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Impacts of changing temporal distribution of traffic emissions on urban air quality

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Exposure to traffic related air pollution emissions has been found to have an adverse impact on human health. The abundance of some chemically reactive species is dependent upon both emissions, and atmospheric chemical processing. As atmospheric chemistry is non-linear, the response of pollutant loading to emissions variations is complex. Here, we use a detailed photochemical box model, based upon the MCM, to study the relationship between different temporal emission profiles, and the resulting levels of (reactive) air pollutants. The mechanism was updated to include the heterogeneous chemistry of dinitrogen pentoxide (N2O5) reactions with aerosol and subsequent chlorine chemistry. The study applied six contrasting emissions distribution scenarios, reflecting idealised traffic scenarios, whilst at the same time maintaining a constant total emission over a twenty-four hour period. The results from the six model simulations revealed that the concentration of a number of atmospheric chemical species including OH, NO_2, NO_3, N2O5, and $ClNO_2$ are sensitive to changes in emission distribution. the largest differences in the concentrations of NO_2, NO_3, N2O5, and $ClNO_2$ were found for the scenarios where emissions were high at night, and when they were constant. The results show maximum NO_2 concentrations in the morning, around 6 to 10 am, when the number of people walking near the road, and/or cycling on the road are usually high. This finding was related to the number of deaths due to exposure to NO_2 in the UK, and compared to the number of deaths in other scenarios. From a simple calculation, we found that the number of deaths related to air pollution would decrease by 5.4% if the duration of peak emissions were reduced from two hours to thirty minutes. The findings from this study revealed that temporal NO_x emissions distributions can shape pollutant concentrations in the troposphere, as daytime chemistry is different from nighttime chemistry.