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Vehicle fleet emissions of black carbon, polycyclic aromatic hydrocarbons, and other pollutants measured by a mobile laboratory in Mexico City

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Abstract. Black carbon (BC) and polycyclic aromatic hydrocarbons (PAHs) are of concern due to their effects on climate and health. The main goal of this research is to provide the first estimate of emissions of BC and particle-phase PAHs (PPAHs) from motor vehicles in Mexico City. The emissions of other pollutants including carbon monoxide (CO), oxides of nitrogen (NO_x), volatile organic compounds (VOCs), and particulate matter of diameter 2.5 μm and less ($PM_{2.5}$) are also estimated. As a part of the Mexico City Metropolitan Area field campaign in April 2003 (MCMA-2003), a mobile laboratory was driven throughout the city. The laboratory was equipped with a comprehensive suite of gas and particle analyzers, including an aethalometer that measured BC and a photoionization aerosol sensor that measured PPAHs. While driving through traffic, the mobile lab continuously sampled exhaust plumes from the vehicles around it. We have developed a method of automatically identifying exhaust plumes, which are then used as the basis for calculation of fleet-average emissions. In the approximately 75 h of on-road sampling during the field campaign, we have identified ~30 000 exhaust measurement points that represent a variety of vehicle types and driving conditions. The large sample provides a basis for estimating fleet-average emission factors and thus the emission inventory. Motor vehicles in the Mexico City area are estimated to emit 1700±200 metric tons BC, 57±6 tons PPAHs, 1 190 000±40 000 tons CO, 120 000±3000 tons NO_x, 240 000±50 000 tons VOCs, and 4400±400 tons $PM_{2.5}$ per year, not including cold start emissions. The estimates for CO, NO_x, and PPAHs may be low by up to 10% due to the slower response time of analyzers used to measure these species. Compared to the government's official motor vehicle emission inventory for the year 2002, the estimates for CO, NO_x, VOCs, and $PM_{2.5}$ are 38% lower, 23% lower, 27% higher, and 25% higher, respectively. The distributions of emission factors of BC, PPAHs, and $PM_{2.5}$ are highly skewed, i.e. asymmetric, while

those for benzene, measured as a surrogate for total VOCs, and NO_x are less skewed. As a result, the total emissions of BC, PPAHs, and $PM_{2.5}$ could be reduced by approximately 50% if the highest 20% of data points were removed, but "super polluters" are less influential on overall NO_x and VOC emissions.

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