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Do air pollution emissions and fuel consumption models for roadways include the effects of congestion in the roadway traffic flow?

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ABSTRACT

Road transport emission and fuel consumption models are currently used extensively to predict levels of air pollution along roadway links and networks. This paper examines how, and to what extent, models which are currently used to predict emissions and fuel consumption from road traffic include the effects of congestion. A classification framework is presented in which a key factor, *driving pattern*, connects emissions to congestion. Prediction of the effects of different driving patterns in emission models is generally restricted to certain aspects of modelling, i.e. hot-running emissions of regulated pollutants. As a consequence, the effects of congestion are only partially incorporated in the predictions. The majority of emission models explicitly incorporate congestion in the modelling process, but for one important family of emission models, namely average speed models, this could not be determined directly. Re-examination of the (light-duty) driving patterns on which three average speed models (COPERT, MOBILE, EMFAC) are based, shows that it is likely that congestion is represented in these patterns. Since (hot-running) emission factors are based on these patterns, this implies that the emission factors used in these emission models also reflect different levels of congestion. Congestion is thus indirectly incorporated in these models. It is recommended, that, in order to get more accurate (local) emission predictions and to achieve correct application in particular situations, it is important to improve current average speed models by including a congestion algorithm, or alternatively, at least provide information on the level of congestion in the driving patterns on which these models are based and recommendations on what applications the models are suitable for.

1. Introduction

Major efforts have been made in recent decades to reduce air pollution and improve urban air quality. Despite this, air quality issues such as photochemical smog formation and visibility degradation have proven to be persistent. Estimates are that, worldwide, nearly one billion people in urban environments are continuously being exposed to health hazards from air pollutants (Ahrens, 2003).

Around the world road traffic is the dominant anthropogenic source of air pollution in urban areas (Fenger, 1999). This is not only because of the magnitude of its emissions, but also because pollutants are emitted in close proximity to people, thus enhancing exposure levels.

Road transport has grown continuously over the last decades and further increase in the demand for transport is projected (e.g. BTE, 2000). Not only is there ongoing growth in the traffic flows on road links and networks, the incidence of congested traffic conditions has become increasingly common and severe, particularly in major cities (e.g. Austroads, 2000). This paper addresses the issue of whether current emission models for road transport take congestion into account, either implicitly or explicitly.

Traffic congestion has repeatedly been indicated as a major factor in road traffic emissions and air quality degradation (e.g. Oduyemi and Davidson, 1998; Carr et al., 2002). A sensitivity analysis conducted for an urban network (Brisbane, Australia) indicated that, after traffic activity (expressed as vehicle kilometres travelled (VKT)), congestion is the most important contributor to predicted total emissions for CO and HC (Smit, 2006). Emission tests on modern cars with advanced emission control systems (DoTRS, 2001) have demonstrated that their emissions are particularly sensitive to the occurrence of congestion in the driving cycle.

Emission models are commonly used to provide traffic emission information for the prediction and management of air pollution levels near roadways (Smit et al., 2008) and this may be at different scales ranging from road links to city-wide road networks (Affum and Brown, 1999). How, and to what extent, do these current emission models[1] include the effects of congestion in the link or

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[1] For readability purposes, the term “emission” is used in this paper to indicate air pollutant emissions, fuel consumption and CO_2 emissions.

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