1. INTRODUCTION

Modelling of turbulent dispersion of a contaminant in an atmospheric flow (as opposed to the simplest case of diffusion) is a problem of great theoretical and practical importance. First the accuracy of the prediction is a proof of the understanding of the basic phenomena of turbulent transport and provides an ideal test bench for the verification of the assumptions made. Second the usefulness of such a tool to predict the potential consequences related to normal or accidental releases of gaseous pollutants during production, transport, storage or manipulation is fully recognized. The fact that the above mentioned release will normally take place in the atmospheric surface layer, with all the associated uncertainties in terms of structure of the wind and of the terrain, cannot but further complicate the problem.

Some of the aspects of the associated difficulties and of the problems related to the results from full scale and model tests and their interpretation are discussed in reference 1. These highlight the necessity for accurate and efficient theoretical models.

The classical theoretical approaches to the problem are gaussian-like solutions or models based on the solution in an Eulerian reference frame of the classical turbulent diffusion equation :

$$\frac{\partial C}{\partial t} + U_i \frac{\partial C}{\partial x_i} = \frac{\partial}{\partial x_i}\left(K_L \frac{\partial C}{\partial x_i}\right) + \frac{\partial \overline{u_i c'}}{\partial x_i} \qquad (1)$$

where t is the time, x_i a space coordinate in a Cartesian frame of reference, U_i and u_i are respectively the mean and fluctuating components of the velocity vector, C and c' are respectively mean and fluctuating concentration and K_L is the molecular diffusivity of the medium.

In the current models, velocity concentration fluctuations are treated with the eddy diffusivity approach to yield :

$$\frac{\partial \overline{u_i' c}}{\partial x_i} = K \frac{\partial C}{\partial x_i} \qquad (2)$$

where K is the turbulent (eddy) diffusivity.

There is some accumulated evidence (Refs. 2,3,4) that these solutions maybe are insuffient to predict all the complexities associated with the different flow fields. In particular (Refs. 3,4), finite difference solutions of equation 1 seem to be extremely sensitive to the definition of the discrete mesh.

Better results and, in particular, the elimination of the problems related to the mesh could be hoped for by the use of a Lagrangian approach, in which the behaviour of the pollutant is simulated by "markers" whose displacements reproduce the statistics of the considered turbulent transport. The average history of a large number of marker releases then yields the ensemble solution of the diffusion equation. However, according to a recent reviewer (Ref. 5), the modelling of the turbulent motion of particles has been mostly limited to the case of homogeneous turbulence. For inhomogeneous turbulence and elevated sources the treatment has often been empirical and, from a certain number of standpoints, unsatisfactory.