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Black carbon emissions of individual cars measured under real conditions

Measurements of individual vehicle emissions are usually made in laboratory tests. In this study, researchers followed cars driving in real conditions to measure emissions of air pollutants, including black carbon and nitrogen oxides. The study shows that diesel cars contribute disproportionately to air pollution, and highlights the value of on-road measurements.

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Vehicle traffic is a major source of air pollution, linked to respiratory disease and premature death. A recent study found transport emissions in the UK alone may cause 7500 premature deaths every year. Quantifying emissions is important for generating estimates like this, as well as developing appropriate regulations.

Describing aggregate emissions from all road traffic is one way of measuring the impact of traffic on air pollution, but for a more fine-grained picture, measurements are needed per vehicle. One way of describing these emissions is by emission factors, which relate the quantity of emissions to the activity that generates them. Most emission factors are estimated by laboratory tests, which can only evaluate a limited number of vehicles and cannot replicate real driving conditions.

To overcome these limitations, 'real-world' emission factor measurement techniques have been developed, which can measure emissions by following travelling vehicles (the chasing method). This method not only provides more realistic emissions estimates, it can also measure a large number of vehicles over a short period of time and capture a range of emission factors to measure a distribution, which is more representative than a single value.

This research, which was part-funded by the European Social Fund, used this method to measure black carbon (BC), particle number (PN) and nitrogen oxides (NO_x). Each of these is emitted from internal combustion engines and has a negative impact on human health.

The researchers performed the measurements over a seven-day period in December 2011 (which limits their application to vehicles older than Euro 6 standard), on Slovenian highways and regional roads, which are part of trans-European corridors and important connectors between central and eastern Europe. Emission factors were calculated as the pollutant emitted per kilogram of fuel consumed. The total sample included 139 vehicles.

Vehicles were separated into three categories (goods vehicles, gasoline passenger cars, and diesel passenger cars) according to European legislation[1]. Using license plate numbers and registration certificates, the authors obtained data on each vehicle, including the fuel used, date the vehicle first entered service, weight and engine power. This information was used to compare the effects of different vehicle properties on emissions.

The results showed significant differences in emissions depending on the age of the car. For example, diesel cars that were in use for less than five years had a 60% lower emission factor for black carbon than those used for five to 10 years. Newer petrol-fuelled cars also had a 47% lower BC emission factor. Similarly, the NO_x emission factors of newer goods vehicles were 52% lower and PN emission factors were 67% lower. The authors put this down to advances in engine operation and exhaust after-treatment devices due to stricter emission standards.

A small number of vehicles were found to disproportionately contribute to total emissions. The top 25% of emitting diesel cars contributed 63% of BC emissions to the total emissions of the fleet, 61% of PN and 47% of NO_x. To tackle this, the authors recommend regulation that excludes high emitters by retrofitting old vehicles with after-treatment devices and incentivising the exchange of older vehicles for new ones.

This study represents the first on-road measurement of BC emissions for individual diesel cars and under real traffic conditions. Although its findings were made in Slovenia, the study is relevant to the wider European situation as the composition of the cars sampled was very similar to the European vehicle fleet, based on Eurostat vehicle fleet statistics. The study also describes a simple and efficient methodology for monitoring emissions of in-use vehicles. In policy terms, the method could be used to evaluate the impact of emission reduction approaches.

1.Directive 2001/116/EC. See: http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32001L0116