

## **Microclimate and Local Climate.**

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## Book Reviews

MICROCLIMATE AND LOCAL CLIMATE. Roger G. Barry and Peter D. Blanken. New York: Cambridge University Press, 2016. 316 pp. \$84.99 (hardcover). ISBN: 978-110714-5-627.

MICROCLIMATE AND LOCAL CLIMATE represents a unique approach to the study of climate at its most fundamental level: it considers the physical processes of radiation and energy, moisture, and momentum exchanges at and near Earth's surface to be common to—and to interact across—both the microscale (“centimeters to meters”) and the local, or topographic, scale (from ~10 m to 1 km). The spatial-scale context is fundamentally geographic, as befits the academic heritage of the authors, and Earth's physical and living environments are treated as a closely coupled system throughout the book. The subject matter draws upon concepts not just from physical geography and climatology, but also from a wide range of cognate disciplines: meteorology, biology and ecology, hydrology, environmental physics, biogeochemistry, soil science, and statistics. Moreover, this book has direct application and relevance to those same disciplines and to others, such as agriculture, forestry, landscape architecture and urban design, environmental history, and, I would argue, even the history and philosophy of science. The authors synthesize a large number of published studies, both recent and historical (i.e., pre-2000!), to comprehensively provide detail on the physical processes of micro- and local-scale climates, the associated spatial patterns, the implications for humans, and recent and anticipated future changes.

The book comprises three parts (Controls of Microclimate, Local Climates, and Environmental Change), with chapters and sub-chapters organized logically within each part. At the outset (Preface, Introduction) the authors make clear the time and space-scale distinctions between microclimates and local/topo-climates, and also the features uni-

fying them. One can identify at least the following prominent themes running through the book: (1) radiation, energy and heat budgets; (2) boundary layers (e.g., between atmosphere and Earth's surface, an organism and the air around it); (3) mass (e.g., water) and energy exchanges; (4) the “active surface” (e.g., a soil surface, vegetation canopy, roofs of buildings) at which radiation, energy, and moisture exchanges occur; (5) feedbacks (physical, chemical, biological); (6) environmental gradients, fluxes, and storage; (7) Ohm's Law as a useful analogy for environmental flows; (8) cross-spatial scale interactions; (9) upscaling vs. downscaling; (10) urban climates; (11) the dependence on Earth surface cover types, including snow, ice and water; and (12) the importance of global environmental changes, both anthropogenic and natural.

Although the presentation and discussion of meteorological processes are central to the book's subject matter, the main emphasis and applications are climatological. Biological processes are separated according to vegetation—discussed across a number of chapters—and “insects, reptiles, and mammals,” which warrant their own chapter (9, Bioclimatology). The book considers the theory and the applications of micro- and local-scale climate processes using in situ data and also remotely sensed observations. There is an entire chapter devoted to instrumentation and measurement techniques. Modeling, both to clarify underlying physical mechanisms and to compare with observations, includes statistical, physical/dynamical, and hybrid (empirical-physical) approaches. The modeling topic comprises much of Chapter 6, although it is also represented in other chapters and chapter sections. Urban micro- and local- to regional-scale climates are considered in three chapters (8E, 10, 11C) and involve not just the urban heat island effect but also gases, aerosols, energy and moisture budgets, and modeling of urban surface heterogeneity.

An additional strength of the book is the “Box” format—essentially sidebars—where important background or pertinent related concepts are explained in detail (e.g., “The Global Hydrologic Cycle,” and “Determining the Average Wind Speed and Direction Using Vectors”), which avoids disrupting the flow of the main discussion. Color photographs and

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maps, line drawings, and graphs are clear and uncluttered, always germane to the discussion at hand, and fully explained by their captions. Much use is also made of tables, which are highly relevant and clear in the message they are intended to convey. Where detailed information on a topic is to be given later in the book or was provided earlier, those chapters and sub-sections are often mentioned in the text. Immediately following the last chapter there is a “Problems” section organized by chapter. These questions are of the written and numerical kinds, with answers available at the Cambridge University Press website. A comprehensive glossary, list of symbols, and an index complete the book.

The authors’ intended audience is upper-level undergraduate and beginning graduate-level students, although even seasoned scientists and established academics will find this book an essential reference work. Accordingly, the book assumes at least some basic knowledge of environmental science and/or physical geography. Such a reader would already have the necessary understanding of, for example, atmospheric lapse rates and what makes air stable, unstable, and neutral. Moreover, such a reader would likely not be confused that the symbol  $\lambda$  can denote both radiation wavelength (p. 82, Symbols section) and the latent heat of vaporization (e.g., p. 99, Symbols section). Formulae are given and equations worked through that are mostly pre-calculus. Although there are a few partial differentials presented (e.g., measuring turbulent fluxes, p. 73), it is pointed out that finite differences are practical for most applications.

Given the book’s structure, and the fact that microclimates and local climates are treated in successive parts and then together in the context of global change, there is inevitably some repetition of concepts and definitions. However, such repetition should be helpful both to those readers who will use the book primarily as a reference work, and to those who will read it from beginning to end and may need a reminder. I found relatively few typographical errors, none of which affects the intended meaning. Note that the term  $S_{we}$  (“snow water content”) on pp. 138–139 means the same as the SWE (snow water equivalent) on pp. 36–37 and elsewhere (e.g., p. 199). Also note that, in keeping with the original literature, the symbol for albedo, or reflection coefficient  $\alpha$ , is also the exponent in the wind profile power law relationship, the shape parameter of the gamma distribution, and the Priestley–Taylor value. Just a few times in the book is the definition of a concept or principle given

sometime after its first mention (sensible heat, eddy covariance method, albedo).

MICROCLIMATE AND LOCAL CLIMATE is so all-encompassing—almost encyclopedic—that I was hard-pressed to find any related topics or issues that were omitted! I came up with only two possibilities, and both of these would be small extensions of points already covered in the book. One involves the role of horizontal gradients between land use/land cover in generating local-scale contrasts of sensible heat and Bowen ratio, which may result in cloud and precipitation gradients across those boundaries. The logical place for such additional discussion is toward the end of Part II, where Mosaic Landscapes are presented. My other suggestion would have been for a little discussion of the role of synoptic circulation types in micro- and local-scale surface energy budget differences, as an extension to the role of wind direction. However, both these suggestions are minor in the bigger picture; they in no way detract from the overwhelming strengths of this unique book, as described above, and its comprehensive treatment of the smaller-scale physical processes linking an active surface and sub-surface with its boundary layer(s) on climatic timescales. In short, this book is an outstanding, essential addition to the personal library of every student of climate and environmental science writ large!

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