Emvin, P. and L. Davidson, Development and Implementation of Fast Implicit Multigrid Method for Large Eddy Simulations

Emvin, P. This thesis discusses the full multigrid method applied to turbulent flow in ventilated enclosures using structured and unstructured grids, Department of Thermo- and Fluid Dynamics, Gothenburg, 1997.

Large eddy simulations represent a promising concept in turbulence modelling as they are consistent with the Navier-Stokes equations in the limit of zero grid size. We have in this work used the dynamic subgrid model, and a spatial discretization. The purpose of this work has been to develop as fast a solver as possible for stretched grids.

This means that we have not considered any issues concerning the validity of this model and space discretization, and the discretization error is probably larger than the whole subgrid model as we use filter size and spatial discretization of the same size. In addition, no attention is paid to analyzing what kind of grid is suitable for these applications. These grids have a maximum aspect ratio of about 100, which must be accounted for in constructing the solver. We have thus in this work focused on developing as efficient a solver as possible for this class of problems, as they are typical of LES applications.

We must have a sufficient resolution, and we need to run the simulation long enough to obtain a stable average, while we simultaneously have a sufficient resolution in time. When using a fully explicit time-accurate formulation, the time step becomes very small. Even when using an implicit pressure equation, the time step may become a factor of ~ 3 – 10 smaller than is required by accuracy.

Thus, if using a fully implicit method or only an implicit pressure equation, the efficiency of the matrix solver is crucial if one should benefit from the longer time steps admitted.

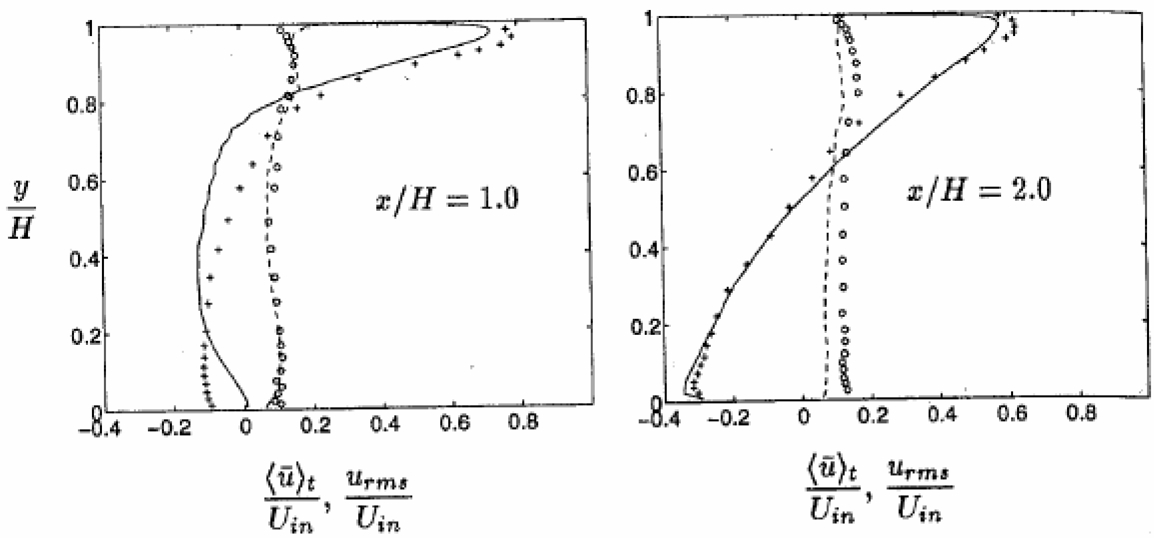

Figure 5: Time-averaged velocity and resolved rms velocity profiles. Symmetry plane $z/H = 0.5$. Solid lines: $\langle \bar{u} \rangle_t / U_{in}$; dashed lines: u_{rms}/U_{in}; +: experimental mean velocity; o: experimental fluctuations.