

Dispersion processes and modelling in an urban street network

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Understanding dispersion processes in urban areas is important for modelling air quality as well as pollution from accidents or terrorist releases. The chaotic nature of turbulent flow and the complexity of the building geometry both contribute to making such modelling non-trivial. Urban geometry affects the mean flow and turbulence significantly and thereby exerts a strong control on dispersion processes. This is explored using results from recent direct numerical simulations (DNS). It is shown that generic dispersion processes can be identified, and that they can be linked to features of the geometry, mean flow and turbulence. Essentially, this includes advection effects within the building geometry due to mean flow channelling, 'topological' splitting of the plume around buildings, and turbulent vertical transfer as a result of predominantly unsteady exchange processes. Secondary sources, resulting from entrainment of material in building wakes and their subsequent re-release, modify both the near-source concentration pattern and its subsequent evolution. Further effects come into play when the non-regular aspects of real urban geometries are taken into account. This includes mechanisms that enhance vertical scalar transfer induced by variations in building heights, as well as the skewing of the dispersion plume with height as a result of asymmetries in the flow. Some of these generic processes are used as the basic ingredients of a simple network model of dispersion, which is shown to give good agreement with DNS and wind tunnel data.