23rd International Conference on
Harmonisation within Atmospheric Dispersion Modelling
for Regulatory Purposes
15-19 September 2025, Hamburg, Germany

SHORT ABSTRACT

Abstract title: A dual-model analysis toward a harmonised CFD approach for urban air quality: Case study of Milan, Italy

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Abstract text

The application of Computational Fluid Dynamics (CFD) models in urban air quality studies has advanced significantly in recent years (Tominaga, 2024), yet differences in numerical solvers and methodologies introduce variability in results, posing challenges for harmonisation and reproducibility (Martín et al., 2024; Pantusheva et al., 2022; Tominaga et al., 2023). OpenFOAM and ANSYS Fluent are widely used CFD software for simulating pollutant transport and dispersion in complex urban environments. (Guo et al., 2023; Lauriks et al., 2021; Raghunathan Srikumar et al., 2024).

This study uses the city of Milan as a case study to compare the performance of both CFD models. A computational domain of $2250\,m \times 2250\,m \times 300\,m$ was defined, with an internal explicitly modelled interest area of $900\,m \times 900\,m$. Both models were subjected to identical methodologies, ensuring consistency in domain requirements, mesh resolution, boundary conditions, and turbulence modelling. Traffic emissions of nitrogen oxides (NOx) were allocated along Viale Marche, a primary urban road link. The modelling approach used a passive scalar to simulate dispersion processes within the urban boundary layer. Model outputs were assessed through a comparative analysis of the resulting velocity and turbulence fields and pollutant concentration distributions.

The study showcases the main methodological differences due to model numerical approaches and the comparative analysis revealed key variations and similarities in the simulated pollutant concentration patterns, offering valuable insights into how solver-specific characteristics influence dispersion processes in complex urban environments. These findings underscore the importance of harmonised CFD methodologies and contribute to improving the accuracy, consistency, and reliability of high-resolution urban air quality simulations, with direct implications for informed decision-making and the development of more effective air quality policies.

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