THE OFFICIAL MAGAZINE OF THE OCEANOGRAPHY SOCIETY

Oceanography

CITATION

Y.-H. Tseng. 2009. Review of *The Dynamics of Coastal Models*, by C.J. Hearn. *Oceanography* 22(1):241–243, doi:10.5670/oceanog.2009.31.

Hydrographic Office.

Within the history and philosophy of science, Reidy's book makes the valuable contribution of fleshing out the central figure of William Whewell. Long acknowledged for his multi-volume *History of the Inductive Sciences* (1837) and his *Philosophy of Inductive Sciences* (1840), Whewell's own research had not been recognized by scholars. Yet, as he wrote his books, Whewell was engaged in a 20-year study of tides. He coined the term "scientist" in 1833 and used his tidal studies to reflect on the appropriate social and intellectual role for scientists. Reidy convincingly demonstrates that the challenges of studying the ocean, including its global extent, influenced Whewell's articulation of what it meant to do science and to be a modern scientist.

A powerful artifact linked knowledge of the ocean to power and, thereby, made scientists the arbiters of knowledge about the sea. The product of systematic ocean investigation under Whewell was the iso-tidal map of the world. Charts with co-tidal lines represented knowledge visually in a way that could pass easily between men of science and mariners. Similarly, in the same period, other geophysical sciences recorded meteorological data and measurements of magnetic variation on equally practical charts. The co-evolution of modern science, state funding, and political and economic uses of knowledge of the ocean is emphasized in a small section of the book examining the United States. Systematic study of tides by the Coast Survey was underway by the 1850s; in the same decade, there were two independent American coinages of the term "scientist." As in Britain, elite men of science in the United States successfully organized their work, linked it with the government, and created knowledge that conferred power on their nation.

Reidy's writing brings his actors, their story, and this time period to life. The volume itself is beautifully made, with over 60 figures that do much more than illustrate. Photographs and drawings of imperiled and wrecked ships remind modern readers of the overarching importance of tides to a sea-borne economy and society. Tide tables and self-registering tide-gauge tracings help explain the origins and power of co-tidal maps. The press is to be commended for the high-quality illustrations, the brief but helpful glossary, and the useful bibliography.

Near the end of the book, Reidy reminds us that Whewell's tidal theory was not correct; tide prediction is more local than global. Yet this fact only adds heft to his argument that the modern conception of the scientist was forged by studying the global ocean and, thereby, was inextricably linked to imperialism and worldwide trade.

Helen Rozwadowski *(helen.rozwadowski @uconn.edu) is Associate Professor, History, and Coordinator of Maritime Studies, University of Connecticut, Avery Point, Groton, CT, USA.*

The Dynamics of Coastal Models

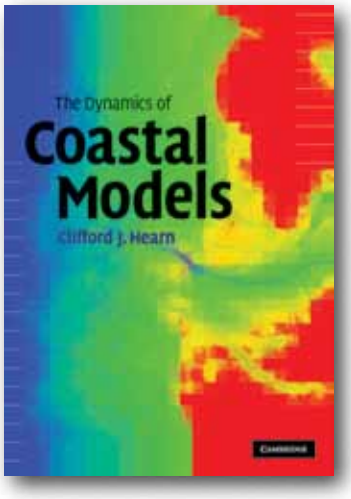
By Clifford J. Hearn, Cambridge University Press, 2008, 488 pages, ISBN 978-0-521-80740-1, Hardcover, $100 US

REVIEWED BY YU-HENG TSENG

Everything should be made as simple as possible, but not simpler.

—Albert Einstein

The basic governing equations of coastal dynamics have been known for decades, but how can these equations be formulated to improve our understanding of coastal basins? *The Dynamics of Coastal Models* by Clifford Hearn does a great job of explaining and illustrating fundamental coastal dynamics and equations through the use of simple analytical and numerical models. It motivates readers to further explore model physics using simple Microsoft Excel or Matlab examples from which basic ideas can be easily extracted (numerical codes are also tabulated). These examples are so simple that interested readers who have a basic math and science background can gain useful physical and mathematical insights into coastal dynamics through the simple models presented (which are never higher than two-dimensional). These models are very powerful tools, enabling clear demonstration and easy understanding of basic principles.



This book, aimed at the introductory level, lays out the fundamental scientific principles of coastal models. It could serve as the first advanced textbook for graduate students who are interested in modeling coastal dynamics. Hearn's perspective is

very general and keeps explanations as simple as possible, and consequently the book will broaden students' perspectives. Its twelve chapters are written in a coherent and ordered manner. Most of the fundamental dynamics for coastal basins are addressed. Sophisticated numerical methods, modeling techniques, and complicated three-dimensional dynamics are all omitted to maintain simplicity. Thus, this book does not help students understand complicated models used in realistic applications, but rather introduces the concepts step by step.

The book starts by defining coastal basins and their characteristics. Although interacting directly with land and atmosphere, coastal basins usually contain a mixture of marine and freshwater. This book explains the basic dynamics and boundary fluxes of coastal basins using simple box and one-dimensional models. The box models represent a coastal basin as a box (zero order) varying with time, which can simplify the intrinsic dynamic using a simple system. The physical bases of the models are clearly illustrated, including some fundamental ingredients (e.g., continuity and conservation laws).

After introducing basic concepts, Hearn runs through chapters on other fundamental dynamics and processes that feed into coastal models. These chapters are more suitable for graduate students because they require some background in ordinary differential equations and dynamic systems in order to better understand the underlying physics and processes. Fortunately, the mathematical formulation provided in the book is derived as simply as possible, and easy examples are given. Readers can follow these chapters without losing generality. For example, the influence of the Coriolis force on the rotating Earth is explained and discussed by means of interesting examples such as Foucault's pendulum. Some simplification is definitely made so that analytical solutions can be obtained and programmed easily. The chapter on the physical processes of hydrodynamic models focuses on wind stress, Ekman balance, and geostrophic current. Simple mathematical models are then used in the text for further explanation, although more detailed models would lead to much greater accuracy in terms of describing circulation realistically. Hearn follows these chapters with discussions in a very coherent way.

Hearn's discussion of simple models for tides and long waves is very helpful for beginners. Useful Matlab codes explore the behavior of surface elevation (including wave motions) and effects of coastal slopes. Numerical approaches are inevitable in this chapter. Basic numerics, such as grid arrangement, the selection of vertical and horizontal coordinate systems, and finite difference, are provided and discussed, although not in great detail. Nevertheless, the book provides enough information for a beginner to choose the required numerical methods.

Various aspects of mixing and turbulence are also emphasized in this book. In coastal basins, molecular processes of mixing and turbulence should both be addressed because the coastal ocean includes not only relevant open ocean dynamics but also bottom boundary layer dynamics (logarithmic layer). Chapter 7 starts from very general concepts of turbulent mixing, such as classical mixing length and Fick's law. It even discusses molecular viscosity in great detail using Stokes' law. Several different length scales are briefly introduced without detailed derivation, followed by the complicated turbulence closure. A reader who does not have any background in turbulence or fluid dynamics will find this chapter difficult but useful further reading is suggested at the end of the chapter.

It is helpful that the basic ideas behind modeling advection in coastal basins are described in a separate chapter. To facilitate understanding of advection, Hearn starts with the inertial force, tidal jet, and Bernoulli model. He also emphasizes the hydraulic jump and flow over a slope using several numerical examples. Readers could also practice the coding themselves. Avoidance of further discussion of nearshore processes in the coastal basins makes this book more concise and focused.

In general, this book is well organized except for some discussions close to the end. Several miscellaneous topics related to coastal basins are presented without clear organization, detracting from the specific focus of this book. For example, Chapter 9 discusses several aspects of stratification, such as temperature, vertical mixing, and potential energy. An example of wind-driven currents in stratified basins is also provided here as a separate section. An improvement would be to include a brief introduction at the beginning of all chapters describing how the following sections are organized and arranged. This addition would help advanced readers decide which materials they want to read or skip, and is very important for an advanced textbook. Similar miscellanea can be found in the final chapter, which discusses, without going into great detail, available wave models for coastal basins and the physical conditions that lead to sediment erosion, transport, and deposition.

Chapter 10 discusses more complicated dynamics in partially mixed basins and emphasizes the dominant processes of salt and heat transport. It again raises the issue of vertical mixing, which may also lead to horizontal advection resulting from the vertical shear induced by tides and winds. Hearn gives a logical explanation for the turbulence mixing process and the dispersion and exchange rates in basins. Some fundamental ocean processes such

as El Niño are also briefly introduced for information purposes, although the discussion is not very detailed. More advanced students can also use the phase planes to understand the Stommel transitions in a basin. This book provides many useful realistic examples at the end of each chapter.

In addition to boundary layer dynamics, the other important surface process that deserves specific attention in coastal dynamics is surface friction, owing to the very nature of solids and fluids. Roughness plays a major role in models of coastal basins at a variety of spatial scales. Chapter 11 on roughness, fractals, and self-similarity introduces ideas that target multiscale dynamics in coastal basins.

In order to cover the comprehensive subject of coastal dynamics, the book briefly introduces some chemical and biological processes using simple models. Both are important dynamics in the coastal ecosystem. Further detail, however, is absent because of irrelevant mechanisms and topics.

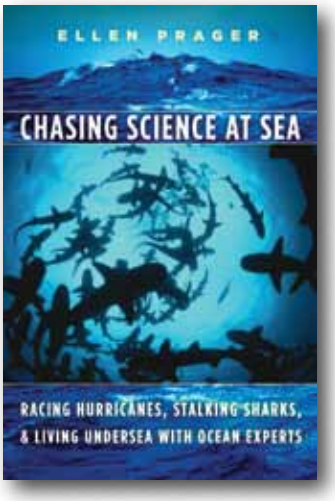
The failure to discuss nonhydrostatic influences, not even to mention the topic, is the main weakness of this comprehensive textbook on coastal dynamics. It is well known that nonhydrostatic dynamics plays an important role in coastal dynamics. It is the critical characteristic of coastal basins, where vertical acceleration is as important as other dynamics. Nevertheless, this book represents a significant improvement in advanced textbooks on coastal models. It brings together coastal dynamics through simple code development and encourages readers not to be afraid of using models. Most important of all, the clearly written text and materials will motivate the interested graduate student to seek a better understanding of coastal dynamics.

Yu-heng Tseng *(yhtseng@as.ntu.edu.tw) is Assistant Professor, Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan.*

Chasing Science At Sea: Racing Hurricanes, Stalking Sharks, and Living Undersea with Ocean Experts

By Ellen Prager, University of Chicago Press, 2008,162 pages, ISBN: 978-0226678702, Hardcover, $22.50 US

REVIEWED BY ALICE ALLDREDGE



All marine scientists who work in the field have them—personal stories of amazement, discovery, awe, excitement, and even danger while conducting research. They are the stories we love to tell to friends over a beer or to rapt high school students aspiring to become marine biologists or oceanographers. And in the telling, we ourselves somehow reconnect to the deepest motivations that brought us to marine research in the first place. Reliving those marvelous adventures displaces our disgruntlement with e-mail, proposals, and mundane paper work and reminds us how lucky we are to be marine scientists.

Ellen Prager's delightful and engrossing book, *Chasing Science at Sea*, is a compilation of hundreds of such field stories from marine scientists of all disciplines. They are woven together with interesting facts, descriptions of various field activities, and the lessons learned from setbacks to create a rich and multifaceted portrayal of the world of marine field research. But the purpose of these stories is more than just to entertain. As ocean science has become increasingly dependent on remote technologies, fieldwork has become harder to fund, less prevalent, and more difficult to undertake. Ellen Prager's hope is that these stories will illustrate the value of fieldwork, inspire the next generation of students to a renewed commitment to field-based research, and help preserve some of the history and experiences of modern marine scientists.

Written in an engaging and highly readable style, the stories in *Chasing Science at Sea* include the wonder of discovering new organisms or of seeing amazing sights such as many whale sharks feeding together or the magic of bioluminescence. The activities of field science are also realistically described with examples including the complicated dance required to set out a deep-sea mooring and the challenges of developing appropriate technologies to investigate the deep ocean. Some of the stories, such as a firsthand account of observing the *Titanic* from a Russian submersible, make readers feel as if they had been there themselves. Many of the narratives offer riveting suspense, including tales of outrunning a hurricane, of being aboard