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Real Driving NO_x Emission Measurements of Vehicles with ICAD instruments for Plume Chasing

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Nitrogen Oxide (NO_x) emissions from vehicles are a major cause of poor air quality in urban areas. The emissions per vehicle are regulated by the EURO Norm (EURO V: 2000mg/kWh, EURO VI: 460mg/kWh). Existing possibilities to measure whether the vehicles comply with the regulations (e.g. PEMS: Portable Emission Measurement System) are rare and costly. Within the framework of the EU project CARES (City Air Remote Emission Sensing) different remote emission sensing techniques and instruments are further developed. 'Plume Chasing' is one of them. With the Plume Chasing method, the emissions of a vehicle are measured in the wake of the investigated vehicle, i.e. in the diluted emission plume. This is done with a for this purpose optimized ICAD NO_x-CO_2 instrument (Airyx GmbH), that allows fast (1s time resolution) and simple measurements with high accuracy (sub ppb for NO_x) with a high measurement range (0-5000ppb). With these characteristics, it is perfectly suitable to detect malfunctioning or illegally manipulated emission control systems like SCR (selective catalytic reduction).

Several validation studies of Plume Chasing against the established PEMS have shown very good correlations. During a 3-day study in Sweden in November 2019, Plume Chasing measurements of a EURO V and a EURO VI truck were performed with activated as well as deactivated emission control system for several hours in different driving conditions. The derived Plume Chasing NO_x emission values even for short measurement times of one and two minutes showed excellent correlation with the averaged PEMS NO_x data of the trucks with R^2~0.9. The study demonstrated the robustness of the Plume Chasing method in detecting high emitter trucks. To further test and optimise different measurement configurations and data analysis algorithms, within the CARES project several ICAD NO_x-CO_2 instruments are installed together with e.g. LICOR CO2-sensors or Condensation Particle Counters in a measurement vehicle from TNO, Netherlands.

Studies on German and Austrian highways in 2018 and 2019 showed that among several hundreds of trucks up to 35% of the EURO V trucks and up to 25% of the EURO VI trucks showed consistently high emissions exceeding the EURO norm limit, which provides strong evidence for a high number of defect or manipulated emission control systems. A recent study in Denmark showed 9,7% of the vehicles exceeding the standards. The vehicles were afterwards inspected by the police and defects or manipulations of the emission control system could be confirmed.