matthias Budde, Till Riedel, Michael Beigl, Klaus Schäfer, Stefan Emeis, Josef Cyrys, Jürgen Schnelle-Kreis, Andreas Philipp, Volker Ziegler, Hans Grimm, Thomas Gratza (2017) SmartAQnet: Remote and In-Situ Sensing of Urban Air Quality, Proc. SPIE 10424, Remote Sensing of Clouds and the Atmosphere XXII, 104240C, doi:10.1117/12.2282698

[2] Orasche J., Schnelle-Kreis, J., Abbaszade, G., Zimmermann, R. (2011): Technical Note: In-situ derivatization thermal desorption GC-TOFMS for direct analysis of particle-bound non-polar and polar organic species, Atmospheric Chemistry and Physics, 11, 8977-8993.