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A local scale finite element moldel for stack pollutant dispersion over complex terrains

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Conventional air quality models uses Lagrangian [1,2] or Eulerian [3] strategies, and the numerical approach is normally obtained by using finite difference schemes. In this paper, we introduce a local scale Eulerian air pollution model that is related to unsteady propagation problems which may be mathematically described by convection-diffusion-reaction equations. We solve the couple problem applying a three-dimensional finite element discretization with unstructured and adapted meshes. The tetrahedral mesh is adapted to the topography and the plume rise. The local area of interest is up to tens of kilometres and it includes the stacks.

The wind field is crucial for the pollutant transport, specially in complex terrain areas. We use a mass consistent model that is solved with the finite element method taking into account the plume rise effect [4,5,6].

Chemical reactions have been solved by two models [7]. The first one is a linear model relating two chemical species and the second one is the RIVAD model involving four species with non-linear chemistry. The numerical solution for the linear problem is obtained using stabilized finite elements with least squares and a Crank-Nicolson time integration. In the non-linear case, we apply a Strang splitting and a ROS2 time integration scheme.

We present several applications of the model. On the one hand, we consider two test problems that involve one and two stacks over a plane terrain. On the other hand, we simulate the pollution that is produced by a stack placed in the Island of La Palma (Canary Island, Spain). Expected results have been simulated in both cases within a reasonably computing time.

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