

Quotes from pre-publication reviews

‘This book will undoubtedly be welcomed by the extensive engineering community concerned with the impact of ocean waves on ships, off-shore structures, coastal protection, dikes, harbours, beaches and tidal basins . . . The book contains a trove of practical information on all aspects of waves in the open ocean and coastal regions . . . providing an invaluable source of information.’

K. Hasselmann, Director (retired) of the Max-Planck-Institut für Meteorologie, Hamburg, and Emeritus Professor of Theoretical Geophysics, University of Hamburg, Germany

‘The author, well-known for his work in wave modeling and the development of the SWAN model, provides a valuable introduction to ocean wave statistics, generation by wind, and modeling in deep and shallow water. . . The book will be very helpful to students, as well as professionals, interested in wind-wave wave modeling. All SWAN users will want a copy.’

R.A. Dalrymple, Williard & Lillian Hackerman Professor of Civil Engineering, Johns Hopkins University, USA

‘. . . the best introduction to practical engineers to grasp the directional spectral wave approach. . . The book is excellent not only as a textbook for students but also as a reference book for professionals.’

Y. Goda, Executive Advisor to ECOH CORPORATION, Emeritus Professor of Civil Engineering, Yokohama National University, Director-General (retired) of the Port and Airport Research Institute, Japan

‘. . . ideally suited as a reference work for advanced undergraduate and graduate students and researches. . . The book is a “must have” for engineers and scientists interested in the ocean. . . The book explains quite complex processes with remarkable clarity and the use of informative examples. Drawing on the author’s international reputation as a researcher in the field, the book brings together classical theory and state of the art techniques in a consistent framework. It is an invaluable reference for students, researchers and practitioners.’

I. Young, Vice-Chancellor and President of Swinburne University of Technology, Australia

Cambridge University Press
978-0-521-86028-4 - Waves in Oceanic and Coastal Waters
Leo H. Holthuijsen
Frontmatter
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‘This is a great book. The author is one of the leading experts in the field of waves who has taught the subject for over 20 years – and it shows. The book has a broad scope, which would be of interest to students just learning the subject, as well as professionals who wish to broaden their range of knowledge or who want to refresh their memory . . . recommended for introductory as well as advanced students and professionals.’

J. W. Kamphuis, Emeritus Professor of Civil Engineering, Queen’s University, Canada

‘This book presents an original and refreshing view on nearly all topics which are required nowadays to deal with wind generated waves at the sea surface. . . . The logical structure . . . and the fact that it avoids complex numbers and vector notation will . . . facilitate its comprehension.’

A. Sánchez-Arcilla, Professor of Coastal Engineering, Universitat Politècnica de Catalunya, Spain

‘. . . highlights key concepts, unites seemingly unconnected theories, and unlocks the complexity of the sea. [This book] will become an important reference for students, coastal and ocean engineers, and oceanographers.’

J. Smith, Editor, International Conference on Coastal Engineering, US Army Engineer Research and Development Center, USA

‘. . . Although several books on waves already exist, I find this new contribution particularly valuable . . . I will thus particularly recommend [it] for people wishing to acquire and understand the key-concepts and essential notions on waves in oceanic and coastal waters.’

M. Benoit, Research Engineer, Laboratoire National d’Hydraulique, France

‘This book is exceptionally well organized for teachers who want a thorough introduction to ocean waves in nature. It fills a key gap in text books, between overly simplistic treatments of ocean waves and detailed theoretical/mathematical treatises beyond the needs of most students. I found the text very clear and readable. Explanations and derivations within this book are both innovative and instructive and the focus on key elements required to build a strong foundation in ocean waves remains strong throughout the book.’

D. T. Resio, Chief Research and Development Advisor, US Army Engineer Research & Development Center, USA

WAVES IN OCEANIC AND COASTAL WATERS

Waves in Oceanic and Coastal Waters describes the observation, analysis and prediction of wind-generated waves in the open ocean, in shelf seas, and in coastal regions. The book brings graduate students, researchers and engineers up-to-date with the science and technology involved, assuming only a basic understanding of physics, mathematics and statistics.

Most of this richly illustrated book is devoted to the physical aspects of waves. After introducing observation techniques for waves, both at sea and from space, the book defines the parameters that characterize waves. Using basic statistical and physical concepts, the author discusses the prediction of waves in oceanic and coastal waters, first in terms of generalized observations, and then in terms of the more theoretical framework of the spectral energy balance: their origin (generation by wind), their transformation to swell (dispersion), their propagation into coastal waters (shoaling, refraction, diffraction and reflection), the interaction amongst themselves (wave-wave interactions) and their decay (white-capping, bottom friction, and surf-breaking). He gives the results of established theories and also the direction in which research is developing. The book ends with a description of SWAN (Simulating Waves Nearshore), the preferred computer model of the engineering community for predicting waves in coastal waters.

Early in his career, the author was involved in the development of techniques to measure the directional characteristics of wind-generated waves in the open sea. He contributed to various projects, in particular the Joint North Sea Wave Project (JONSWAP), which laid the scientific foundation for modern wave prediction. Later, he concentrated on advanced research and development for operational wave prediction and was thus involved in the initial development of the computer models currently used for global wave prediction at many oceanographic and meteorological institutes in the world. More recently, he initiated, supervised and co-authored SWAN, the computer model referred to above, for predicting waves in coastal waters. For ten years he co-chaired the Waves in Shallow Environments (WISE) group, a world wide forum for research and development underlying operational wave prediction. He has published widely on the subject and teaches at the Delft University of Technology and UNESCO-IHE in the Netherlands.

Cambridge University Press
978-0-521-86028-4 - Waves in Oceanic and Coastal Waters
Leo H. Holthuijsen
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WAVES IN OCEANIC AND COASTAL WATERS

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*Delft University of Technology and
UNESCO-IHE*



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press
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[More information](#)

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo
Cambridge University Press
The Edinburgh Building, Cambridge CB2 2RU, UK
Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521860284

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First published 2007

Printed in the United Kingdom at the University Press, Cambridge

A catalogue record for this publication is available from the British Library

ISBN-13 978-0-521-86028-4 hardback

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Contents

<i>Preface</i>	<i>page</i> xiii
<i>Acknowledgements</i>	xv
1 Introduction	1
1.1 Key concepts	1
1.2 This book and its reader	1
1.3 Physical aspects and scales	3
1.4 The structure of the book	7
2 Observation techniques	10
2.1 Key concepts	10
2.2 Introduction	10
2.3 <i>In situ</i> techniques	12
2.3.1 Wave buoys	13
2.3.2 Wave poles	15
2.3.3 Other <i>in situ</i> techniques	17
2.4 Remote-sensing techniques	18
2.4.1 Imaging techniques	19
Stereo-photography	19
Imaging and non-imaging radar	20
2.4.2 Altimetry	21
Laser altimetry	21
Acoustic altimetry	22
Radar altimetry	22
3 Description of ocean waves	24
3.1 Key concepts	24
3.2 Introduction	24
3.3 Wave height and period	25
3.3.1 Waves	25
3.3.2 Wave height	27
3.3.3 Wave period	29

viii	<i>Contents</i>	
3.4	Visual observations and instrumental measurements	29
3.5	The wave spectrum	31
3.5.1	Introduction	31
3.5.2	The random-phase/amplitude model	33
3.5.3	The variance density spectrum	36
3.5.4	Interpretation of the variance density spectrum	38
3.5.5	Alternative definitions	41
	The spectral domain	41
	Formal definition	42
3.5.6	The frequency–direction spectrum	43
3.5.7	The spectrum at sea	47
3.5.8	Wave-number spectra	48
	The one-dimensional wave-number spectrum	49
	The two-dimensional wave-number spectrum	49
	The three-dimensional frequency–wave-number spectrum	50
3.5.9	Spectrum acquisition	51
3.6	Transfer functions and response spectra	52
4	Statistics	56
4.1	Key concepts	56
4.2	Short-term statistics	56
4.2.1	Instantaneous surface elevation	57
4.2.2	Wave height and period	60
	Wave period	60
	Crest height	62
	Wave height	68
4.2.3	Wave groups	75
4.2.4	Extreme values	77
	Extreme elevations	78
	Extreme wave heights	82
4.3	Long-term statistics (wave climate)	85
4.3.1	The initial-distribution approach	87
4.3.2	The peak-over-threshold approach	95
4.3.3	The annual-maximum approach	98
4.3.4	Individual wave height	101
4.3.5	Wave atlases	105
5	Linear wave theory (oceanic waters)	106
5.1	Key concepts	106
5.2	Introduction	107

<i>Contents</i>		ix
5.3	Basic equations and boundary conditions	107
5.3.1	Idealisations of the water and its motions	108
5.3.2	Balance equations	109
	Mass balance and continuity equations	112
	Momentum balance	112
5.3.3	Boundary conditions	114
5.3.4	The velocity potential function	115
5.4	Propagating harmonic wave	118
5.4.1	Introduction	118
5.4.2	Kinematics	119
	Particle velocity	120
	Particle path	121
5.4.3	Dynamics	123
	The dispersion relationship	123
	Phase velocity and group velocity	125
	Wave-induced pressure	128
5.4.4	Capillary waves	129
5.5	Wave energy (transport)	131
5.5.1	Wave energy	131
5.5.2	Energy transport	132
5.6	Nonlinear, permanent waves	137
5.6.1	Introduction	137
5.6.2	Stokes' theory and Dean's stream-function theory	139
5.6.3	Cnoidal and solitary waves	142
6	Waves in oceanic waters	145
6.1	Key concepts	145
6.2	Introduction	146
6.3	Wave modelling for idealised cases (oceanic waters)	147
6.3.1	Idealised wind	148
6.3.2	The significant wave	150
6.3.3	The one-dimensional wave spectrum	155
6.3.4	The two-dimensional wave spectrum	162
6.4	Wave modelling for arbitrary cases (oceanic waters)	167
6.4.1	The energy balance equation	169
6.4.2	Wave propagation and swell	174
6.4.3	Generation by wind	177
6.4.4	Nonlinear wave–wave interactions (quadruplet)	183
6.4.5	Dissipation (white-capping)	188
6.4.6	Energy flow in the spectrum	192
6.4.7	First-, second- and third-generation wave models	194

x	<i>Contents</i>	
7	Linear wave theory (coastal waters)	197
7.1	Key concepts	197
7.2	Introduction	197
7.3	Propagation	199
7.3.1	Shoaling	199
7.3.2	Refraction	202
7.3.3	Diffraction	210
7.3.4	Refraction and diffraction	217
7.3.5	Tides and currents	218
7.3.6	Reflections	221
7.4	Wave-induced set-up and currents	225
7.4.1	Introduction	225
7.4.2	Wave momentum and radiation stress	225
7.4.3	Wave-induced set-up, set-down and currents	234
7.5	Nonlinear, evolving waves	239
7.5.1	Introduction	239
7.5.2	The Boussinesq model	240
7.6	Breaking waves	242
8	Waves in coastal waters	244
8.1	Key concepts	244
8.2	Introduction	245
8.3	Wave modelling for idealised cases (coastal waters)	246
8.3.1	The significant wave	247
8.3.2	The one-dimensional wave spectrum	250
8.3.3	The two-dimensional wave spectrum	256
8.4	Wave modelling for arbitrary cases (coastal waters)	256
8.4.1	The energy/action balance equation	257
8.4.2	Wave propagation	263
8.4.3	Generation by wind	268
8.4.4	Nonlinear wave–wave interactions	269
	Quadruplet wave–wave interactions	269
	Triad wave–wave interactions	270
8.4.5	Dissipation	276
	White-capping	276
	Bottom friction	276
	Depth-induced (surf-)breaking	281
8.4.6	Energy flow in the spectrum	284

<i>Contents</i>		xi
9	The SWAN wave model	286
9.1	Key concepts	286
9.2	Introduction	286
9.3	Action balance	288
9.3.1	The action balance equation	288
9.3.2	Generation by wind	289
9.3.3	Nonlinear wave–wave interactions	292
	Quadruplet wave–wave interactions	292
	Triad wave–wave interactions	293
9.3.4	Dissipation	294
	White-capping	294
	Bottom friction	295
	Depth-induced (surf-)breaking	296
	Reflection, transmission and absorption	296
9.4	Wave-induced set-up	296
9.5	Numerical techniques	298
9.5.1	Introduction	298
9.5.2	Propagation	299
	Numerical schemes	301
	Solvers, grids and boundaries	305
9.5.3	Generation, wave–wave interactions and dissipation	306
	Positive source terms	307
	Negative source terms	307
	Numerical stability	308
9.5.4	Wave-induced set-up	309
	<i>Appendix A Random variables</i>	310
	<i>Appendix B Linear wave theory</i>	318
	<i>Appendix C Spectral analysis</i>	324
	<i>Appendix D Tides and currents</i>	335
	<i>Appendix E Shallow-water equations</i>	342
	<i>References</i>	347
	<i>Index</i>	379

Preface

In my position as associate professor at Delft University of Technology and as a guest lecturer at UNESCO-IHE (Delft, the Netherlands), I have for more than 20 years, with great pleasure, supported students and professionals in their study of ocean waves. At Delft University I have had, in addition, the opportunity to work with colleagues, notably Nico Booij, on developing numerical wave models, one of which (SWAN) has widely been accepted as an operational model for predicting waves in coastal waters.

Over the years, I have made notes to assist these professionals, students and myself, during courses, workshops and training sessions. With the growing interest and willingness of others to formalise these (mostly handwritten) notes, I found that I should make the effort myself. The result is this book *Waves in Oceanic and Coastal Waters*, which provides an introduction to the observation, analysis and prediction of wind-generated waves in the open ocean, in shelf seas and in coastal regions. The title of the book is a little prosaic because I want to focus directly on the subject matter of the book. A more poetic title would be *Waves of The Blue Yonder*, which would convey better the awe and mystery that I feel when watching waves at sea, wondering where they come from and what they have seen on their journey across the oceans. The cover photo illustrates this feeling beautifully.

Understanding the text of the book requires some basic knowledge of physics, mathematics and statistics. The text on *observing* waves (Chapter 2) is descriptive; no mathematics or statistics is used. Understanding the text on *describing* ocean waves (Chapters 3 and 4) does require some knowledge of mathematics and statistics, since concepts of analytical integration and probabilities are used. The text on the linear *theory* of surface gravity waves (Chapters 5 and 7) and the text on *modelling* wind-generated waves (Chapters 6 and 8) rely heavily on the concepts of conservation of mass, momentum and energy. Therefore, some background in physics is needed. These concepts are expressed with partial differential equations, so some background in mathematics is also needed. Finally, the book ends in Chapter 9 with a description of the fundamentals of SWAN (both its physical principles and numerical techniques).

I first treat waves in oceanic waters and later in coastal waters. The reason for this separation is both didactic and practical: the physical processes increase in number

and complexity as waves move from the ocean into coastal waters. Describing waves in the oceans therefore gives a good introduction to the more challenging subject of waves in coastal waters. In addition, many readers will be interested only in the ocean environment and need not be bothered with the coastal environment.

I am well aware that many formulations in this book can be written in vector or complex notation. Such notation would make for compact reading for those who are familiar with it. However, students who are not familiar with it would not readily absorb the material presented, so I have chosen not to use it. With a few exceptions, I have written in terms of components rather than vectors and real quantities rather than complex quantities. Concerning the references in the book: I have used a fair number of these, to (a) refer to specific information, (b) indicate where issues are being discussed and (c) refer to books and articles for further reading. I have not tried to be complete in this. That would be nearly impossible, if only because of the continual appearance of new publications. Moreover, any subject is accessible on the Internet, which is completely up to date, including electronic versions of scientific and engineering journals.

If this book helps professionals to enjoy their work more, students to pursue their interest in waves and others to look at waves with an informed eye, it has more than served its purpose.

L. H. Holthuijsen, Delft

Acknowledgements

I was supported in writing this book by three close friends and colleagues: Luigi Cavaleri of the Istituto di Scienze Marine in Venice (Italy), whom I visited so often (memories of Venice waking up in the early morning sunlight, when it is still a cool and quiet place); Masataka Yamaguchi of the Ehime University in Matsuyama (Japan), who introduced me to the many charms of Japan (memories of the mountains and quiet villages along the rugged Pacific coast of his home island Shikoku); and Nico Booij, with whom I shared, almost daily, my professional enthusiasm, ideas and dreams in such diverse places as Delft, Reykjavík and Beijing. They read the book from cover to cover (and back, more than once) and they gave their comments and suggestions freely. This was not a trivial effort. They saved me from embarrassing errors and helped achieve a balance between scope, reliability and accessibility on the one hand and detail, accuracy and formalism on the other. I am very grateful to them and I am proud that they are my friends, and have been for 25 years now. I also want to thank Linwood Vincent of the US Office of Naval Research, whose inspiring words encouraged me to write this book.

In addition, I have had the privilege to be assisted by several colleagues with specific information, in particular on the subject of wave statistics: Akira Kimura of the University of Tottori, Japan; Evert Bouws and Sofia Caires of the Royal Netherlands Meteorological Institute; Ulla Machado of Oceanor, Norway; Sverre Haver of Statoil, Norway; Agnieszka Herman of the Lower Saxonian Central State Board for Ecology in Norderney, Germany; and Pieter van Gelder, André van der Westhuysen and Marcel Zijlema of the Delft University of Technology. Mrs. Paula Delhez and her colleagues of the Delft University Library helped me find the references in this book. I am very grateful to all of them because their help greatly improved the quality of the book. Still, any errors that are left (and fate dictates that some will be) are wholly mine.

In the book I have used data provided by the Royal Netherlands Meteorological Institute (the Netherlands), Fugro Oceanor AS (Norway), the National Oceanic and Atmospheric Administration (USA) and Statoil Norge AS (Norway). I am grateful for their permission to use these data (further acknowledgements are given in the text). I am also grateful to the copyright holders for permission to use the figures listed below.

Datawell, the Netherlands: Fig. 2.3.

Institute of Marine Sciences, Italy: Fig. 2.4.

Det Norske Veritas, Norway: Fig. 3.3.

American Society of Civil Engineers, USA: Fig. 4.1.

Royal Society of London, UK: Fig. 4.16.

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Elsevier, the Netherlands: Figs. 6.18 and 8.9.

I am deeply indebted to Philip Plisson for his gracious permission to use his poetic photo for the cover of the book.