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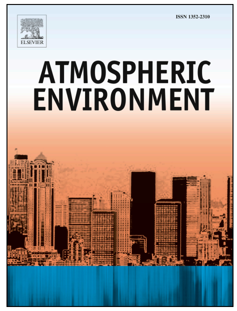

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Operational evaluation of the RLINE dispersion model for studies of traffic-related air pollutants

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Abstract

Exposure to traffic-related air pollutants (TRAP) remains a key public health issue, and improved exposure measures are needed to support health impact and epidemiologic studies and inform regulatory responses. The recently developed Research LINE source model (RLINE), a Gaussian line source dispersion model, has been used in several epidemiologic studies of TRAP exposure, but evaluations of RLINE's performance in such applications have been limited. This study provides an operational evaluation of RLINE in which predictions of NO_x, CO and $PM_{2.5}$ are compared to observations at air quality monitoring stations located near high traffic roads in Detroit, MI. For CO and NO_x, model performance was best at sites close to major roads, during downwind conditions, during weekdays, and during certain seasons. For $PM_{2.5}$, the ability to discern local and particularly the traffic-related portion was limited, a result of high background levels, the sparseness of the monitoring network, and large uncertainties for certain processes (e.g., formation of secondary aerosols) and non-mobile sources (e.g., area, fugitive). Overall, RLINE's performance in near-road environments suggests its usefulness for estimating spatially- and temporally-resolved exposures. The study highlights considerations relevant to health impact and epidemiologic applications, including the importance of selecting appropriate pollutants, using appropriate monitoring approaches, considering prevailing wind directions during study design, and accounting for uncertainty.

Keywords RLINE, dispersion model, model evaluation, exposure

1 Introduction

While controls on vehicle emissions have helped to moderate effects of increasing traffic and urbanization, exposure to traffic-related air pollutants (TRAP) remains a public health concern due to the many adverse health outcomes associated with exposure [1–4], and because many people live and work near major roads, e.g., 4% of the US population (11.3 million persons) live within 150 m of a major highway, and up to 40% in cities [4, 5]. The association between TRAP exposure and adverse health outcomes revealed by health impact and epidemiologic studies plays a critical role in developing air quality policies and standards. However, exposure assessment remains a recognized weakness of these studies [6]. The most accurate approach for determining exposures, personal measurements, is rarely feasible or cost-effective given the number of subjects required and the cost, burden and other limitations of the sampling equipment. Ambient air quality monitoring can be used, particularly in time series studies, however, conventional monitoring networks are spatially too sparse to capture small-scale variation or spatial gradients, e.g., the elevated concentrations found near large roadways [7]. Surrogate measures, such as the proximity to roads and traffic intensity, only indirectly indicate concentrations and have other limitations [6]. Spatially- and temporally-resolved exposures are especially needed for urban-scale cohort and panel studies [8].

Combined modeled frameworks, which can include pollutant emission and physically-based dispersion models can provide predictions of near-road exposures at high spatial and temporal resolution, and new