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Essentials of the Earth's Climate System

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Book Reviews

ESSENTIALS OF THE EARTH'S CLIMATE SYSTEM. By Roger G. Barry and Eileen A. Hall-McKim. West Nyack, New York: Cambridge University Press, 2014. 259 pp. $65.00 (softcover). ISBN: 978-1-107-62049-0

As more people become aware of environmental changes (local and global) and the important role that weather and climate play in these changes, the need for a simple, yet accurate and comprehensive explanation of climate increases. ESSENTIALS OF THE EARTH'S CLIMATE SYSTEM aims to fulfill that need. In this textbook the authors "seek to provide a modern global overview of the world's climate on all space and time scales." The book is intended for undergraduate/graduate students taking a one-semester course, an elective perhaps, in climatology, or for the student who would like to have some basic understanding of climate while studying for a related major, like environmental science, or even a completely different major. Together, the authors bring a wealth of knowledge and experience to the subjects discussed in the text, and I think that they have succeeded in producing a textbook that will be well appreciated by its intended audience. I daresay that its clarity and use of non-mathematical explanations/discussions, where possible, may make it accessible even to an upper level high school student. What follows is a general comment on the book

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as a whole, a brief statement of the content of the chapters, and a summarizing statement on the merits of the book.

The book is structured into 12 chapters, 2 appendices, a glossary, and a detailed bibliography, which together give a comprehensive, and interesting, overview of climatology. The chapters follow a logical sequence of topics from the fundamental—the elements of climate (energy, moisture, atmospheric pressure, and wind)—through to applied climatology (the application of climatic information to water resources, renewable energy, and agriculture). The layout of each chapter is also logical, allowing the student to navigate a considerable amount of material with relative ease. A number of the chapters in this book begin with a brief history of the topics treated, providing a richer context within which to view the material.

Each chapter is well illustrated with clearly drawn maps and diagrams and well-chosen photographic images. There is liberal use of examples and boxes that give interesting side notes, sometimes biographical or historical, to augment the main material of the text. The examples are global in scope and the authors do a very good job of using contemporary observational data to explain the complexities of climate. At the end of each chapter there is a brief summary that very clearly and concisely describes the material discussed in the body of the chapter. This is immediately followed by a series of questions designed to test student knowledge and acquisition of the basic themes in that chapter. The summary and the questions together are excellent review tools.

The topics covered in the different chapters introduce the student to climate at a variety of scales, from micro- and local to synoptic and global. Each of these scales of climate is usually the focus of a single book. In Essentials, the treatment of the topics is done in such a way that the student could begin to understand the climate (for example the urban heat island) in which she/he lives daily and simultaneously see how it fits in with the larger scale climate. There is exposure to the large variety of climates at the local scale (urban, forest, lake/coastal) as well as at the global scale (for example in the discussion on climatic classification). The importance of the human experience of climate, one of the underlying themes of the book, becomes clear in Chapter 4—Local and Microclimates—and is unavoidable in later chapters on Future Climates and Applied Climatology.

The Introduction (Chapter 1) begins with detailed definitions of climate and how it is calculated, as well as a very lucid discussion of why climate matters. It also includes a history of climatology—a good overview of the development of climatology from the 17th century to present day—with more than enough references for the interested student to research further, should she/he desire. One mark of the book's accessibility and, I think, a sign that the authors have a good grasp of their target audience (the modern student) is that many of the references made in this chapter (and in the following chapters) are accessible online, not only in hardcopy. In fact, one of the appendices is devoted to a listing of the web links that appear in the body of the book.

Chapter 2 discusses the essential elements of energy (chiefly solar radiation) and moisture and the response of the climate system to them. It moves quickly from the discussion of solar energy as the main form of energy available to our system to heat fluxes, the energy balance, and temperature as a response to absorbed solar energy and the heat fluxes. The material on moisture begins with the way in which it is measured and continues to a short discussion on clouds and lightning and longer discussions of precipitation and evaporation. There is a strong spatial slant to the material; most of the illustrations are well-designed maps, as is the authors' expressed intent in the Preface of the book.

Chapter 3 describes the dynamic elements of the climate system—atmospheric pressure, air masses, winds, large and small storm systems, frontal zones, and storm tracks. The treatment of these topics is largely non-mathematical, thus reducing quite complex concepts of atmospheric motion to easily understandable material in only a few pages. The illustrations are key to promoting understanding of the material in this chapter. They are remarkably clear and instructive, excellent for classroom presentations as well. Along with the material in Chapter 2, Chapter 3 sets the stage for a deeper consideration of the large-scale dynamics of the system explored in Chapter 5.

Chapter 4 (local and microclimates) clearly explains how the local and small-scale characteristics of a place shape the resulting climate. Forests, water bodies, and the city are shown to create their own climate—notably in the case of the city, the urban heat island. The human body's response to climate extremes of heat and cold is an interesting inclusion in this chapter.

Chapter 5 deals with the large-scale dynamics of the system—the general circulation of the atmosphere. The latitudinal differences in received solar energy and angular momentum are discussed. The global distribution of winds, both meridional and zonal, are described, including the effects of large mountain barriers on winds. The role of winds in redistributing energy globally is described. This is the most mathematical chapter, understandably. However, the concepts are described in relatively simple language.

One of the unique aspects of this book is the devotion of a whole chapter (Chapter 6) to the discussion of the atmospheric circulation modes that are important explanatory tools for modern climatology. These include modes, such as ENSO, that the average student will have heard about at least in the popular press as well as the less well-known ones such as the semi-annual oscillation (SAO). Normally basic climatology textbooks have some discussion of ENSO, but only passing reference is made to the other modes of circulation. In Essentials, each circulation mode is clearly defined and its link to regional and global climate variability are made clear, showing just how well connected the climate system is.

Chapter 7 deals with synoptic climatology. It begins with a definition of the term and the mention of a number of textbooks that deal with the subject at length. A brief history of the development of the field is also offered. This chapter talks about types of synoptic classification including regional, continental, and hemispheric classifications, and describes how each is derived. The modern day use of synoptic classification to diagnose GCM output and to evaluate the teleconnection patterns such as those described in Chapter 6 is discussed.

Chapter 8 describes the effect of the ocean on climate and, separately, the effect of land on climate. The material on the ocean focuses on the distribution of warm and cold ocean currents and their global impacts. Attention is paid to the Arctic and Southern Oceans and sea ice, a detail that is particularly important given that they are important for environmental change. Air-sea interaction via the exchange of energy and moisture fluxes, the development of extensive cloud bands associated with warm/cold ocean currents, as well as the ocean currents' role in steering atmospheric circulation systems are discussed. The effects of land are described in terms of continentality, vegetation cover, and snow cover.

Climatic classification is the subject of Chapter 9. The chapter begins with a listing of different types of classification schemes, and their authors, while noting quite appropriately the arbitrariness that underlies all classification schemes. It describes the climate

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types found on land in terms of their temperature and precipitation characteristics and explains why these climates developed where they did, building very nicely on the effects of land that were discussed at the end of the preceding chapter. The treatment of climatic types is comprehensive, ranging from deserts and monsoonal to tundra and ice plateaus. Comparisons to the classic Koppen's classification (mentioned in Chapter 1) are made where relevant.

Another interesting topic that sets this book apart from other climatology texts is its discussion of past climates. This is done in Chapter 10, which nicely summarizes what we know about climate from early earth history through the Cenozoic, the Quaternary, and the Anthropocene, a relatively newly minted term describing the period during which human impact on the physical environment became more significant. Of course, the treatment of these topics is necessarily light, yet the information given is comprehensive enough so that the interested student has clear avenues for deeper research. Because it immediately precedes the chapter on future climates (Chapter 11), it helps to place the projected changes discussed there in a broader temporal context.

Most students (and most people for that matter) are interested in climate because of how it affects their daily lives. Because of this, the two final chapters (11 and 12) of the text will most likely be the most appreciated of the book. In just a few pages the authors touch upon the tools that are used to evaluate climate change, the projected changes themselves, and their expected impacts—societal and environmental. For the student taking a related major such as environmental science, the chapter on applied climatology (Chapter 12) discusses some of the most societally important applications of climatic information, for example, water resources, renewable energy, and agriculture. This chapter also discusses the increasingly important role that climate forecasts have and refers to the predictability associated with a number of the circulation modes detailed in Chapter 6. This is a good example of how well tied together this textbook is.

In summary, this is a well-structured, lucidly written, and very well-illustrated climatology textbook. It is comprehensive, touching upon all of the fundamental elements of climate and drawing on climatic information from the earliest times to contemporary times. Its spatial approach to describing climate allows the student to appreciate the climate in which she/he lives and, simultaneously, where it fits into the global climate. The authors have made difficult subject matter at once interesting and informative. This is a book that the student new to climatology will appreciate and the teacher of climatology will welcome as an extremely useful resource.

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