Three-dimensional Simulation of Wind Fields and Air Pollution over Complex Terrain

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Abstract

In this talk we introduce a new methodology for wind field simulation or forecasting over complex terrain. The idea is to use wind measurements or predictions of the HARMONIE mesoscale model as the input data for an adaptive finite element mass consistent wind model [1,2]. The method has been recently implemented in the freely-available Wind3D code [3]. A description of the HARMONIE Non-Hydrostatic Dynamics can be found in [4]. The results of HARMONIE (obtained with a maximum resolution about 1 Km) are refined by the finite element model in a local scale (about a few meters). An interface between both models is implemented such that the initial wind field approximation is obtained by a suitable interpolation of the HARMONIE results. The final model approximation is adjusted to this interpolated field verifying incompressibility and tangency to terrain. In addition, measured data can be considered to improve the reliability of the simulations. An automatic tetrahedral mesh generator, based on the meccano method [5,6], is applied to adapt the three-dimensional discretization to complex terrains. This method combines several former procedures: a mapping from the meccano boundary to the solid surface, a 3-D local refinement algorithm and a simultaneous mesh untangling and smoothing. The key of the method lies in defining a one-to-one volumetric transformation between the parametric domain (a simple cuboid in this case) and the physical domain. The main characteristic of the whole framework is a minimal user intervention. The final goal is to validate our model in several realistic applications in Gran Canaria Island, Spain. For this purpose, genetic algorithms are used to obtain the optimal model parameter values. These wind simulations can also be used for air pollution modeling [7].

References

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