Ultrafine particle dispersion modelling at Frankfurt airport and Rhine-Main-Area, Germany

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Air pollutant emissions represent a significant hazard to human health. Mobile measurements of ultrafine particles (UFP) show high variability in time and space in cities (Schneidemesser *et al.*, 2019). In epidemiologic studies it has been difficult to separate negative health effects of UFP from effects of other aerosol fractions (Ohlwein *et al.*, 2018). In recent studies, airports have been identified as a significant source of increased atmospheric UFP number concentrations. There is a need to further understand the airport contribution to ambient near-ground UFP concentration by means of measuring and modelling. In this project (Lorentz *et al.* 2021), total UFP number concentration was estimated using a combination of two well-established small-scale models (LASAT, LASPORT) and a large-scale CTM model (EURAD, MADE) in a 35 km square with centre Frankfurt a. M. airport to model the year 2015.
Emissions were determined for aircraft traffic, road traffic, airport ground services and regional/mesoscale background using standard national and international inventories (HBEFA, ICAO, GRETA) and specific data obtained from the airport. The series of hourly mean apportioned by different source groups were compared to measurements.
The model results suggest that aircraft main engines are the dominant local source of UFP number concentrations (90%), mainly with high contributions from taxiing. Long-time averages of UFP number concentration are dominated by background contributions at locations further away from the airport, while the airport contribution to hourly mean concentrations can be significant even at some distance from the airport. Up to 25% of UFP in the airport surrounding was attributed to airport and aircraft, considering only non-volatile (nv) particles.
The maximum of measured total UFP during three annual cycles occurred in summer. In contrast, modeled background (CTM) showed highest concentrations in winter.
An important aim was to identify shortcomings of current state-of-the-art modelling of UFP in the context of airports. Inconsistent UFP diameter ranges in the applied databases, models and measurements are significant. Also emission databases like the one applied for aircraft engines do not include information on volatile UFP. For future projects, the use of thermo denuders would allow to separately assess volatile and non-volatile UFP.

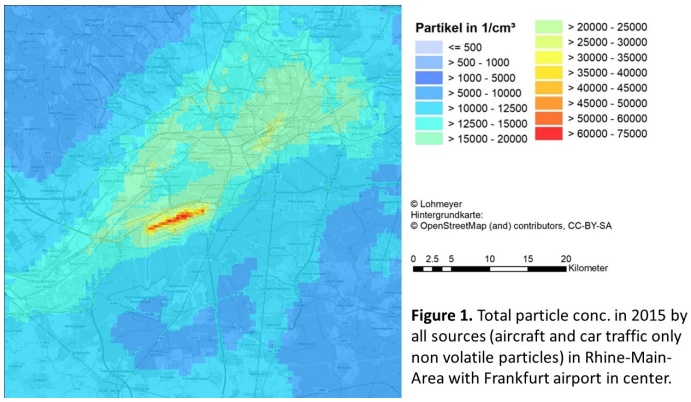

Figure 1. Total particle conc. in 2015 by all sources (aircraft and car traffic only non volatile particles) in Rhine-Main-Area with Frankfurt airport in center.

Helmut Lorentz *et al.* **2021** UBA-Texte 14/2021.
Simone Ohlwein *et al.* **2018** UBA Texte 5/2018.
Erika von Schneidemesser *et al.* **2019**, Sci. Tot. Env., **688**, 691 - 700.