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Vehicle Real Driving Emissions of Nitrogen Oxides in an Urban Area from a large Vehicle Fleet

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Nitrogen Oxide (NO_x=NO +NO_2) emissions by road vehicles are the major contributor for poor air quality in urban areas. High NO_x concentrations, and especially NO_2, are typically the most problematic pollution in cities. However, emissions vary significantly depending on the type of vehicle, its engine, the age, condition of the vehicle, driving properties, modifications and many more. Even if official NO_x emission data of the manufacturer exist, they are only valid for new vehicles and the current vehicle emission scandal shows clearly that these data are often wrong. Thus, real driving emissions (RDE) of the current vehicle fleet is required. With such data the contribution of individual vehicles to the NO_2 and NO_x levels in urban areas can be estimated. Significant reduction of NO_x concentrations can be achieved by identifying the strong emitting vehicles and excluding, replace or modify them.

We developed a precise and fast ICAD (Iterative CAvity DOAS) NO_2 instrument which can measure the concentration within the emission plume of vehicles under real driving conditions. The sampling was performed with an inlet at the front of a car which was following the investigated vehicles. The instrument measure NO_2 and additionally CO_2 with a time resolution of 2 seconds. With the observed NO_2 values already strong emitters can easily be identified. With the use of known CO_2 emissions, more reliable emissions for NO_2 can be calculated for each vehicle. Currently the system is expanded with a NO_x channel to derive the total nitrogen oxide emissions.

The system was successfully applied in several studies over the last two years to investigate NO_2 RDE. More than thousand vehicles were investigated. We observed that several vehicles from various brands show much higher emissions than allowed (more than a factor of 5). Highest emissions correlate for trucks and busses typically to older vehicles, what is not the case for cars. A large variability between different cars was found which could often make up a factor of 10 or more. Often new Diesel cars are one of the strongest emitters, which agree well with other findings. However, older busses and trucks feature regularly the highest emissions, but also here strong variability between different vehicle types with different exhaust treatment and modification is observed. This is especially a problem with busses from the public transport which significantly contribute to urban air pollution. Identifying first the strongest emitting busses, which should be replaced first, can help to faster improve urban air quality. New busses and trucks, beside from few exceptions, show surprisingly relatively low emissions. The exceptions indicate potentially broken NO_x exhaust treatment. All these findings show that regular RDE are necessary for the whole vehicle fleet to identify strongest NO_x emitters and develop strategies to reduce their emissions. They also allow to provide more accurate model calculations on total emissions in urban areas.