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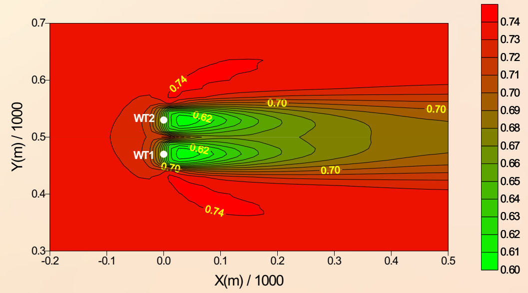
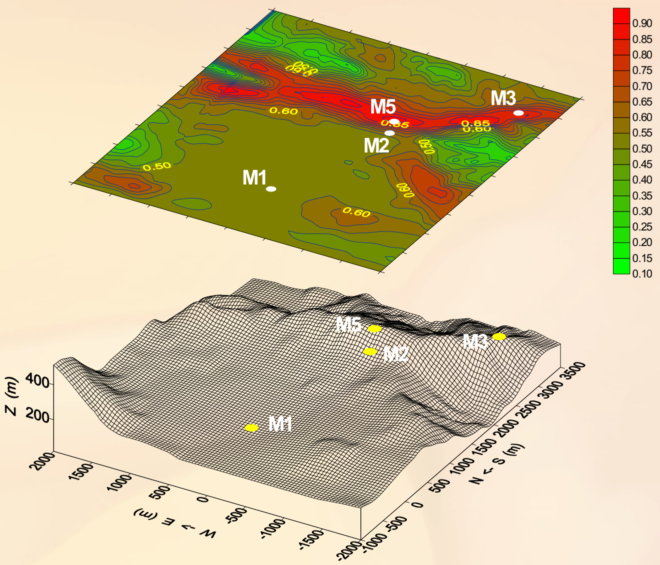
WIND FLOW MODELLING

Two computational tools - based on different levels of approach - for wind flow modelling over complex terrain have been developed at CRES: A 3-D Navier-Stokes solver and a 3-D Boundary Layer model. The three-dimensional mean flow field structure (velocity components, flow angle) and the turbulent quantities (for the Navier-Stokes solver) are obtained at desired elevations dealing with the examined wind direction.



3-D Navier-Stokes solver: The Reynolds averaged Navier-Stokes equations in their incompressible form are integrated on body-fitted structured meshes employing a pressure-correction algorithm. A fully implicit multi-block iterative scheme is developed for that purpose. Turbulence closure is achieved using the standard k-ω model with suitably modified constants for atmospheric flows. Wall-function type boundary conditions, which take into account the surface roughness length, are imposed. Isolated machines or arrays of wind turbines can be embedded into the computational domain, in order to study their upstream influence and wake evolution. This is accomplished by simulating the machine(s) as momentum absorbers, distorting the mean wind field and turbulence characteristics.



3-D Boundary Layer model: The method is based on a viscous-inviscid interaction scheme, where a 3-D full potential solver accounts for the inviscid "background" flow and a 3-D integral boundary layer solver for the viscous effects. The existence of a prevailing flow direction (longitudinal) is presumed, which is defined from the inviscid "background" flow streamlines. Along this direction the atmospheric boundary layer is modelled using a velocity profile family with two different slopes in the logarithmic scale, for the inner and the outer regions correspondingly. The Mager's velocity profile family describes the lateral velocity component, which measures the boundary layer skewness due to the three-dimensional viscous effects. The integral treatment of the boundary layer equations is suggested as a fair compromise between physical relevance of the model and computational effort required.

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