Abstract

In the assessment of air quality in urban areas, emissions from road transport remain as a key factor. Limits for particulate matter (PM10) were introduced in Europe and measures to meet those values were taken (low emission zones). Since 2010, limits were also introduced for NO_2, which are currently often exceeded significantly. From 2015 increased penalties will be introduced in this field and effective emission reduction measures become inevitable. Mobile measurements are a useful tool to assess the impact of appropriate mitigation measures.

The MOBILAB represents a versatile platform for mobile measurements. The basic concept has been developed in a previous work [Urban, 2010]. In this study, the instrumentation was significantly extended. The particle measurement technology now consists of a PM10 filter sample collector for discontinuous particle analysis in the laboratory, a high temporal resolution particle counter and an ELPI for particle size-resolved measurement of 7 nm to 10 microns. The gas phase measurement technique includes equipment for high time resolution measurements of NO, NO_2, O_3, CO, CO_2, CH_4, and a collection system for the discontinuous sampling of canisters for specific VOC analysis in the laboratory. The reliability and maximum duration of daily measurements was significantly improved.

The MOBILAB was used for measuring a wide area of concentrations ranging from lightly loaded background areas to urban "hotspots".

As a part of the PEGASOS campaign, comprehensive measurements were carried out in rural background areas in the Rotterdam region in May 2012 where the MOBILAB served as a mobile ground station. It was shown that the altitude profiles measured aboard the Zeppelin could be linked to the ground-based MOBILAB measurements, when the various layers of the atmosphere during the breakup of the morning inversion layer were examined. Furthermore, the MOBILAB measurements in the Netherlands were used for evaluation of EURAD model predictions, which were created as part of the PEGASOS campaign. For CO it could be shown that the model results were in good agreement with the MOBILAB-measurements. In contrast, larger underestimations (up to a factor of five) were found for the nitrogen-oxides. Moreover, the particle size distribution was studied in rural areas and compared with measurements from urban areas in Düsseldorf and Bonn. It could be shown that emissions from diesel engines are the primary source of particle emission in urban areas. In rural areas this was not the case.

In the course of measurements in urban road tunnels in Düsseldorf and Bonn, the emission profile of the current vehicle fleet was studied under real conditions. It was shown that the VOC emissions can be attributed almost exclusively to gasoline-powered cars. In case of the nitrogen-oxide emissions, diesel cars were identified as the main source of emissions. It was shown, that the changes in the VOC-emission-patterns which were observed in the tunnel resulted in a decrease of ozone production and thus in a reduced trace gas degradation.

As a further possibility to reduce emissions, the reduction potential of alternative fuels based on water-in-diesel-microemulsions was investigated. In earlier experiments with optimized engines in an engine laboratory, the use of water-in-diesel emulsions or microemulsions showed a significant reduction of nitrogen-oxide and particulate emissions. Within this work it was investigated, to what extent these reductions can be realized for a standard car under realistic experimental conditions on

a chassis-dynamometer. With respect to the nitrogen oxides, no significant improvements could be detected. For particulate emissions, however, a significant reduction in particle mass could be detected. Consequently, the emissions of elemental soot particles were reduced by a decade so that benefits in the regeneration of diesel particulate filters can be expected. To reduce the emissions of organics from the particulates the introduction of an additional oxidation catalyst seems inevitable.

As part of the exhaust emission tests, the influence of modern diesel cars with DPF on the particle concentration in the environment was analyzed. These studies were carried out in a hall with comparable conditions as they are encountered for inner-city-conditions of large urban areas. It was shown that modern diesel cars with DPF emit organic substances that lead to an increase in the particle mass in the proximity.

This last case stresses the importance of studies from the point of view of atmospheric chemistry, to investigate side effects which can accompany changes in the exhaust treatment systems of modern cars. An example for such side effects could be the increase in emissions of ammonia and isocyanic acid when SCR-technologies are implemented to reduce the nitrogen-oxide emissions.