



Urbanization and Air Pollution Effects on Precipitation Microphysics: Evidence from Disdrometer Observations in Belgium

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Urbanization and air pollution are increasingly recognized as important modifiers of precipitation microphysics, yet their combined influence on raindrop size distributions (DSDs) remains uncertain. This study investigates how urban land cover and particulate air pollution affect rainfall microphysical properties using multi-year disdrometer observations at three urban-edge sites near Brussels, Liège, and Ghent. Measurements from two optical laser disdrometers and one forward-scattering disdrometer are combined with ERA5 reanalysis data, Local Climate Zone (LCZ) classifications, and gridded air-quality datasets. Disdrometer data are subjected to quality control, including filtering for liquid precipitation, internal consistency checks based on rainfall rate, and comparison with nearby rain-gauge measurements. Raindrop size distributions are characterised using integral microphysical parameters, including volume mean diameter (VMD), area mean diameter (AMD), rainfall rate, reflectivity, and kinetic energy. Convective and stratiform precipitation are distinguished using reflectivity-based thresholds and variability in rainfall rate. Urban effects are quantified by relating wind-direction-dependent urban fraction to disdrometer-derived DSD parameters. Preliminary results indicate a site-dependent response of raindrop diameter to upwind urban fraction, with statistically significant positive relationships at two locations and a negative relationship at one location, highlighting the complexity and heterogeneity of urban-precipitation interactions. Seasonal stratification and wind-speed filtering do not reveal a consistent pattern across all instruments. The influence of air pollution is assessed using daily mean PM_{2.5} and PM₁₀ concentrations, with initial analyses suggesting that elevated pollution levels are associated with more extreme DSD behaviour, characterised by an increased occurrence of significantly smaller and larger drop sizes compared to more narrowly distributed DSDs under cleaner conditions. Ongoing analyses further examine how these effects depend on precipitation type and how they translate into changes in rainfall kinetic energy. This work provides new observational insight into the nonlinear interactions between urban environments, aerosols, and precipitation microphysics with implications for urban hydrology, radar-based rainfall estimation, and the representation of aerosol-cloud-interactions in climate models.