Simulation of transport and diffusion in complex terrain by an integrated modelling system

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The assessment of the pollution levels, particularly in complex terrain, requires a model system able to give reliable simulations of the atmospheric transport and diffusion processes. The temporal and spatial variations of flow conditions call for a complete description of the 3-D wind and turbulence fields. Consequently, the application of full 3-D Lagrangian models may be recommended.

An integrated system of 3-D models, RMS, able to carry out the simulation of the transport and diffusion in complex terrain, will be illustrated. This system is composed by the model RAMS (giving the flow field), the Lagrangian Stochastic Model (LSM) SPRAY (computing the diffusion) and the interface code MIRS.

RAMS, developed at the Colorado State University numerically solves the Reynolds averaged equations, in the atmosphere, for the conservation of momentum, heat, moisture and mass. We also recall that it has a non-hydrostatic option and includes a two ways nesting and a nudging procedure.

MIRS, developed by our team, reads the RAMS outputs and prepares the SPRAY inputs and also prescribes all the turbulence information not directly given by RAMS, such as the 2-D mixing height field, the 3-D wind standard deviation, the Lagrangian decorrelation time scales and the third and fourth order moment of the vertical velocity fields, that may be needed by SPRAY.

SPRAY, developed by us in cooperation with ARIANET, Milan, is a LSM for the simulation of the dispersion of inert gases in complex terrain. In SPRAY, the dispersion calculation is based on the generalized Langevin equation. The key input is the Eulerian PDF of the turbulent velocities. There are different options for the PDF to be used along the vertical and the user can choose between bi-Gaussian PDFs (with different closures) and the Gram-Charlier PDF truncated to the third or fourth order moment. The model makes use of the Gaussian PDF in the horizontal directions. Plume rise is accounted for.

After introducing our modelling integrated system RMS, we will present and discuss the results of the simulation of transport and diffusion of tracer gases obtained by RMS in real site applications (Southern Germany, during TRACT campaign; Brazilian coast - São Paulo State –, and Northern Italian coast.