Numerical Modeling of Flow and Pollution Dispersion over Real Topography

Luděk Beneš, Karel Kozel, Ivo Sládek

Department of Technical Mathematics
Faculty of Mechanical Engineering
Czech Technical University of Prague
Karlovo nám. 13
121 35 Praha2
email: benes@marian.fsik.cvut.cz

The contribution deals with a problem of flow and pollution dispersion in the Atmospheric Boundary Layer (ABL). Majority of the human activity is concentrated to the ABL and the air pollution resulting from the rapid industrialization has become a serious environmental problem. On this account, the better understanding of behavior in ABL is necessary.

A mathematical and numerical investigation of the atmospheric boundary layer flow in two real cases is presented. The first one is flow over surface brown coal mine and coal depot in North Bohemia. The influence of a rampart or protective forest blocks on the reduction of dustiness has been studied. The second one is part of real orography close to the Prague.

The flow is assumed to be steady, incompressible, turbulent and indifferently stratified. The mathematical model is based on the system of RANS equations for a viscous incompressible flow. Closure of the system of equations is achieved by turbulence models. Two different models was tested, either a simple algebraic turbulent model designed especially for ABL or a two equation $k - \varepsilon$ model. Additional transport equation for concentration of passive pollutant has been considered in order to study the pollution dispersion over the complex 3D topography.

The influence of forest was modeled by specific aerodynamic force corresponding to the drag induced by the vegetation.

The full system of RANS equations in conservative form was solved using artificial compressibility method. For the spatial discretization the finite volume cell centered method was used. The time integration is performed by the explicit Runge-Kutta scheme of the second order.