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BOOK REVIEW

Large-Eddy Simulations of Turbulence. By Marcel Lesieur, Olivier Métais & Pierre Comte. Cambridge University Press, 2005. 248 pp. ISBN 0521 78124 8. £35.00.

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This book is an organized and structured presentation of the main achievements of the team created and lead by Marcel Lesieur in Grenoble since the 1980s in the field of large-eddy simulation of turbulent flows. This team was among the first to investigate this field in France, and played an important role in the development of large-eddy simulation in that country. Therefore, the book is also an interesting guided tour of the world of large-eddy simulation.

The book emphasizes the main ideas and is very richly illustrated, including very nice supplementary online movies, which help the reader to understand the flow dynamics. This movie gallery is certainly unique, and will be useful to all teachers of fluid mechanics. The scope of the book is oriented toward physical modelling and fluid dynamics, and issues related to numerical methods, boundary conditions and formal series expansion modelling are not adressed.

The book is made up of eight chapters. Chapter one is devoted to the presentation of the large-eddy simulation (LES) technique. It includes a brief reminder about the principles of fluid mechanics and the statistical description of isotropic turbulence. Both direct numerical simulation and large-eddy simulation are introduced in the second part of the chapter, with historical perspectives. Chapter two deals with vortex dynamics. After a discussion of the dynamics of vorticity, the reader is provided with a presentation of the main definitions of coherent vortices. The filtering paradigm for LES in the physical space is introduced in Chapter 3 along with the concepts of eddy viscosity and eddy diffusivity. The governing equations are given in both Galilean and rotating reference frames. Large-eddy simulation in the spectral space is discussed in Chapter 4. The main results dealing with interscale coupling and energy transfer obtained from theoretical analyses (EDQNM – eddy-damped quasi-normal Markovian, RNG – renormalization groups, etc.) are summarized, and their parameterization via the definition of spectral eddy viscosity and diffusivity is presented. The last part of the chapter is devoted to the recent results dealing with isotropic turbulence obtained by the authors.

The extension of spectral LES to inhomogeneous turbulence (temporal mixing layer, plane channel flow) is addressed in Chapter 5. Both the dynamics of the flows under consideration and the extended models developed in Grenoble are presented. Advanced subgrid modelling for inhomogeneous flows in the physical space is treated in Chapter 6. Several approaches (selective models, filtered models) developed by the authors for the design of self-adaptive models that are well-suited to these lows are presented and illustrated. Chapter 7 discusses the extension to compressible flows without shocks. Governing equations deduced from the application of a convolution filter to the compressible Navier–Stokes equations are presented. The issue of choosing a set of computational unknowns for compressible LES is addressed, the emphasis being on the pseudo-temperature/pseudo-pressure developed

in Grenoble. The chapter is illustrated with many examples of applications, ranging from low-Mach-number flow to smooth supersonic flows. The application of LES to geophysical fluid dynamics is presented in Chapter 8. The main basis for the understanding of flows with stratification and/or rotation and/or shear effects are first recalled. Illustrative examples are then given.

This book is a good first course in the field of LES. It will provide the reader with many examples of the use of LES in flows with complex dynamics (but simple geometries). Therefore, anyone interested in taking a first look at LES without wishing to explore the corresponding theoretical background, or looking for up-to-date survey of recent approaches and issues in this field will enjoy it and should buy it. More expert readers interested in the history of LES will also find here a very nice compilation of the main achievements of the team at Grenoble. This book is certainly a welcome complement to others dealing with LES, since it is the only one to provide the reader with a large number of LES results. It can therefore be recommended to all involved in Computational Fluid Dynamics, including researchers, engineers and PhD students.

P. Sagaut