**Dynamic estimation of peak concentrations in odour impact modelling: case studies.**

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Atmospheric dispersion modelling is playing an increasingly important role in the assessment of odour impact, supporting and complementing information obtained through measurement techniques, particularly within permitting procedures for industrial activities with potential odour emissions.
Despite the similarities between odour and conventional atmospheric pollutants, applying dispersion models typically used for air pollutants to odour assessment presents specific challenges: odour nuisance depends on concentrations perceived over very short time scales, on the order of a few seconds. In contrast, most dispersion models provide hourly averaged concentrations, thereby losing information on short-term concentration peaks. Up to now, many guidelines and regulations across various countries have recommended the use of the "peak-to-mean ratio" method to estimate peak concentrations. This method involves multiplying the hourly mean concentrations provided by atmospheric models by a country-specific factor to obtain the peak value. However, being a static approach, it may inadequately capture the actual odour impact, potentially leading to either underestimation or overestimation of concentrations depending on the distance from the emission source.
In recent years, the use of more advanced models, particularly Lagrangian models, has been increasingly encouraged as an alternative to the more widely used Gaussian models, which tend to provide an overly simplified representation of reality. Building on this, more sophisticated methodologies for estimating peak concentrations have also been promoted, in particular "dynamic peak-to-mean" approaches. These methods are capable of directly capturing short-term concentration fluctuations during atmospheric dispersion simulations and, consequently, the associated peak values.
Based on two case studies, this work examines the differences, advantages, and limitations of two dynamic peak-to-mean methodologies, the variance transport method and the micromixing method, in comparison with the static peak-to-mean ratio approach. Concentration estimates generated by point and area sources, the two most common types of emission sources in odour impact assessment, are specifically analysed, focusing on the 98th percentile of peak concentrations, a statistic required by regulations. All simulations were carried out using the SPRAY Lagrangian particle dispersion model, which incorporates both dynamic algorithms.
The results of these simulations allow evaluation not only of the peak concentrations themselves, but also of the practical implications of using dynamic versus static approaches. The use of dynamic algorithms results in a moderate increase in computational time, although this increase is not significant. Peak concentrations estimated with the dynamic methods are analysed in detail, allowing assessment of the conditions under which the static peak-to-mean approach may lead to misrepresentation of odour impact.
In conclusion, dynamic peak-to-mean methodologies appear promising for providing a more realistic estimation of odour impact, in line with the most recent regulatory recommendations. However, these approaches require further investigation and validation, as they are currently implemented in only a limited number of commonly used dispersion models, and their application, as well as comparison with measured data, remains relatively limited. Nevertheless, they represent an important avenue for the future development of odour dispersion modelling.