Preface

Turbulence modeling is a complex subject and methods developed to deal with it are numerous and diverse. Many schools of thought exist and communication and understanding among them is often lacking. Comparisons may be odious but they need to be made and explored if a scientific discipline is to progress. This is why *Multiscale and Multiresolution Approaches in Turbulence* is so timely. It brings together many topics not found in one place before. A number have appeared only in very recent research papers and here grace the pages of a book for the first time. The proximity invites comparisons and suggests a greater unification of turbulence methodology than is at first apparent. The subject of the work is modeling, but the dual themes, expressed in the title, are multiscale and multiresolution approaches. These words conjure up fundamental and computational concepts, and, indeed, the text presents both in an integrated way. Multiscale and multiresolution methods have attracted enormous recent interest in a variety of scientific disciplines, and they seem to provide the ideal framework for organizing much, if not all, contemporary turbulence research.

The treatment begins in Chapter 1 with a brief introduction to turbulence ideas, including randomness, coherent structures, turbulent length and time scales, the Kolmogorov energy cascade, and transfers of energy between scales. In Chapter 2, the enormous cost of direct numerical solution of the Navier–Stokes equations is used to motivate the practical need for modeling. This amounts to approximating the effects of unrepresented scales and the basic strategies are described next, namely, Reynolds Averaged Numerical Simulation (RANS) and Large Eddy Simulation (LES), and are followed by a discussion of multilevel methods. Chapter 3 deals with statistical multiscale concepts and various RANS models are presented, including eddy-viscosity and Reynolds-stress models. Chapter 4 is concerned with multiscale subgrid models and self-adaptivity in LES. Fundamental ideas are introduced, along with the Germano identity, dynamic models, self-similarity, and variational multiscale (VMS) methods. Chapter 5 presents structured multiscale subgrid models for LES based on the estimation of small scales. Various reconstruction techniques are described, including deconvolution, multifractal, and multigrid, in addition to zonal multigrid/multidomain methods. Unsteady turbulence simulations on self-adaptive grids are discussed in Chapter 6, covering dynamic multilevel and adaptive wavelet methods, and DNS and LES with adaptive mesh refinement (AMR). Global hybrid RANS/LES approaches are presented in Chapter 7, including unsteady statistical modeling, blending, and Detached Eddy Simulation (DES). The theoretical basis of zonal RANS/LES methods commences Chapter 8 and is followed by a discussion of inlet data generation and turbulence reconstruction techniques.

This text is a very important addition to the literature on turbulence. It provides an excellent introduction to many areas of contemporary research and it systematically organizes many seemingly disparate approaches within its dual themes of multiscale and multiresolution methodology. Researchers will find it useful as a guide to the strengths and weaknesses of current technology, a classification system within which new developments will likely fit, and a hierarchy for locating methods to compare with. Student and expert alike will benefit greatly by reading it from cover to cover, and will also find it a reference work of lasting value.

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