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Investigation of characteristics and transformation processes of megacity emission plumes using a mobile laboratory in the Paris metropolitan area

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A growing fraction of the world's population is living in urban agglomerations of increasing size. Currently, 20 cities worldwide qualify as so-called megacities, having more than 10 million inhabitants. These intense pollution hot-spots cause a number of scientific questions concerning their influence on local and regional air quality, which is connected with human health, flora and fauna. In the framework of the European Union FP7 MEGAPOLI project (**M**egacities: **E**missions, urban, regional and **G**lobal **A**tmospheric **POL**lution and climate effects, and **I**ntegrated tools for assessment and mitigation) two major field campaigns were carried out in the greater Paris region in July 2009 and January/February 2010. This work presents results from mobile particulate and gas phase measurements with focus on the characteristics of the Paris emission plume and its impact on the regional air quality and on aerosol transformation processes within this plume as it travels away from its source. In addition differences between summer and winter conditions are discussed.

The mobile laboratory was equipped with high time resolution instrumentation to measure particle number concentrations ($d_P > 2.5$ nm), size distributions ($d_P \sim 5$ nm – 32 μm), sub-micron chemical composition (non-refractory species using Aerodyne HR-ToF-AMS, PAH and black carbon) as well as major trace gases (CO_2, SO_2, O_3, NO_x) and standard meteorological parameters. On-board webcam and GPS allow detailed monitoring of traffic situation and vehicle track. In a total of 29 mobile and 25 stationary measurements with the mobile laboratory the Paris emission plume as well as the atmospheric background was characterized under various meteorological conditions. This allows investigating the influence of external factors like temperature, solar radiation or precipitation on the plume characteristics.

Three measurement strategies were applied to investigate the emission plume. First, circular mobile measurements around Paris provide cross sections through plume air masses as well as local background variation measurements. Second, radial measurement trips beginning near the outer area of the agglomeration extending up to ~200 km distance from Paris along the direction of the emission plume provide insight into the extension of the plume and transformation processes. Third, stationary measurements at different locations provide background as well as pollution measurements, especially if the wind direction is shifting, causing the plume to pass over the measurement site.

During radial measurement trips the decrease in the concentrations of primary pollution marker species as hydrocarbon-like organic aerosol, black carbon, PAH and NO_x with increasing distance from Paris is clearly observed. This decrease is mainly caused by dilution processes, but additional aging effects are also detectable. While entering the emission plume on cross section measurements a significant increase in such marker species compared to background values can be seen. On the other hand, overall statistics of both campaigns shows that day-to-day background variations influenced mainly by long range transported pollution (i.e. air mass origin) are stronger than variations between background and plume on specific days.

A description of the methods developed for analysing the mobile data will complete this presentation.