



Review

Recent advances on the numerical modelling of turbulent flows

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ABSTRACT

This paper reviews the problems and successes of computing turbulent flow. Most of the flow phenomena that are important to modern technology involve turbulence. The review is concerned with methods for turbulent flow computer predictions and their applications, and describes several of them. These computational methods are aimed at simulating either as much detail of the turbulent motion as possible by current computer power or, more commonly, its overall effect on the mean-flow behaviour. The methods are still being developed and some of the most recent concepts involved are discussed.

Some success has been achieved with two-equation models for relatively simple hydrodynamic phenomena; indeed, routine design work has been undertaken during the last three decades in several applications of engineering practice, for which extensive studies have optimised these models.

Failures are still common for many applications particularly those that involve strong curvature, intermittency, strong buoyancy influences, low-Reynolds-number effects, rapid compression or expansion, strong swirl, and kinetically-influenced chemical reaction. New conceptual developments are needed in these areas, probably along the lines of actually calculating the principal manifestation of turbulence, e.g. intermittency. A start has been made in this direction in the form of ‘multi-fluid’ models, and full simulations.

The turbulence modelling approaches presented here are, Reynolds-Averaged Navier–Stokes (RANS), two-fluid models, Very Large Eddy Simulation (VLES), Unsteady Reynolds-Averaged Navier–Stokes (URANS), Detached Eddy Simulation (DES) and some interesting, relatively recent, hybrid LES/RANS techniques.

A large number of relatively recent studies are considered, together with reference to the numerical experiments existing on the subject.

The authors hope that they provide the interested reader with most of the appropriate sources of turbulence modelling, exhibiting either as much detail as it is possible, by means of bibliography, or illustrating some of the most recent developments on the numerical modelling of turbulent flows. Thus, the potential user has the appropriate information, for him to select the suitable turbulence model for his own case of interest.

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