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SHORT ABSTRACT

Abstract title: An assessment and modelling of aromatic VOCs in Spain using the MONARCH system

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Abstract text *(maximum 350 words.)*

Volatile organic compounds (VOCs) are significant contributors to air pollution and pose serious health hazards to humans. One essential aspect of VOCs is their contribution to tropospheric chemistry, as they are major precursors for ozone (O_3) formation and also play a key role in the formation of secondary organic aerosols (SOA) . Among the VOCs, aromatic compounds, such as benzene, toluene, and xylene (BTX), are of particular concern not only because of the significant contribution in terms of emissions and ozone formation potential but also due to adverse health effects.

For main criteria pollutants such as NO_2, O_3, PM10 or PM2.5 the performance of air quality models is continuously being evaluated. However, an important gap exists when evaluating VOCs modelled concentrations. Our work aimed to evaluate the performance of the MONARCH system, which is coupled with a bottom up emission model (HERMESv3), in reproducing concentrations of benzene, toluene, and xylene (i.e. o-m-p xylene) in Spain using observational data for the year of 2019.

The model performs well in replicating benzene concentrations in non-industrial areas, although it tends to underestimate them, particularly in winter. However, its performance deteriorates significantly in industrial zones, especially near refineries, car manufacturing facilities, and coke ovens, where substantial underestimations occur. Despite some improvements identified in an industrial sensitivity analysis, the model

still strongly underestimates concentrations near industrial sites, potentially due to underestimations in total emissions. The traffic sensitivity analysis showed a slight improvement for the city of Barcelona, but the model continues to significantly underestimate in this region.

Overall, the model accurately replicates hourly, monthly, and weekly cycles for toluene, but tends to underestimate at traffic stations and overestimate at urban background stations. Similarly, for xylene, the model effectively reproduces these cycles but notably underestimates concentrations at traffic stations during winter months. Industrial facilities also show significant underestimations, despite some improvements in model performance identified from the industrial sensitivity analysis.

This study not only advances our understanding of VOCs in Spain but also has the potential to enhance air quality modelling accuracy, which can lead to more effective pollution control strategies.