Numerical simulations of turbulent flows over hills and complex urban areas with dispersion of pollutants

Project Aim

This project is part of the long-term investigations at our Department of Multi Scale Physics aimed at the mathematical modeling and numerical simulations of environmental flows and turbulent dispersion. In this particular project we focus our investigation at the turbulent flows over complex terrains and urban areas (street canyons) with dispersion of pollutants.

Progress

Several extensions of standard two-equation eddy-viscosity turbulence models have been investigated, which are expected to eliminate some well-known deficiencies of the standard models relevant for accurate predictions of environmental flows. These include effects of surface roughness through generalized wall functions, a redefined TKE production, a time-scale limiter and a hybrid RANS/LES approach. Another novelty is an efficient representation of blocked flow regions for mimicking built objects. The accuracy and robustness of these models in a structured non-orthogonal Navier-Stokes solver have been investigated. We simulated the flow and spreading of traffic pollution in urban street canyons at lab- and full-scale, and found good agreement with available measurements. Recently, we started to study flow and turbulence around the TU Delft campus. Also we tested few variants of the models that incorporate effects of trees on velocity and turbulence. Further investigations including a novel hybrid RANS/LES approach are currently under development.

Dissertations

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Scientific Publications

1. Kenjeres S. , Hagenzieker R. and Hanjalic K. (2007), "Numerical Predictions of Traffic Pollution in Urban Areas", Proceedings of the XXI International JUMV Automotive Conference, Science and Motor Vehicles, 23-25 April, 2007, Beograd, Serbia, Paper NMV0723, pp.1-16.
2. Hanjalic, K. and Kenjeres, S. (2008), "Some Developments in Turbulence Modelling for Wind and Environmental Engineering", Journal of Wind Engineering and Industrial Aerodynamics, Vol. 96, Issues 10-11, pp.1537-1570.

Project leaders

S Kenjeres, K Hanjalic, CR Kleijn

Research theme

Complex dynamics of fluids
Mathematical and computational methods for fluid flow analysis

Participants

S Kenjeres, K Hanjalic, CR Kleijn

Cooperations

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Funded

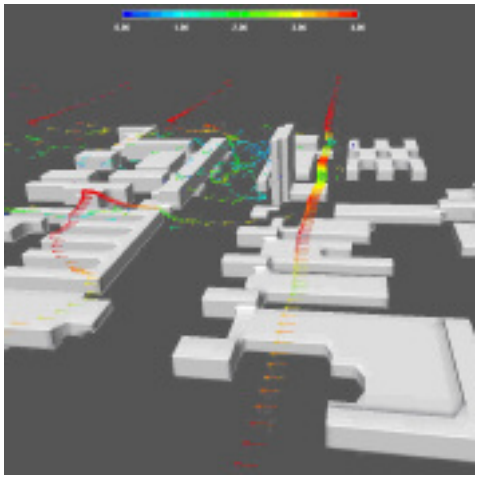
TU Delft, KNAW
1st 50% 2nd 50% 3rd -

Start of the project

2001

Information

S Kenjeres
015 278 3649
S.Kenjeres@tudelft.nl
www.msp.tudelft.nl



T-RANS numerical simulation of flow around the TU Delft campus. Fully developed atmospheric boundary layer velocity and turbulence parameters are specified at the inlet for different wind orientations. Newly developed non-equilibrium wall-functions for rough surface areas are applied, Re~107, Kenjeres, Valk, Kleijn (2007)