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Aerosol Formation and Transport to and from Polluted Megacities

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Pollution from megacities and large urban areas is important not only for local effects on health, visibility, and ecosystems, but also because of its influence on atmospheric chemistry and radiative forcing in regional scales. We combine in this study results from major field campaigns and chemical transport modelling to examine the sources of particulate matter in selected megacities and their effects on the air quality of surrounding areas.

Three megacities where major field campaigns have taken place recently are used in our analysis: Paris, Mexico City and New York. In Paris we use data from the MEGAPOLI field campaigns in 2009 and 2010, in Mexico City the results of the MILAGRO field campaign and in New York results from the USEPA Supersites project.

The regional chemical transport model PMCAMx is used to simulate air quality in these three areas. New primary and secondary organic aerosol modules have been added to PMCAMx using the volatility basis-set approach (Murphy and Pandis, 2009): both primary and secondary organic components are assumed to be semivolatile and photochemically reactive and are distributed in logarithmically spaced volatility bins. The emission inventories in the corresponding domains are modified and the primary organic aerosol emissions are distributed by volatility based on dilution experiments (Robinson et al., 2007). The performance of PMCAMx in reproducing the aerosol concentration, composition, and average diurnal variation in all cases is encouraging.

The Particle Source Apportionment Technology (PSAT) algorithm (Wagstron et al., 2008) running in parallel with PMCAMx is used to quantify the contributions of the various sources and the role of long range transport to particulate levels inside the three cities. In all cases most of the black carbon, fresh primary organic aerosol, and ammonium nitrate is originating from sources inside the megacity. However, most of the sulfates and oxygenated organic aerosol are the result of emissions from outside the megacity. Significant contributions for these secondary components are found from areas that are 100-600 km away. The effect of the megacities on their surroundings is similarly quantified and the results are used to discuss strategies for improvement of air quality in these areas.

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