DETERMINATION OF CONCENTRATION FLUCTUATIONS WITHIN AN INSTANTANEOUS PUFF THROUGH WIND TUNNEL EXPERIMENTS

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Abstract: The instantaneous release of a dangerous substance in the atmosphere (industrial accident, malicious act) remains a difficult problem of modelling because of the turbulent nature of the atmospheric boundary layer. Indeed, the majority of dispersion models is based on a statistical description of turbulence and provides averages on a whole of possible realization of the flow. These approaches, justified for long releases, become insufficient in the case of short releases, because the transport of the pollutant is then only due to one particular realization of the flow. Consequently, the peaks of concentration affecting the exposed population are likely to be underestimated. It is thus necessary to improve the models of dispersion so they can provide a probability of concentration at each location. The literature offers several approaches to describe the probability density function of the fluctuations of concentration but very few experimental data are available to validate these approaches, in particular in the case of short releases and a fortiori in an urban context, in the presence of buildings. This is why we carried out a series of wind tunnel experiments to characterize the fluctuations of concentration during the passage of an isolated puff transported in a boundary layer flow. The experiments were initially carried out on a flat ground, then in the presence of buildings. A specific experimental methodology was designed to measure the fluctuations of concentration. A FID allows the measurement of the temporal evolution of the concentration during the passage of a puff. For each position of the sensor compared to the source, measurement is carried out for a hundred rejections, in order to be able to estimate and connect the characteristics of the instantaneous puffs to the characteristics of the average puff (position of the centre of mass, standard deviation of the temporal distribution of concentration…). The results obtained made it possible to quantify the relative influence of the various mechanisms which lead to the dispersion of a puff: Dispersion of the position of centre of mass Relative dispersion (around centre of mass) Internal fluctuation Moreover, they led to the quantification and the taking into account of the variability of parameters essential for the modelling of the internal fluctuations. A discussion makes it possible to connect the role of the three phenomena described above to the particular configuration of the boundary layer flow in the wind tunnel (roughness, presence of obstacles).