DESCRIPTIVE PHYSICAL OCEANOGRAPHY

An Introduction

4th (SI) Enlarged Edition

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Descriptive Physical Oceanography

An Introduction

by

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Preface to the Fourth Edition

THE development of interest in oceanography in recent years has led to an increased demand from students for information on the subject. The texts available hitherto have been either more elementary in treatment or more comprehensive and extensive than may be desirable for an introduction to the subject for the undergraduate. The present text is an attempt to supply information on the Synoptic or Descriptive aspects of Physical Oceanography at a level suitable as an introduction for graduate students, for undergraduates in the sciences and possibly for senior school students who wish to learn something of the aims and achievements in this field of scientific study.

The main object in preparing this fourth edition, in response to suggestions from many users, has been to enlarge significantly the illustrative material with some forty-five additional figures, the original ones having been redrawn, and updated where necessary. The text has also been brought up to date and a selection of references to the original literature has been added. In these tasks, the original author has been fortunate to gain the collaboration of his colleague, Dr. William J: Emery, who has joined him as co-author. A section numbering system has been introduced and there are some minor rearrangements of material. In particular, the discussion of the optical properties of seawater has been moved to Chapter 3 and upwelling to Chapter 8. An elementary discussion of the geostrophic method has been introduced to permit the qualitative deduction of currents from the density distribution.

The International System of Units (SI units) is used as a basis, since this has been recommended by the International Association for the Physical Sciences of the Ocean. For brevity, the term "sverdrup" (Sv), which is not an SI unit, will still be used for volume transports; dissolved oxygen will be expressed in millilitres per litre (mL/L) as most of the existing literature uses this unit, and dynamic metres will be used in the geostrophic method discussion for the same reason. As it may be some time before all oceanographers adopt the SI and to assist in relating to the wealth of literature using the previous mixed system of units, an Appendix describing the two systems is included.

In presenting the synoptic approach it must be emphasized that this represents only one aspect of physical oceanography. The other, and complementary, one is the dynamical approach through the laws of

mechanics. This is described in other texts such as those by Knauss, McLellan, Pond and Pickard, Sverdrup *et al.* or Von Arx listed in the Suggestions for Further Reading. The student who requires a full introduction to physical oceanography must study both aspects.

This text is intended to be introductory to the subject. For the student in physics and mathematics it should serve to present the main aspects of the field before he or she proceeds to the more advanced texts and original literature making free use of mathematical methods. For the student in the biological sciences it may provide sufficient information on descriptive physical oceanography to supply the necessary background for studies of the fauna and flora of the sea. The text by Tchernia provides a more detailed coverage of the oceans by regions.

If the reader concludes the text with a feeling that our knowledge of the sea is incomplete at present, one of our objectives will have been achieved. This was to indicate to the student that there is still much to be learned of the ocean and that if he or she is interested in observing the marine world and interpreting it there are still many opportunities to do so.

The Bibliography at the end of the book is in two sections. The "Suggestions for Further Reading" lists a number of texts which would be helpful to a student wishing to read further in descriptive oceanography together with some sources of tables of use to physical oceanographers and a list of some journals which contain articles in the field of oceanography. The "References to Journal and Review Articles" section provides the specific references made by author and date in the body of the text for the convenience of the student who wishes to examine these items in more detail. Suggestions are also offered for more extensive lists of references.

The text is based on a course presented by the authors and colleagues for thirty years at the University of British Columbia to introduce undergraduate and graduate students to physical oceanography. It owes much to the more comprehensive text *The Oceans* by Sverdrup, Johnson and Fleming, and G. L. Pickard wishes to acknowledge this and also the stimulation received during a year at the Scripps Institution of Oceanography. He is particularly indebted to Dr. J. P. Tully of the former Pacific Oceanographic Group for initiating him into oceanography and for encouragement since, and to Dr. R. W. Burling and others for reading the original manuscript and offering constructive comments on that and on subsequent editions of the text. W. J. Emery would like to acknowledge the guidance of Dr. Klaus Wyrtki in introducing him to physical oceanography and providing opportunities for study. Dr. Aas, of the University of Olso, offered some helpful suggestions on the optical aspects and these have been incorporated.

Finally, it will be realized that although the authors have personal experience of some aspects of physical oceanography and of some regions, they have relied very much on the results and interpretations of others in order

to present an adequate coverage of the subject. They therefore gratefully acknowledge their indebtedness to the many oceanographers whose works they have consulted in texts and journals in assembling the material for this book.

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