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BOOK REVIEWS

The Turbulent Ocean. By S. A. Thorpe. Cambridge University Press, 2005. 458 pp. ISBN 0521 835437. £45 (hardback).

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The main difference between Steve Thorpe's book and many other texts on turbulence and geophysical fluid dynamics is in its focus on physical phenomena and processes rather than on mathematical formalism and turbulence modelling. A novice to oceanography is likely to be stunned by the diversity of the turbulent patterns, while reading this book. *The Turbulent Ocean* will be found tremendously useful by graduate students as well as by researchers, because it compiles and overviews a large set of phenomena, ranging from internal waves to convection and from double diffusion to planetary waves. The main beauty and uniqueness of this book is that it allows the reader to grasp essential physics without being buried under an avalanche of mathematical methods and the corresponding theoretical assumptions, as is often the case with texts on turbulence and ocean dynamics. It is fair to compare this book to Van Dyke's famous *An Album of Fluid Motion* (Parabolic Press, 1982), because both of them focus on the beauty of organized coherent structures.

Geophysical fluid dynamics, and ocean turbulence in particular, is a very young and dynamic area of science. It deals with an immense collection of processes operating on different scales and driven by different mechanisms, many of which are not yet completely understood. Therefore, even an introduction to, and phenomenological description of, these processes is a formidable task that requires encyclopaedic knowledge of the field. Thorpe's book is a gem of this sort. It is a skilfully written and well-illustrated handbook that will help anyone to get an introduction to a particular phenomenon. Typically, there is a general description of each physical process, with the key historical and recent observational references, as well as with the references to the review, theoretical and lab experiments articles. It is followed by discussion of some interesting physical properties and important dynamical ingredients of the underlying mechanism.

Topics covered in the text include internal waves, stratified shear flows, convection, double diffusion, boundary-layer processes, air–sea interface, planetary waves, and mesoscale eddies. Among the topics, chapters on gravity waves and Kelvin–Helmholtz instability are written very substantially and thoroughly, reflecting author's exceptional expertise in this field. Particular emphasis is placed on small-scale rather than on the large-scale turbulence, because the former has been the main research subject for the author. On the other hand, planetary waves and mesoscale eddies, as well as their interaction with turbulence on smaller scales, are definitely not among the most extensively covered topics of this book. This may create a false impression that the large-scale ocean turbulence lacks diversity of interesting and complex phenomena.

There are many exciting illustrations in the book, and many of them are in colour. Finally, there is a nice chapter discussing techniques for measuring the important properties of turbulence, and at the end, there are very useful appendices with notations, main parameters, and acronyms. I've enjoyed reading this book, and I highly recommend it as a very useful introduction to turbulent phenomena found in the ocean.

Pavel Berloff

Theory and Applications of Ocean Surface Waves. By C. C. Mei, M. Stiassnie & D. K.-P. Yue. Advanced Series on Ocean Engineering, vol. 23. World Scientific, 2005.

Part 1: Linear Aspects. xxvi + 513 pp. ISBN 981 256 156 0 (hback) and 981 256 157 9 (pback)

Part 2: Nonlinear Aspects. xxiii + 567 pp. ISBN 981 256 1587 (hback) and 981 256 159 5 (pback)

Two volume set: ISBN 981 238 893 1, US$128 or £74 (hback) and 981 238 894 X, US$88 or £51 (pback).

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Our demands on coastal regions, our increasing marine transport and our exploitation of oil from beneath ever greater ocean depths all have to counter the, often damaging, effects of water waves on the sea surface. The extent of our application of water wave theory to assist in these activities has developed strongly over the last half-century, and this two-part set gives a mainly theoretical perspective on a wide range of the problems that are encountered.

The books should be considered as a second expanded edition of Mei (1983, 1989), with two further authors. Part 1 contains chapters 1 to 8 of Mei (1983) with new typesetting, and the original figures copied with some slight loss of quality. Other than a small number of dispersed extra paragraphs, the only differences are the addition of a chapter on 'Multiple scattering by seabed irregularities' and a section, in the chapter on 'Floating body dynamics', on 'Trapped modes near a mobile storm barrier', motivated by structures planned to protect Venice.

Part 2 has more substantial changes, reflecting the greater development of nonlinear aspects of the subject in recent years. The major change is the replacement of the chapter 'Wave-induced stresses in a poro-elastic seabed', with two new ones. A chapter on 'Broad-banded nonlinear surface waves in the open sea' by Stiassnie introduces Zakharov's equation and demonstrates its use for a number of problems, some of them already approached from another direction earlier in the book. In a substantial chapter on 'Numerical simulation of nonlinear wave dynamics', Yue gives prominence to boundary integral methods in two and three dimensions. Some of the other chapters are re-organised and/or have new sections.

These books introduce the reader to many of the mathematical approaches to studying waves propagating in the open ocean, waves meeting obstacles and waves in coastal environments. Much of the introductory material is well presented, and followed by many specific examples, often with full mathematical detail. The choice of examples has a very strong connection with the authors' published work, although where appropriate there are plenty of references to, and discussion of, other work. An example is the very full discussion of harbour oscillations.

In over 1000 pages of text, one might expect a comprehensive coverage of the subject area. However, the above-mentioned bias in choice of topics means that a number of other topics are neglected or given brief treatment. This is acknowledged for some topics and reference made to other texts, to which the next book in the publisher's series, Svendsen (2006), should be added. A major omission is a discussion of the spectral representation of ocean waves. Other than using Fourier techniques to solve problems, a wave spectrum is very briefly mentioned in only one place in Part 1, and, although the spectral representation is fundamental to the chapters in Part 2 on narrow-banded and broad-banded nonlinear surface waves, the discussion there goes more or less straight to modulations of a wave train and the Zakharov

equation respectively. This is indicative of the level at which the books are written, in that a good knowledge of mathematics and fluid dynamics is assumed.

The books propagate the misuse of certain commonly used terms. Solitons are introduced, but their special property of emerging unchanged from interactions is not, and 'soliton' is used for solitary waves with a greater generality than is appropriate. Similarly, the phrase 'infra-gravity waves' is used to describe low-frequency gravity waves, when it is more appropriate for waves dominated by the Earth's rotation, which are not included.

Overall the books are well presented with only a few typographic errors, which makes some other minor mistakes more irritating. Mei has an unusual notation for the Jacobian elliptic functions, inconsistent with Stiassnie's use of the normal notation in chapter 14. Jaswon is consistently misspelt. At least three of the works referred to are not listed in the references: that is Dingemans (1996), Porter & Stazinger (1995) and Massel (1983): the first of these should probably be Dingemans (1997) and for the latter two, Porter (2003) may be a better reference. A very good feature is that the 29-page list of references does indicate the pages on which the references occur.

These books can certainly benefit graduate students and researchers, and Part 2 is a worthwhile improvement over the earlier editions. Practicing engineers may find some parts hard to follow. The bulk of the two-volume set illustrates the difficulty of presented a rapidly growing field of knowledge: perhaps too many mathematical details have been included. Another modern problem arises from the many numerical results demonstrated: the reader may wish to access relevant programs, some of which need much entry of messy algebra. This could be usefully satisfied by reference to freely available programs, where they exist, or preparation of open source programs.

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