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BOOK REVIEW

Multiscale and Multiresolution Approaches in Turbulence. By Pierre Sagaut, Sebastian Deck & Marc Terracol. Imperial College Press, 2006. 356 pp. ISBN-10: 186094650X, ISBN-13: 978-1860946509, £78.00.

This book provides a comprehensive coverage of recent developments in the area of multiple scale and multiple resolution approaches to turbulence. It is unique in that it attempts to unify many different techniques under a single mathematical umbrella. In particular, this book covers LES, DES, hybrid RANS/LES and multiscale RANS turbulence models.

The book is suitable for those commencing their doctoral studies, as well as existing CFD practitioners who wish to keep their knowledge up to date on some of these specialised areas. In many respects, this book does not attempt to be a traditional text book, but is a well-structured documentation of many recent research advances. The underlying mathematical approach can make the material a little harder to digest, but the effort of the reader is well rewarded with a thorough treatment of the material.

The book commences with a general introduction to turbulence and definitions of turbulence scales—obviously, these are critical to the approaches described in later chapters. Chapter 2 moves on to the simulation of turbulence and covers both Reynolds averaging and LES filtering leading on to multilevel decomposition. The chapter concludes with an excellent summary that describes the various approaches in a hierarchy of resolved physics and graphically shows the resolved and unresolved parts of the turbulence spectrum for DNS, RANS, multiscale statistical approaches, LES and multilevel LES. This unifying description then allows the authors to describe these methods in later chapters.

While the casual reader may assume that the book is purely about LES and the related unsteady simulation methods, in fact, chapter 3 covers a relatively new class of RANS turbulence models where multiple scales are considered. The chapter concludes with a useful section on difficulties with these models and significant achievements to date.

The next chapter documents subgrid closures in which some estimation of the smaller scales is used to improve the closure. This is an area in which the authors have been particularly active and they provide a comprehensive review of the work. Unfortunately, the authors are not critical of the methods and provide little evidence that there is a significant benefit in solution accuracy for the increased complication of the proposed methodologies. The only test case shown is a channel flow and the reader is not left with any clear idea which of the methods presented may be most appropriate or practical for their own application area. This is logically followed by a review of self-adaptive grid adaption unsteady flow methods. This suffers from similar problems as the previous chapter, but does at least include solutions for a free shear layer and an unsteady shedding problem.

The remainder of the book covers hybrid RANS/LES methods and distinguishes between those that automatically switch between the methods ('global') and those that have predefined RANS and LES zones ('zonal'). This fits within the overall proposed framework of methods as the RANS and LES have different characteristic scales and so the hybrid methods are interpreted as multiresolution. A classification

of unsteady approaches is proposed and there is a good review of the many different methods proposed and some complex flow examples have been shown. The evolution of the popular DES method is documented and the issue of the 'grey area' where the flow is neither purely LES nor RANS is noted and discussed. Within the zonal LES/RANS chapter, a small section is devoted to inlet boundary conditions including precursor calculations and recycling methods. It would have been useful to include more material on boundary conditions and in a more prominent manner as this can often be the key to a successful large eddy simulation.

The book could be improved by a final chapter which summarizes the conclusions of the previous chapters and perhaps look forward to what may be achieved in the future by multiscale and multiresolution approaches. Currently, the book just stops at the end of chapter 8 and this comes as a surprise to the reader. The rest of the book is extremely well structured with an underlying logical evolution and clear introductions to each chapter. Also, the book is well presented and appears to be almost free of typographical errors. The authors are to be congratulated on the considerable task of putting together this material in such a high quality manner.

To summarize, this is a very comprehensive documentation of a variety of approaches to turbulence and presents this in a unified manner by the prior definition of multiscale and multiresolution methods. Much of the material covered is recent and represents the latest knowledge in this area. I would recommend the book to practitioners in the field of turbulence simulation both to provide information on new techniques that they may wish to apply in their own area and to provide a reference on more well-used LES and DES techniques.

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