Geophysical Research Abstracts, Vol. 7, 07772, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07772

Recent developments in subgrid-scale modelling for turbulent shear flows

L. Kleiser

ETH Zürich, Institute of Fluid Dynamics, CH-8092 Zürich, Switzerland
(kleiser@ifd.mavt.ethz.ch)

Demand for turbulent flow computations has been strongly increasing in the recent past, driven by the need for more complex, accurate and fast flow predictions in numerous applications and by wide-spread access to exponentially increasing computing power. Conventionally, numerical computations of engineering or geophysical turbulent flows are based on the Reynolds-averaged Navier-Stokes (RANS) equations for which statistical turbulence models are needed. Such computations can only give statistical information about turbulence. Moreover, severe limitations of existing turbulence models still represent a key problem of Computational Fluid Dynamics for which no solution has come into sight despite decades of research.

Alternative turbulent flow simulation approaches are the Direct Numerical Simulation (DNS), in which all relevant length and time scales down to the Kolmogorov scales have to be resolved by the numerical grid, and the Large-Eddy Simulation (LES), in which "only" the large scales are resolved while their interaction with the non-resolved subgrid scales is modeled. DNS and LES have become indispensible tools in transition and turbulence research during the past twenty years.

In DNS, the required computation time typically increases with the third power of the flow Reynolds number. This severely limits the range of problems accessible to DNS. Computationally LES is much less expensive than DNS, allowing to compute turbulent flows at higher Reynolds numbers. Significant progress in subgrid-scale modeling has been made recently. LES is expected to play a major role in the future prediction and analysis of certain complex engineering turbulent flows in which a representation of unsteady turbulent fluctuations is important, such as large-scale flow separation in aerodynamics, coupled fluid-structure interaction, turbulent flow control, aeroacous-

tics and turbulent combustion. Multiphase flows are another important area of LES application.

This talk will discuss recent progress in subgrid-scale modelling including our recently developed approximate deconvolution modelling approach (ADM) and high-pass-filtered (HPF) eddy-viscosity models. Some LES results will be presented for turbulent and transitional flows with an engineering background.