Proceedings of the Third International Symposium on Air Quality Management at Urban, Regional and Global Scales. p. 699, 26-30 September 2005, Istanbul – Turkey

LARGE EDDY SIMULATION OF A CONTINUOUS AREA SOURCE IN A CONVECTIVE BOUNDARY LAYER

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ABSTRACT

This work describes the three-dimensional structure of an inert passive atmospheric pollutant continuously emitted by an area source located near to the surface in a highly convective planetary boundary layer (CBL) $\left(-434 \le z_i/L \le -62\right)$. The CBL properties were numerically simulated using a large eddy simulation model development by Moeng. Under quasi-steady equilibrium conditions, the turbulent flow in the CBL is characterized by asymmetric structures composed of updrafts and downdrafts that produce pollutant transport in the layer. The vertical profile of the skewness of pollutant concentration is negative for almost the whole extension of the mixed layer, except in the regions near to the surface and close to the top of CBL. The latter negative fluctuations are related to the penetration of clean air in the top of CBL, which moves towards the surface in horizontally-narrow and vertically-extensive areas, provoking a decrease of pollutant concentration values. This decrease in pollutant concentration in the mixed layer simulated by the LES is $\partial\langle c\rangle/\partial t \approx -0.15\,\mathrm{ppm\,h^{-1}}$, comparable to the time rate of variation of carbon monoxide concentration of $-0.20\,\mathrm{ppm\,h^{-1}}$, as observed on average at the surface in the city of São Paulo.

Key Words: LES Model, CBL, Pollutant Dispersion, Source Area, Carbon Monoxide.