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ity to describe a given phenomenon. Instead, they are of maximum complexity, only limited by computational constraints. Such models do not provide immediate insight into dynamics—in the same way as the uninformed look at observed data provides knowledge about reality only when the analysis is guided by appropriate “conceptual” (minimum complexity) models. The quasi-realistic models are obviously not as complex as reality, but they are supposed to approximate the real world’s complexity as much as possible. Thus, using the models is not a trivial affair either.

The usage of such models is dealt with in Chapters 5 and 6. First, the satisfactory performance of the models in reproducing the present state is demonstrated; this includes the simulation of modes of variability, in particular ENSO. Then, in Chapter 6, a series of experiments on the sensitivity of the climate system on scales of decades to centuries

is discussed. The authors present paleoclimatic studies, the understanding of climatic history of the past one thousand years, and the effect of increased atmospheric concentrations of greenhouse gases and aerosols. The carbon cycle is considered as well as the possible climatic effects of a nuclear war.

An Introduction to Three-Dimensional Climate Modeling (second edition) concludes with a detailed call for further improvements of quasi-realistic climate models—maybe we will enjoy a third version of the book in another 10 or 20 years? In an appendix, a variety of useful technical aspects (such as computer architectures) are described; the 36-page reference list is very useful; the index is done well.

Before concluding, it may be worthwhile pointing out what the book does not cover—among other things, models of intermediate complexity, which are needed for integrations of many thou-

sands of years. Only little is said about regional modeling, which likely will acquire more prominence after the Tenth Conference of the Parties to the UN Framework Convention on Climate Change rightly pointed out that after having broadly understood the dynamics of anthropogenic climate change, more emphasis has to be given to the possible impacts a changing climate may have on environmental risks, on societies, and on ecosystems.

I conclude with compliments to the authors for a useful and carefully written book. I will assign *An Introduction to Three-Dimensional Climate Modeling* (second edition) to my new Ph.D. students in the same way as I have asked them for almost two decades to read the first edition. ☐

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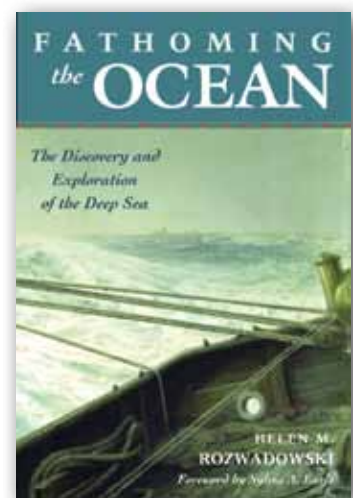
Fathoming the Ocean *The Discovery and Exploration of the Deep Sea*

By Helen M. Rozwadowski
Belknap Press of Harvard University
Press, 2005, 276 pages, Hardcover:
ISBN 0674016912, \$25.95 US

REVIEWED BY CHARLES H. GREENE

As oceanographers contemplate a renewed commitment to ocean exploration (National Research Council, 2003), Helen

Rozwadowski has given us a book chronicling the importance of discovery and exploration in the early Anglo-American roots of oceanographic science. Prior to the mid-19th century (approximately 1830-1880), what lay beneath the ocean’s surface was a great mystery, fertile ground for the imagination and superstitions of mankind. During these dark ages, navigators considered the



deep sea to be anywhere that their 100-fathom sounding lines failed to touch

bottom. Furthermore, while incredible monsters and denizens of the deep were believed to inhabit the sea, most naturalists thought that ocean life could not survive at depths greater than 300 fathoms. Remarkably, in less than 150 years, ocean explorers and scientists would go on to visit the great depths of the Marianas Trench and discover the amazing communities of deep-sea animals living entirely off the inorganic chemicals spewed forth from the hydrothermal vents of mid-ocean ridges. How did ocean exploration and science emerge from a seafaring tradition in which mariners attempted to minimize their time at sea and rarely strayed from proven trading routes? In her timely and carefully researched book, Rozwadowski answers this question not only by documenting the people and events involved, but also by providing the societal context for this 19th century period of ocean enlightenment.

As a historian of science, Rozwadowski is interested in telling her readers what people did, where they did it, when they did it, and, most importantly, why they did it. The first forays into ocean exploration were an outgrowth of the navigational needs of mariners. While the sounding of coastal bottom depths had a long maritime tradition, it was only in the mid-19th century that naval officers and hydrographers began testing the limits of just how deep they could drop their sounding lines before touching bottom. What they found astounded them. The deep sea was much deeper than previously imagined; this finding had important implications for a variety of commercial and scientific enterprises, including the eventual successful deployment of the first Trans-Atlantic telegraph cable.

As the more educated members of society began to fathom the newly discovered depths of the ocean, their curiosity was aroused and they began to wonder what other secrets remained hidden. This new intellectual engagement with the sea coincided with an emerging and broader cultural obsession with all things marine. In both Great Britain and America, maritime commerce gradually awakened the general public's interest in the sea. First flocking to the beaches by rail, and then to the coastal and open ocean in vessels ranging from rowboats to luxury steamship liners, middle- and upper-class citizens began to view the sea as a destination where they could enjoy and put to useful purpose their leisure time. It was within this intellectual and cultural context that benthic dredging became popular and the science that would later become marine ecology began to emerge from its roots in shell collecting and descriptive natural history.

During the latter portion of the mid-19th century, interests in hydrography and marine zoology converged, and a new breed of professional ocean scientist, the oceanographer, took to the sea. While the *Challenger* expedition is often viewed as the beginning of modern oceanography, Rozwadowski clearly shows that its roots were much deeper. The questions addressed and the technologies employed by *Challenger's* oceanographers were not new; rather, the expedition simply represented a scaling up of ongoing practices. This being the case, perhaps the *Challenger* expedition is best viewed as the culmination of the first stage in oceanography's evolution as a scientific discipline.

If a summary of oceanography's

early evolution was the only thing that Rozwadowski's book had to offer, then I could only recommend it to a rather small group of individuals interested in the history of ocean science. Fortunately, this is not the case. *Fathoming the Ocean* draws together many cultural and scientific threads, challenging its readers to reflect not only on oceanography's past but also to think about how that past influenced the events that followed. For example, the author explicitly discusses how the *professionalization* of oceanography during the latter half of the 19th century led to the virtual exclusion of women from this field of study for nearly a century. This professional exclusion of women occurred, in part, due to the practice of oceanographers going to sea to conduct research on ships that banned women. The eventual lifting of this ban in the 1970s, combined with the field's active encouragement of young women to pursue careers in ocean science, led to the recent renaissance of women in oceanography (see Special Issue: Women in Oceanography, *Oceanography* Vol. 18, No. 1, March 2005).

While reflecting on Rozwadowski's description of oceanography's *professionalization* during the latter half of the 19th century, I began to think about some of its other consequences. For example, sometime during the late 19th and early 20th century, the interests of marine ecologists and oceanographers began to diverge, subsequently creating a rift that became institutionalized in Anglo-American universities and research laboratories and remains so to this day. What were the factors leading up to this schism? As with the exclusion of women, part of the answer is likely associated

with the seagoing habits of oceanographers. Going to sea on extended cruises to conduct their research, oceanographers typically require specialized equipment and ships, both of which involve significantly greater investments of government funding. However, I am certain that the answer to this particular question lies deeper than simply the financial implications of oceanographers going to sea in ships. Eric Mill's (1989) *Biological Oceanography: An Early History, 1870-1960* picks up the story of biologi-

cal oceanography where Rozwadowski's *Fathoming the Ocean* leaves off, weaving together Anglo-American traditions with influences from the European continent. Although both books provide many of the clues necessary to answer my question, neither addresses it directly. On the other hand, perhaps the sign of a really well written book, especially one devoted to history, is not only the story it tells, but also the number of intriguing questions it inspires its readers to ponder on their own. ☒

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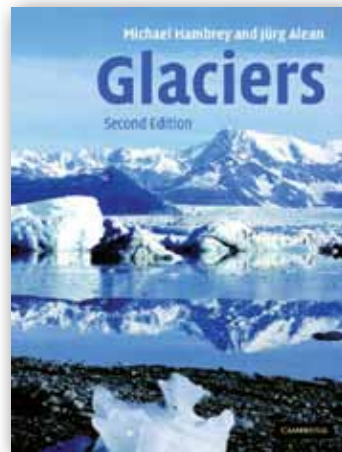
Glaciers

By Michael Hambrey and Jürg Alean
2nd Edition, Cambridge University Press, 2004, 394 pages.
Hardcover: ISBN 0521828082, \$60 US

REVIEWED BY W.T. PFEFFER

Glaciers have, with dinosaurs, woolly mammoths, Egyptian mummies, and pyramids, a kind of intrinsic allure that causes people to become fascinated by them not as a particular representative of a broader interest, but simply for their own sake. Consequently, glaciologists are frequently drawn into their subject based on a life-long attraction to glaciers and the world of snow and ice rather than as geologists or physicists simply seeking an application of their skills. The authors of *Glaciers*, like so many of us, evidently fall into this category, and their book is written for an undergraduate audience al-

ready attracted to glaciers and seeking an introduction to them as a field of study. The book is qualitative in nature—not the only approach to the subject, but reasonable for this audience—and filled with inspirational photographs on nearly every page. Taken on its own terms, the book might work for an undergraduate geography or geology class. However, I am troubled by a number of aspects. A student using this as a primary text would require some rather devoted guidance on the part of the instructor to



wend a path through the world of glaciers as it is presented here—the instructor being a sort of a Virgil to Hambrey and Alean's Dante.

The descriptive approach is good for an introduction to a complex subject, but description alone can become confusing without a conceptual context. The authors adhere doggedly to categorization, indicating in bold face not only the definitions of principal features such as moraines, firn, and foliation, but also those for minutiae like “basket-of-eggs topography,” “ice ships,” and “knock-and-lochan topography.” You can even learn about the relative merits of dog-sledging, man-hauling, and mechanized transport, and the distinctions between Temporary Scientific Research Camps and Permanent Stations. This information gets disorienting after a bit, and I doubt the introductory student will have much success separating the critical concepts from the ephemera. In the chapter on mass balance, snow swamps are introduced with the same emphasis as funda-