VRG22-003 - Atmosphere Cityscape Aerosol Interactions

Zusammenfassung

Urban areas are hotspots for climate change and air pollution. Atmospheric aerosol particles can be dangerous for human health and influence the climate by scattering incoming solar radiation or altering the properties of clouds. The urban aerosol system is highly complex as various sources contribute to the aerosol budget and induce feedbacks affecting urban heat islands, local precipitation or urban biological activity. The dominant source for particle number concentrations is new particle formation (NPF), where supersaturated vapors form new liquid or solid particles under suitable conditions. If these particles grow fast enough to avoid scavenging by larger pre-existing aerosol, NPF influences the climate and, especially in urban environments, affects air quality by contributing to the ultra-fine aerosol burden, a health threat, which is debated to become part of European air quality regulations. Studying the interaction processes between the city-sphere and the atmosphere related to aerosol formation is hence crucial to understand the urban environmental system and transform our cities into sustainable and healthy living places. In the future, urban aerosol sources face dramatic changes as a transforming car-fleet and reduced industrial emissions result in less directly emitted aerosol particles and reduced secondary inorganic aerosols. However, the relative importance of aerosol production from NPF in urban areas increases due to the reduced condensation sink and a variety of emerging organic non-combustion related emissions. As they are associated with a high population density, even modern city districts have high emissions of such volatile chemical products (VCPs) evaporating e.g., from cleansing agents, personal care products, adhesives, coatings or asphalt. While these sources certainly contribute to the formation of secondary organic aerosol (SOA) by condensing onto larger pre-existing particles, their potential in forming and growing new aerosol is poorly quantified. However, recent observations during the Covid-19 lockdown periods show that NPF plays a major role in any reduced emission scenario. As other oxygenated organic molecules can efficiently form and grow new particles, the oxidation products of VCPs have the potential to become important drivers of NPF in future urban areas. The Vienna Research Group (VRG) on Atmosphere-Cityscape Aerosol Interactions (ACAI) will investigate the role of VCP emissions and NPF in the environmental system of the city of the future. The VRG assesses the broad variety of emerging urban emission sources with a multi-method, interdisciplinary approach. Embedded in the Faculty of Technical Chemistry of the TU Wien, the VRG builds up expertise on ultra-fine aerosol particles, complementing the existing aerosol research. We use ultra-high-resolution chemical ionization mass spectrometry to identify gas-phase oxidation products from different VCPs in chamber experiments. Using the existing capacities at the TU Wien on FTIR Spectroscopy we constrain the functionalization of these oxidation products. Thereby, we can better estimate their volatility and hence determine their potential to form and grow small aerosol particles. With this methodological approach applied to laboratory measurements together with the Faculty of Civil Engineering at the TU Wien we investigate the NPF potential of building materials, such as asphalt, adhesives and coatings. In ambient measurements in the Seestadt, a newly built Viennese city district and Europe's largest urban development area, we directly measure NPF in an environment representative for the cities of the future. The identified molecular fingerprints of the individual sources characterized in the laboratory are used in source apportionment revealing the most important secondary aerosol formation precursors. Our investigations aim to bridge the gap between the current underpredictions of SOA in urban areas by most air quality models and set a new focus on the organic oxidation chemistry in NPF and subsequent growth in the urban environmental system. This, in turn, has the potential to give advice to air quality policy makers by clarifying the role of the atmosphere-cityscape interactions of building materials and urban planning action. Ultimately, our results will contribute to material choices in building technologies and raise awareness on the emissions of non-combustion sources with respect to outdoor and indoor air quality.

Wissenschaftliche Disziplinen:
105208 - Atmospheric chemistry (40%) | 103039 - Aerosol physics (40%) | 201105 - Construction material practice (15%) | 201212 - Urban design (5%)

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Aerosols; Volatile Organic Compounds; New Particle Formation; Nanoparticle Growth; Volatile Chemical Products

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Weiterführende Links zu den beteiligten Personen und zum Projekt finden Sie unter
https://wwtf.at/funding/programmes/vrg/VRG22-003/