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REVIEWS

Computational Fluid Dynamics. By M. B. Abbott and D. R. Basco. Longman, 1989. 425 pp. £32.

In recent years there has been a considerable increase in the use of computational models to predict complex flow fields for a wide range of engineering and scientific applications. The authors, and in particular Professor Abbott, have been at the forefront of the rapid developments and expansion in computational fluid dynamics (CFD), and the book therefore draws upon a wealth of expertise in this field. The book provides an excellent fundamental introduction to CFD for senior undergraduate and graduate students in engineering and physical sciences, with the emphasis being on the scientific principles of numerical modelling using the finite-difference solution procedure.

In the introductory chapters there is a concise explanation of the Navier–Stokes equations, turbulence and the advective–diffusion equation for vorticity and scalar transport. This is followed by a fundamental review of the finite-difference method, including an account of the basic – but often overlooked – properties of stability, accuracy, consistency and convergence. The various widely used explicit and implicit schemes are then discussed, together with the solution procedures, for the diffusion problem in both one and two dimensions.

Following the introductory chapters, the transport of a scalar property is considered more rigorously in terms of such aspects as treating the 'wiggles', or grid scale oscillations, using refined higher-order schemes such as QUICK and QUICKEST, and using Lagrangian methods for modelling abrupt gradients. Unsteady flow modelling is then studied in detail, in terms of both the fluid mechanics and the numerical representation, commencing with a thorough review of the method of characteristics. Abbott's first book entitled *An Introduction to the Method of Characteristics* provided a comprehensive treatment of this method when first published in 1966. In the current book the role of the method of characteristics is also considered in modern CFD, with particular application to its use in developing radiating boundary modules. This chapter is followed by a concise outline and comparison of the various solution methods, with the general conclusion being that the ADI (Alternating Direction Implicit) technique converges more rapidly for hyperbolic and parabolic equations, whereas the SOR (Successive Over Relaxation) method has advantages in application to equilibrium or elliptic type problems.

A welcome addition in this new book, in comparison with Abbott's previous book entitled *Computational Hydraulics*, is the extensive chapter on turbulence. The chapter gives an overview of the various classes of turbulence models, ranging from the zero-equation type (e.g. Prandtl's mixing-length model) to the increasingly used two-equation formulations of the $k-\epsilon$ and algebraic stress models. There is also a welcome discussion on subgrid-scale stress models and large-eddy simulations in two dimensions. Finally, there is a review of other numerical methods, including finite-element, spectral and filter-scheme methods.

In summary, this is an excellent and valuable textbook. It covers most of the recent developments in the field and is written in a clear and concise style. It will be an essential textbook to graduate students studying CFD and to engineers and scientists applying CFD techniques to solve practical problems.

R. A. Falconer

Lectures on Air Pollution Modeling. Edited by A. VENKATRAM and J. C. WYNGAARD. American Meteorological Society, 1988. 390 pp.

Every few years a volume of edited lectures appears, in which a review is given of developments in micrometeorology and its fields of application. The first was the *Workshop on Micrometeorology* (Am. Met. Soc.), which appeared in 1973, and the second *Atmospheric Turbulence and Air Pollution Modelling* (Reidel) in 1982. The present book, based on a course given in San Diego in 1986, can be considered as the third in this row.

However, some differences are apparent in this series. The *Workshop on Micrometeorology* is completely devoted to the subject of atmospheric turbulence, whereas in the second book about half the space is taken up by a discussion of atmospheric dispersion problems. This development has continued so that the *Lectures on Air Pollution Modeling* are, as the title suggests, almost completely devoted to dispersion modelling. Nevertheless, throughout the book it is made clear that success in air pollution modelling depends heavily on progress in micrometeorology. Therefore it is quite appropriate that the book starts with an excellent review by Wyngaard on the structure of the planetary boundary layer. It should be pointed out that Wyngaard also contributed to both predecessors mentioned above. No doubt he is the right person to inform us about the developments in micrometeorology.

The book then moves to its main subject: modelling of air pollution dispersion. The core of the book is centred on the results obtained in the convective boundary layer (CBL). The study of the CBL, which started with the work of Deardorff around 1970, has led to new concepts in dispersion modelling. The three chapters written by Briggs and Weil present a review of these achievements. Owing to this emphasis on the CBL, other types of the planetary boundary layer seem somewhat underexposed. They are treated in a chapter by Venkatram, in which he discusses primarily some of his own work on diffusion in the stable boundary layer and in complex terrain.

A reader out for some quick and impressive results is likely to be somewhat disappointed. The presented models are undeniably based on improved physical ideas. However, this does not seem to lead to a dramatic increase in the agreement with observations, in comparison for instance with the standard Gaussian models. Here I can recommend reading the section by Venkatram on model evaluation. In short he argues that a model should first be based on correct physics and after that simplified as much as possible in order to be useful in practice. Even then deviations between model results and observations are unavoidable owing to errors in input parameters and in measurements but also to so-called inherent uncertainty. Venkatram especially stresses the point that a comparison of a model with observations as the only measure of model performance is, to say the least, ambiguous.

In the final chapter Sykes, Deardoff and Willis give a short discussion of concentration fluctuations. Perhaps these chapters are in the first place representative of the research that lies ahead, because at the moment concentration fluctuations constitute an area of very active research. New techniques, such as large-eddy simulations and stochastic particle models, which are only cursorily mentioned in this book, are now being developed further. Already the research is in progress that perhaps can fill the next volume of the series in 1995.

It is almost unavoidable that a book with more than one author suffers some redundancy and duplication. However, this is nowhere annoying. The editors have given much attention to the layout of this book. The result is an attractive product, which is a pleasure to read. In conclusion, this book can be recommended to anyone who wants to keep abreast of the present state of the art in micrometeorology and air pollution modelling.

F. T. M. NIEUWSTADT

Dynamic Meteorology. By S. PANCHEV. Kluwer, 1985. 360 pp. Dfl200 or US $74.

This book covers most of the standard topics in a basic text on fluid dynamics as applied to meteorology, but tends to extend the material beyond the standard level and so could be of some use to those with a deeper interest in geophysical fluid dynamics (GFD). The book consists of a collection of mathematical equations and approximations, but, unfortunately, the motivation for many of the approximations is not given. Nor is it always clear what problem the author is trying to solve. Nonetheless, with a bit of perseverance, even the reader who knows the basics of GFD will find interesting material in the book, including insights into early Soviet contributions.

Chapters 1 to 3 cover basic fluid dynamics as applied to the atmosphere, initially in (x, y, z)-coordinates. But equations are also given in pressure, σ and isentropic coordinates. Scale analysis is used to derive the geostrophic, thermal wind and gradient wind approximations, to derive equations for the isallobaric wind, and to simplify the vorticity equation.

In chapter 5, sound waves, external and internal gravity waves, Rossby waves and topographic waves are introduced followed by a discussion (inadequate) of the evidence for the existence of these waves. Some nonlinear ideas are introduced covering (briefly) instability theory, solutions of the KdV equation and the Lorenz equations. Chapters 6 and 7 cover geostrophic adjustment and the theoretical basis for meteorological weather forecasting.

Chapters 8, 9 and 10 are concerned with the inclusion of frictional effects. The surface boundary layer, including similarity theory, is covered, followed by an analysis of the deeper planetary boundary layer. It would have been useful to have a relatively comprehensive review of where boundary-layer theory stands and how the boundary layer is modelled in say atmospheric general circulation models.

The final chapter is entitled the Atmospheric General Circulation, but only two of the references are at all recent (post-1981), so one is left uncertain as to how relevant much of the material is. The book includes an interesting short biography of famous geophysical fluid dynamicists.

In summary, the book more than covers the material in a normal introductory course on dynamic meteorology, especially in boundary-layer theory. The physical motivation for may of the problems considered or approximations made is lacking, and this detracts from the value of the text. There are a number of ambiguous or erroneous remarks. The book does not have the depth of physical insight of the book by Gill, nor the clarity and conciseness of those by Holton and Houghton. As such it probably will not have a large market in the west.

D. J. ANDERSON

SHORTER NOTICES

The Systematic Experiment. A Guide for Engineers and Industrial Scientists. Edited by J. C. GIBBINGS. Cambridge University Press, 1986. 352 pp. £30 (hardback) or £10.95 (paperback).

This book describes procedure for the design, performance and reporting of laboratory experiments. The authors are engineers and the examples of experimental techniques used reflect their interests, but some of these, and certainly the general points they make about experimentation, will be of interest to those wishing to begin experimental work.

After a general introduction on the role of experiments there are three chapters on the planning of an experiment. The first of these deals with general aspects and emphasizes the important yet often overlooked administrative aspects of the work. These include the availability of equipment, planning the construction of the apparatus and the cost. The other two chapters provide useful information on designing experiments to obtain statistically meaningful measurements, and on the use of dimensional analysis. The next three chapters deal with specific techniques: observations and measurements, photography and interfacing with microcomputers. The examples chosen are perhaps a little idiosyncratic with, for example, a detailed analysis of shutter speeds for still photography and yet only a one-page description of laser-Doppler velocimetry. However, each chapter has a good set of references which will allow the reader to follow up the various topics. The final three chapters deal with experimental error, analysis of results and writing up. There is much useful information here, with some telling illustrations of poorly presented work.

This is an excellent book for supervisors to recommend to new research students. At the least they will learn that 'Manuals are normally available even on the more basic items, and these should be consulted if necessary'.

Finite Approximations in Fluid Mechanics II. Edited by E. H. HIRSCHEL. Vieweg, 1989. 423 pp. £39.70.

This volume contains 32 reports in camera-ready form on work conducted between 1986 and 1988 in a 'priority research programme' of the Deutsche Forschungsgemeinschaft. The reports are essentially independent investigations of industrially related problems in fluid mechanics by numerical methods, undertaken by different research groups in the former West Germany. The progress in the development of numerical techniques represented by the reports is impressive. An overview or summary description of the new developments would have been a useful addition to the volume.

Annual Review of Fluid Mechanics, vol. 23. Edited by J. L. LUMLEY AND M. D. VAN DYKE. Annual Reviews Inc., 1991. 674 pp. $40.

The table of contents in this latest annual volume of a well-known series is as follows:

Gas Turbine Fuels and Their Influence on Combustion. By J. ODGERS and D. KRETSCHMER. Abacus Press, 1986. 185 pp. $40 or £27.50.

The world's existing resources of natural fuel such as oil, coal and gas are limited, and alternative energy sources such as synthetic fuels must be explored. The use of alternative fuels in combustors designed to burn conventional fuels can lead to a variety of problems during combustor operation. The present book is concerned with alternative fuels for gas turbines and with the problems that arise when such fuels are used in conventional gas-turbine combustors.

The book is subdivided into seven chapters. The first two provide an introduction to the subject, and chapters 3 and 4 are concerned with the preparation of fuels and their properties. Combustion of solid, liquid and gaseous fuels is discussed in chapters 5 to 7. Most of the material covered in the book is valid not only for combustion in gas turbines but also for a variety of other combustion processes, and only towards the end of chapter 6 and in chapter 7 are gas turbines specifically addressed.

The book is written in such a way that it can be read by undergraduates. It is not a textbook, but it can be recommended for complementary reading to engineering and chemical engineering students interested in the general area of combustion. The book is essentially a reference book which, besides references, provides some interesting and useful information for researchers and engineers actively involved in the general area of modelling combustion processes.

Structures Spatiales Loin de l'Equilibre. By D. WALGRAEF. Masson, 1988. 182 pp. 240F.

In recent years the study of bifurcations in large-aspect-ratio systems has received an important boost from the influence of the ideas of condensed-matter physics. It has become clear that many of the phenomena associated with pattern-forming instabilities have counterparts in the theory of phase transition. There are also analogies to be exploited between oscillatory fluid instabilities and chemical oscillations in reaction diffusion systems. This short monograph is written with the purpose of emphasizing the unity between these diverse pattern-forming phenomena. The author's range is wide, covering Taylor–Couette flow, chemical systems, metal fatigue, and the effects of anisotropic forcing. There are useful bibliographies at the end of each chapter. The book will be of interest to any scientist working in pattern formation, for it will help to lead him to literature and concepts from other fields.

Turbulence in Fluids, 2nd Edn. By M. LESIEUR. Kluwer, 1990. 412 pp. Dfl 120 or $70.

The first edition of this book, published in 1987, was reviewed in these pages by D. C. Leslie (*J. Fluid Mech.* **194**, 1988, 598–599). In his foreword to the second edition the author writes as follows:

'Four years seems to be a good period of time to assess one's old points of view in such rapidly evolving fields as Turbulence and Fluid Mechanics. The new possibilities offered by direct-numerical simulations have provided a lot of information on vortex dynamics, coherent structures and transition, compressible or rotating flows. The third chapter now gives a basic presentation of the linear-instability theory applied to shear or thermally unstable flows. A substantial part of the phenomenology in Chapter VI is devoted to mixing-length theory applied to turbulent shear flows. Concerning the stochastic models, it seemed necessary to include more information on the D.I.A. and R.N.G. theories. New calculations and experiments on stratified or shear flows have been incorporated, with emphasis put on the three-dimensional structures topology. Recent results on the intermittency of isotropic turbulence, and on passive scalar diffusion are also included. Finally, I rewrote Chapter XII on large-eddy simulation in order to make it more general and accessible to graduate students.'