Air Pollution Modelling Using Finite Differences in A Terrain Conformal Coordinate System

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In this paper a 3-D model for pollutant transport in the atmosphere is proposed. We consider a set of coupled convection-diffusion-reaction equations. The convective phenomenon is mainly produced by a wind field [1, 2, 3] which is obtained from a 3-D mass consistent model. In particular, the modelling of oxidation and hydrolysis of sulphur and nitrogen oxides released to the surface layer is carried out by using a linear module of chemical reactions [4]. Dry deposition process is represented by the so-called deposition velocity and it is introduced as a boundary condition. Wet deposition is included in the source term of the governing equations using the washout coefficient [5].

To obtain a numerical solution, first, the problem is transformed using a conformal coordinate system. This allows us to work with a simpler domain in order to build a mesh that provides high consistency finite difference schemes. Then, the convection-diffusion-reaction equations are solved using a high order time discretization which is obtained following the technique of Lax and Wendroff. The model have been tested with a numerical experiment in the Island of La Palma (at the Canary Islands).

Though, in general, the variable vertical spacing, used in our finite difference discretization leads to schemes of first consistence order, some strategies here proposed provides second order schemes. So, the proposed formulation for the convection-diffusion-reaction problem have interesting properties of consistence and stability. The model does not only allow to generate wind maps from the measurements obtained in few stations, but also to obtain the history of a pollution episode for the considered species.

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