Air quality and health implications of transitioning 30% of the US Midwest heavy-duty transport fleet from diesel to electric power

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Abstract

Background Transitioning to an electric vehicle fleet is an ongoing climate change mitigation action that will reduce tailpipe emissions but increase the energy demand for charging. The subsequent impact this would have on air quality is poorly understood. In this work, we study the effect of transitioning 30% of the heavy-duty fleet in the US Midwest to electric and analyse the corresponding effects on air pollution concentrations and their associated health impacts.

Methods We scaled tailpipe, refuelling, and idling emissions from heavy-duty vehicles (HDVs) by 30% and estimated the additional energy demand needed for charging. The two-way coupled Weather Research Forecast and Community Multiscale Air Quality chemistry-climate model was used to simulate air pollution concentrations after these emission changes. Monthly simulations for each season were run at a 1·3-km resolution. We estimated the associated health impacts of resultant pollutant concentrations using concentrations response functions derived from epidemiological studies.

Findings Compared with a baseline scenario, we estimate that annual NO_2 and $PM_{2·5}$ concentrations will decrease by up to 4·91 parts per billion and 0·49 μg/m³, respectively, across the study domain. By contrast, differences in annual daily maximum 8-h running mean O_3 ($MDA8O_3$) concentrations are spatially heterogenous, with increases along major road networks and metropolitan areas (up to 1·45 parts per billion) and small decreases in less populated regions. We estimate that these changes will lead to a substantial number of NO_2 and $PM_{2·5}$-related avoided deaths and marginal increases in $MDA8O_3$-related health effects.

Interpretation Our results highlight the overall beneficial effect of electrifying HDVs on air quality and human health, despite an increase in energy demand. However, policies aimed to transition to an electric vehicle fleet should consider air quality changes with a focus on areas that could experience $MDA8O_3$ increases, leading to adverse health effects.

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SFC verified and analysed the data. AM did the simulations and verified the data. JLS set up the model. MV adapted the energy dispatch algorithm. MV and DEH conceived the study idea. SFC and AM accessed and verified the data.

Declaration of interests
We declare no competing interests.