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Local Scale Air Quality Model with Several Pollutant Sources

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SUMMARY

This paper shows a finite element method for pollutant transport with several pollutant sources. An Eulerian convection–diffusion–reaction model to simulate the pollutant dispersion is used. The discretization of the different sources allows to impose the emissions as boundary conditions. The Eulerian description can deal with the coupling of several plumes. An adaptive stabilized finite element formulation, specifically Least-Squares, with a Crank-Nicolson temporal integration is proposed to solve the problem. An splitting scheme has been used to treat separately the transport and the reaction. A mass-consistent model has been used to compute the wind field of the problem. Some numerical results in the Gran Canaria island with several sources are shown.

Key Words: Air quality modelling; Eulerian description; Wind field simulation; Adaptive finite element method

1 INTRODUCTION

In this paper, we present a new methodology for local scale air quality simulations by using a non-steady finite element method with unstructured and adaptive tetrahedral meshes based in [1,2]. The wind field is crucial for the pollutant transport, specially in complex terrain areas. In order to simulate it, we have used a mass-consistent model [3]. An adaptive technique has been developed in order to improve the solution of the problem [4,5]. The convection, diffusion and reaction problem is usually solved using splitting schemes and specific numerical solvers for time integration of photochemical reaction terms. A non-steady and non-linear transport model is presented in this paper. A stabilized finite element formulation, specifically Least-Squares, with a Crank-Nicolson temporal integration is proposed to solve the problem. The chemistry is simulated by using the RIVAD/ARM3.

Current Plume in Grid (PiG) models use a Lagrangian description that has problems when two different plumes collide. The proposed Eulerian model in this paper can deal with several plumes colliding without any special treatment. Chemical reaction in the intersection of the plumes is computed neatly. A simplified example can be seen in Fig. 1.

Figure 1: Simplified case for two overlapping plumes

2 CONCLUSIONS

A methodology to deal with several emission points has been presented. Results are promising, and show the simplicity in introducing emission points into the problem. Coupling of several plumes have been simulated.

Numerical results shows that this technique can be useful to deal with several plumes that can collide.

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