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Transport characteristics of aerosol from urban point sources

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Urban aerosols are an important source of regional and global air pollution. The local buildup, long-range transport, and dry and wet deposition of aerosols depend strongly on the aerosol size distribution and on the regional meteorological characteristics.

We examine the characteristics of urban aerosol dispersion based on simulations of monodisperse passive aerosol tracers with sizes of 0.1, 1.0, 2.5, and 10.0 μm, performed with the global chemistry circulation model EMAC (ECHAM5-MESSy-Atmospheric-Chemistry). 39 point sources were selected for the analysis, originating from major population centers (MPCs) around the world. All tracers, one for each source and size, have the same total, constant emission flux, and undergo dry and wet aerosol deposition. Sensitivity simulations are performed in which either there is no activation of the aerosol as cloud condensation nuclei (CCN), or all aerosol is activated as CCN. Using the same constant emission rate for each MPC allows us to compare how different large point sources pollute the atmosphere and the surface on different horizontal scales. The transport and deposition of the aerosol tracers from each MPC are quantitatively compared by the application of metrics.

The analysis focuses on: the efficiency of short- and long-range horizontal transport; the fraction of tracer transported to the upper troposphere; and the fractions which are dry or wet deposited. Smaller particles with longer lifetimes (two to 14 days) are more effective at polluting remote locations (horizontal and vertical) and are deposited mostly by scavenging, while larger particles, with shorter lifetimes (several hours to a couple of days) more effectively pollute the environment nearby their source, and are most strongly removed by dry deposition from the atmosphere.

By means of considering the same emission for each city, the presentation provides a detailed view of how aerosol tracers disperse and deposit on different spatial scales, depending on size and their source location, along with the main regional meteorological characteristics.