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# PHYSICS OF THE SEA

**PRINCIPLES OF OCEAN PHYSICS**
**John R. Apel,** *The Johns Hopkins University Applied Physics Laboratory*
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Over the past decade, a few textbooks concerning the dynamics of ocean circulation have emerged as the result of a period of intense development in physical oceanography and ocean engineering. During that period, the database of physical oceanography has doubled many times. Until recently, students of oceanography used books that were written in the 1960s or earlier; *Principles of Ocean Physics* attempts to remedy that situation. As the author explains in his preface, the book is intended to instruct the student of physics and perhaps to introduce the student to oceanography. As a consequence, it has a slightly different structure from other physical oceanography textbooks, best seen by a summary of chapters.

The book begins with a brief overview of the history of oceanography, one that can be found elsewhere. Chapter 2 reviews the forcing functions and responses of the oceans and includes comprehensive descriptions of the solar radiation and wind field, a description of the general circulation of the ocean, a description of the ocean basins in geology and geophysics, and a brief summary of global tectonics. Chapters 3 to 6 are devoted to theoretical considerations of ocean dynamics. Chapter 3 starts the serious work of deriving the hydrodynamic equations of the sea: the equations of continuity, momentum (including the effect of the earth's rotation), salinity, spherical coordinates, eddy mixing, and boundary conditions. Chapter 4 considers the thermodynamics and energy relations of the ocean, including equations of state, thermodynamics of the water, and total energy equations. Two chapters on general geophysical fluid dynamics follow. The first, Chapter 5, emphasizes fluctuating flows (waves, tides, etc.), whereas Chapter 6 is more concerned with general circulation and concepts of geostrophic flow. The two chapters are necessarily shorter than the new, competing textbooks that focus entirely on these subjects; to that extent, the student would find it advisable to use Chapters 3 to 6 as starting points and then to progress to more specialized books.

Chapter 7, relatively brief, is devoted to ocean acoustics; here, the book could have provided some insight into some of the new advances in acoustics. I would have liked an introductory description of the inverse methods used in modern tomography; perhaps the author felt that such a subject was too mathematical. Nevertheless, the treatment is more comprehensive than is given in other general physical oceanography texts.

Chapter 8, a more exhaustive treatment, covers electromagnetics in the sea and is used as a foundation for later discussions on the application of radar and other microwave techniques to studying the ocean. The discussion is one of the best I have found in any textbook. Chapter 8 concludes by discussing induced electromagnetic forces and their relationship to oceanic currents. Considering the many instruments that use these principles, I felt that techniques were somewhat shortchanged compared with the radar techniques.

Chapter 9, a discussion of the optics of the sea, is, in my view, a singular contribution, including as it does many aspects of optics not covered in other textbooks. It also contains a useful analysis of the absorption spectrum of pigments in ocean waters and of their probable effects on the changing coloration of the waters. Instructive overlaps with remote-sensing images conclude the chapter. The book includes an appendix that lists some of the constants and properties of the ocean and an index.

The book reflects, of course, the interest of the author and, I daresay, his assessment of future contributions to oceanography. The chapters on electromagnetism and optics in the sea are probably its major strengths because those subjects are lacking in numerous other physical oceanography and ocean dynamics textbooks. The ocean observations are particularly current, and examples of remote-sensing images are given; no competing textbook comes close to this standard. On the other hand, the lack of development of inverse theory for tomography and other ocean problems is the book's most serious (but not fatal) shortcoming. In addition, the price is somewhat high for students; fortunately, a softbound volume is offered at about half the cost.

One of the real strengths of the book is that it provides a rather extensive bibliography at the end of each chapter, listing numerous books and some of the more recent and comprehensive journal articles and reports. These can be used by students of physics, applied mathematics, and engineering who read this book to learn more about physics of the ocean. I certainly enjoyed reading *Principles of Ocean Physics* and will keep it on my bookshelf. It is a useful starting book for future ocean physicists.

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