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REVIEWS

Clouds of the World: a Complete Colour Encyclopedia. By R. Scorer.
David & Charles, Newton Abbot, 1972. 176 pp. £12.60.

This is a beautiful book, assembled by an expert observer from a world-wide collection of photographs taken by himself and fellow enthusiasts. The author has previously collaborated in the publication of several books of cloud photographs and many filmstrips which will be familiar to those interested in observing the weather, and the present more comprehensive collection is also described as "an offering in the art of observing". As in the earlier books, we are offered much more than just a set of pictures, however. The author, who is Professor of Theoretical Mechanics at Imperial College, clearly wants to know how the atmosphere *works*, and the material is arranged and described according to the physical phenomenon it illustrates, rather than under the conventional classification of cloud types (whose history is outlined in a preface by Prof. F. H. Ludlam). Thus the first eight chapter headings are: Cumulus, Glaciation of convection clouds, Showers, Cirrus, Wave clouds, Billows, Altocumulus and Warm sector cloud. These are followed by a discussion which ranges beyond the topics immediately suggested by the title, and there are chapters on Fog and inversions, White plumes, Condensation trails, Droplets and windblown material, Optical phenomena, and Rotation.

This collection can be appreciated by readers with a wide variety of interests and technical backgrounds. At the simplest level, it would make a fine 'coffee table' volume, to catch the interest of the amateur natural historian and help him understand what he sees. There are some spectacular satellite pictures, and many taken from the air (including some stereo pairs, with an appendix on how to take and view them). The book will, on the other hand, have its place on library shelves as a modern reference for research meteorologists. Some of the photographs are a little small to show the phenomena to the best advantage (as many as eight pictures $8{\cdot}5 \times 6{\cdot}0$ cm are set on a page), and the author himself must have been dissatisfied with occasional distortions of colour in the reproduction. There are only a few large, clear black and white photographs, which can be the most dramatic of all when the form rather than an optical effect is of interest, but it is probably unfair to expect many of these in a book which aims at such a wide coverage and can properly be described as an encylcopedia.

There is a temptation to get carried away and enlarge on the general attractions of this book, and forget where it is being reviewed. Readers of this *Journal* will, however, particularly appreciate the view outlined in the preface that "beautiful though these pictures are, it is through simplified understanding that we come to like them". The text is written in a style which is very appropriate for readers with a background in fluid mechanics who wish to relate their theoretical and laboratory understanding of idealized processes to atmospheric examples of them. Many diagrams and sketches, as well as photographs of laboratory experiments and radar displays, are used to explain the mechanics of the motion before the related cloud pictures are presented, and the physical discussion is continued in the captions. To give only a few dynamical examples, there are sketches showing the motion in and around thermals (as first described by the author himself using laboratory experiments), the production of lee waves and separation in the flow of air over a mountain, and a set of pictures illustrating current laboratory work on the formation of "billows" in a stratified shear flow. It is a pity that some detailed references are not included with this material, since the few names mentioned in passing will be of little help to readers not already familiar with the field.

The phenomena discussed in this book are of course mainly "mesoscale"; these fall between those customarily treated by dynamical meteorologists and the microphysical processes of special interest to cloud physicists, and are consequently relatively little studied. Though mesoscale processes are readily observed on the atmospheric scale, they are infinitely variable, and satisfactory detailed explanations of some of them have in fact not yet been given. It is too easy to make superficial comparisons between cloud patterns and cellular convection experiments in the laboratory, for instance; but this has been done cautiously here, with suitable warnings against carrying the analogy too far. In other sections, however, readers with specialist knowledge may question the necessarily brief explanations given, or will wish to amplify them and to include ideas of their own. In particular, I disagree with the author's interpretation of the famous photograph of figure 5.7.1 (also reproduced on the cover), and prefer to describe it in terms of an internal hydraulic jump, rather than a rotor associated with lee waves. The distinction is not a trivial one, since it involves the difference between super- and subcritical flow over the mountain.

Whether we take the descriptions at their face value or regard them as a challenge to seek fuller ones, the author has succeeded in his aim. It would be hard to read through this book without catching some of his enthusiasm, and resolving to learn more from what we see in the sky.

J. S. TURNER

Mathematical Models of Turbulence. By B. E. LAUNDER and D. B. SPALDING. Academic Press, 1972. 169 pp. £2.50 or $7.50.

Readers of book reviews in this journal will be conversant with the controversial nature of the research by Professor Spalding and his colleagues at Imperial College into prediction techniques for turbulent flows. Although there are those who are sceptical about the physical basis of some of these techniques, there can be no doubt that these are already being extensively applied in industry. Since anyone researching into fluid mechanics, and turbulence theory in particular, ought to take some interest in how the subject is applied, these prediction techniques should be noted and, if necessary, thoroughly criticized. They should not be ignored.

This book on "Mathematical Models of Turbulence" is based on the material of a course of seven postgraduate lectures at Imperial College delivered in January 1971, the aim of which was "to convey the main concepts of turbulence modelling and to show what progress had been made and what problems remained". Since the book only contains 156 pages some fairly drastic omissions have been made. Therefore readers, or potential buyers, of this book ought to be aware of how these omissions have been made possible. First, the authors assume a familiarity with turbulence theory and with the literature of turbulent prediction techniques. Second, although there are interesting comparisons with the work of other groups, the authors concentrate on the achievements and future plans of their powerful and successful team at Imperial College. For example, the reader of this book is not informed that a most extensive review of methods for computing turbulent boundary layers was undertaken at the Stanford Conference in 1968 and reported by Coles & Hirst in *Computation of Turbulent Boundary Layers*, 1968, vol. II (Proceedings of AFOSR–IFP–Stanford Conference).

The first introductory chapter briefly reviews the various methods of calculating the shear stresses in turbulent flows, and in doing so explains why some of there are not considered later. It is particularly important here to have some knowledge of the literature to understand the authors' implications. For example, the authors' dismissal of what they call "algebraic formulae" for eddy viscosity needs to be understood for what it is, namely a dismissal of the whole approach to turbulent shear flows based on the ideas of self-preservation and equilibrium. The authors are correct in saying that such analyses do not give quantitative predictions without other hypotheses, but a review of mathematical modelling ought to indicate what a powerful aid the concepts of equilibrium and self-preserving flows are to the understanding of turbulent flows.

The second chapter begins with the fighting statement "What most people learn, from cursory readings of the fluid-mechanics literature, is that the mixing-length hypotheses (MLH) is an outmoded historical exhibit, long superseded by the statistical theory of turbulence. The notion is only partically true." A useful account of various mixing-length hypotheses is given for boundary-layer calculations. The important but obvious comment is made that these methods on their own are useless for re-circulating flows. The third chapter treats the application of mixing-length ideas to turbulent transfer of scalar quantities.

Chapter 4 on "One-equation hydrodynamic models of turbulence" is the best chapter, with a complete presentation of the equations used in the models of Patankar & Spalding, Bradshaw and Nee & Kovasznay. There is also some discussion of the physical implications of the various assumptions. Chapter 5 on "Two-equation models of turbulence" (kinetic energy and length scale) is interesting but unsatisfactory because the equations are not derived nor the assumptions stated clearly. What is meant by "optimising" governing questions and how this is achieved is also not clear. Two types of boundary conditions are used for these problems, one for the "free stream" and the other near a wall. These are stated to be valid for all flows, including, presumably, a stagnation point on a wall. Yet no reference is cited, nor any theoretical justification provided, nor any indication given as to the range of validity of the assumptions. An important rider to these calculations, which has often been made by sceptics of these prediction techniques, is admitted by the authors, namely that some of the calculated flows are very insensitive to the particular mathematical model of turbulence employed in the calculation.

Chapter 6 on "Multi-equation models" compares the models employed by different workers. It would appear that three equations is the largest number being used at Imperial College to calculate shear stresses and normal stresses, while five equations are used at Los Alamos, with, as yet, not much better results. The last chapter, on "Probable future developments", suggests that complicated fluid effects will be introduced (e.g. buoyancy; two-phase flow). Advances in the prediction of turbulent stresses are thought to come from more equations and more complicated equations, such as by taking into account length scales in different directions and by variations in the form of the spectra, which the present methods assume are self preserving everywhere! However, the authors wisely remark that such forbidding tasks are not for them. The chapter ends with some confident predictions as to the kind of complicated flows these methods can cope with, the need for money to support this research, and the need for further research on these prediction techniques.

If you accept the solipsism of the authors, concede their definition that "mathematical model" equals "prediction technique", and have a passing knowledge of the literature, you will, as I did, find this rapid run over the problems of computing turbulent flows interesting and stimulating.

J. C. R. Hunt

Shorter Notices

Proceedings of the Xth Symposium on Advanced Problems and Methods in Fluid Mechanics, Rynia, Poland, September 1971. Edited by W. Fiszdon, Z. Plochocki and M. Bratos. Volume 1, Survey Papers, 404 pp.; Volume 2, Contributed Papers, 634 pp. 75 Zl.

These two volumes record the material presented at the latest of a series of symposia in Poland which have become famous as a congenial meeting-ground of east and west. There were 179 participants, and the programme listed 11 survey papers (volume 1) and 63 contributed papers (volume 2) ranging over the whole field of fluid dynamics. Volume 1 also contains an additional contributed paper on the stability of a conducting jet in an electric field by G. I. Taylor, on whom foreign membership of the Polish Academy of Sciences was conferred during the symposium. The two volumes have been reproduced photographically from the typescripts supplied by authors, with considerable savings in time and cost.

Proceedings of the 1972 Heat Transfer and Fluid Mechanics Institute. Edited by R. B. Landis and G. J. Hordemann. Stanford University Press, 1973. 430 pp. $17.50.

This volume contains abstracts of five invited lectures and photostat reproductions of 25 submitted papers which were presented at the now biennial meeting of the Heat Transfer and Fluid Mechanics Institute held at San

Fernando Valley State College in June 1972. The contributed papers include five on turbulent boundary layers, three on free convection problems, five on two-phase (or multi-phase) flow, three on atmospheric fluid dynamics, and nine that defy classification. The overall standard is high, and well up to that established by previous meetings of the Institute.

Directory of Fire Research in the United States, 1969–1971. 6th edition. Committee on Fire Research, National Academy of Sciences, 1972. 287 pp. $11.50.

This paperback gives a short description of all the groups interested in fire research in the United States. The list is divided into Federal Government groups, University groups and Private and Industrial Laboratories. For each group the chief scientists, the purpose of the work and the resulting publications are recorded.

Fluid Power Mechanisms. By C. R. Burrows. Van Nostrand, 1972. 237 pp. £6.00.

This final-year undergraduate text covers the theoretical analysis of servo-mechanisms controlled by hydraulic and gas-operated valves, together with a much less thorough chapter on fluidics, and an introduction to analog computation. The great virtues of the book are that it generally uses the simplest methods of analysis, and that it gives extensive, if uncritical, references to the literature. The weaknesses are that the wood is very difficult to see for the trees, and that the author gives the impression that he has never had to wrestle with the realities of a hydraulic control system misbehaving on the test bed. At £6.00, this is a useful book to borrow from a library.

CORRIGENDUM

'Effects of spanwise rotation on the structure of two-dimensional fully developed turbulent channel flow',

by J. P. Johnston, R. M. Halleen and D. K. Lezius,
J. Fluid Mech. vol. **56**, 1972, pp. 533–558.

Equation (4) in the text, see p. 536, contains errors. It should read

$$\frac{D\bar{u}}{Dt} - 2\Omega\bar{v} = -\frac{1}{\rho}\frac{d\overline{p_\delta^*}}{dx} - 2\Omega\frac{\partial}{\partial x}\int_y^\delta \bar{u}\,dy + \frac{1}{\rho}\frac{\partial\tau}{\partial y}. \qquad (4)$$