

Essentials of the Earth's Climate System

This concise, full-color introduction to modern climatology covers all the key topics of climate science for undergraduate/graduate students on one-semester courses. The book progresses from climate processes to world climate types, past climate change and projected future climates, ending with climate applications. The treatment of topics is non-mathematical wherever possible, allowing students to understand the physical processes more easily.

- Clear, full-color illustrations support the topics introduced in the text.
- Boxes are used to provide supplementary topics, enabling students to increase their knowledge and awareness.
- Each chapter concludes with a summary of the main points and a mixture of review and discussion questions that encourage students to check their understanding and think critically.

Roger G. Barry was born in Sheffield, England and worked for two years in the British Meteorological Office before attending Liverpool University, where he received a BA Honors in Geography. He received an MSc in Climatology from McGill University, Montreal, and a PhD from the University of Southampton in 1965. In October 1968 he moved to the University of Colorado, Boulder to become Associate Professor of Geography, Professor (1971–2004), and Distinguished Professor (2004–2010). In 1977 he became the Director of the World Data Center for Glaciology, which in 1980 merged into the National Snow and Ice Data Center (NSIDC). Roger's teaching and research has spanned climate change, Arctic and mountain climates, synoptic climatology, and snow and ice processes. Roger has published 25 textbooks, including: *Atmosphere, Weather and Climate* (with R. J. Chorley, tenth edition, 2010); *Mountain Weather and Climate* (third edition, 2008, Cambridge University Press); *Synoptic and Dynamic Climatology* (with A. M. Carleton, 2011, Routledge); *The Arctic Climate System* (with M. C. Serreze, 2005, Cambridge University Press); *The Global Cryosphere: Past, Present and Future* (with T. Y. Gan, 2011, Cambridge University Press). He has also published more than 250 research articles, and supervised 65 graduate students. Roger has been a Guggenheim Fellow, a Fulbright Teaching Fellow at Moscow State University, and a Visiting Professor in Australia, France, Germany, Japan, New Zealand, Switzerland, and the United Kingdom. His honors include: Fellow, American Geophysical Union; Foreign Member of the Russian Academy of Environmental Science (RAEN) Founder's Medal, Royal Geographical Society; Humboldt Prize Fellow. He is currently Director of the International CLIVAR Project Office at the National Oceanography Centre, Southampton, UK.

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“Absolutely the ultimate word on the physical, synoptic, and geographic underpinnings of modern climatology and its historic antecedents. This delightful and readable textbook covers all the topics – and then some – likely to comprise an introductory or intermediate-level college course . . . Discussions of the forcing, form, and function of the climate system – on scales ranging from local to global – will be essential reading for university undergraduate and graduate students alike, and a helpful review for seasoned researchers in the climate and atmospheric sciences. The easy-on-the-eye text style is complemented by the many incisive color figures, maps, and graphs, most of which are based on the latest analyses from satellites and global re-analysis data. Beginning and end-of-chapter overviews and summaries highlight the most important concepts and features of climatology study, while the glossary and bibliography are both comprehensive and fully up to date. *Essentials of the Earth's Climate System* is the essential text on climatology, and is destined to become a classic.”

Andrew M. Carleton, *Pennsylvania State University*

“This textbook is a very comprehensive and informative resource for teaching and for general reference. Its layout and organization are efficient and effective, allowing a wide range of material to be covered in a surprising level of detail . . . This book has an important place in the classroom and on any Earth scientist's bookshelf.”

David A. Pepper, *California State University, Long Beach*

“This textbook provides a comprehensive and well-illustrated overview of the climate system by experts with a wealth of experience in climate science.”

Raymond S. Bradley, *University of Massachusetts*

“I can recommend this text, particularly for students studying an introduction to climate science at undergraduate level. The text is accessible and any mathematical treatment is clearly explained and at an introductory level. I am particularly impressed by the scope of material, with chapters on past climates, future climate modeling, and applied climatology, a welcome addition to the usual material on atmospheric systems and local/regional climates. It is also great to see case studies illustrated with examples from all over the world. This book will be a comprehensive resource for all those teaching climate science at an introductory level.”

Nicholas Pepin, *University of Portsmouth*

“ . . . an excellent introduction to climate science, enabling coverage of the main issues in one semester and an inspiration for more in-depth studies. It is simple enough to be understood by geography and environmental science undergraduates without previous knowledge of climatology, but not oversimplified. It skillfully mixes complex concepts with observational data engaging the reader and making the challenging understandable and the seemingly tedious exciting . . . An immense advantage of this textbook is that its first part provides excellent explanations of the very basics of climate science . . . The authors manage to lay the foundations for more advanced studies and engage readers through the use of diverse examples from various parts of the world . . . The authors skillfully intermingle observational data with explanations of complex processes and concepts in an engaging and easy-to-follow manner . . . Overall, I highly recommend this book for undergraduate courses, and every university library should have a copy.”

Maria Shahgedanova, *University of Reading*

“Drawing on more than 50 years of combined experience in climate study, Barry and Hall-McKim give the reader a compact, non-mathematical overview of the fundamental processes of the Earth's climate system. The book is surprisingly comprehensive, given its relatively brief length: coverage ranges from global to the local, from short-term phenomena to long-term climatic change. Complex topics are explained in straightforward, non-complex language, which in turn is supported by excellent color illustrations, and numerous place-specific examples are skillfully employed to illustrate general processes and concepts. *Essentials of the Earth's Climate System* is an ideal introduction to the topic for an upper-level undergraduate course in climate. It is likely to become the standard textbook in its field.”

Thomas Krabacher, *California State University, Sacramento*

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Eileen A. Hall-McKim
UNIVERSITY OF COLORADO AT BOULDER



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Preface

This textbook seeks to provide a modern global overview of the world's climates on all space and time scales. It addresses microclimates to global scale processes and phenomena. It spans climate changes over geologic time and the future climates of the late twenty-first century. It is designed to serve as an introductory course in climatology, suitable for students in environmental sciences, geography, meteorology, and related disciplines. The purpose of the book is first to provide a firm foundation of the physical principles that underpin climatology; second, to describe the spatial climatic characteristics over the globe including local and microclimatic scales; third, to detail the past and projected future climates of the Earth; and fourth, to introduce some applications of climatic information.

The book is organized into 11 parts following a brief introduction on definitions, statistics, and the history of climatology. These are: a global view of the major climatic elements of energy and moisture followed by pressure, wind and storms, local and microclimates, the general circulation, circulation modes, synoptic climatology, the regional effects of land and sea, climatic types on land, past climates, future climate and its impacts, and different examples of applied climatology. Chapters 2, 3, 5, 6, and 7 are more meteorological in content. Chapters 8 and 9 provide detailed accounts of oceanic and land climates.

My meteorological experience began in the early 1950s, when I worked as a scientific assistant in the British Meteorological Office for two years at Royal Air Force (RAF) station Worksop in Nottinghamshire and then, following an undergraduate degree at the University of Liverpool, in 1957–1958 I was a graduate student weather observer at the McGill Subarctic Research Station at Schefferville in northern Quebec-Labrador.

I have carried out meteorological fieldwork in the Canadian Arctic, Papua New Guinea, the Colorado Rocky Mountains, and the Venezuelan Andes. Among the climatologists featured in text boxes, I have personally known Hubert Lamb, Jerry Namias, Murray Mitchell, Herman Flohn, and Herbert Riehl.

The text builds on over 50 years' experience in teaching climatology to geography students at the University of Southampton, UK (1960–1968) and the University of Colorado, Boulder, Colorado, USA (1968–2010).

PREFACE

This textbook contains many **pedagogical features**:

- The treatment is non-mathematical, but physical processes are explained. Where simple equations are introduced, their meaning is fully explained.
- Clear illustrations in full colour support the topics introduced in the text.
- Two types of boxes are used: 'A' boxes for elaborations of points made in the text; and 'B' boxes for wider topics that can be used by teachers and students to expand their information and awareness.
- The main points of each chapter are recapped in a summary section at the end of chapters.
- A mixture of review and discussion questions encourage students to check their understanding and think critically.
- Students are further supported by a glossary, a list of useful websites, and an appendix on units.

The book is supported by a number of **online resources**, to be found at www.cambridge.org/climatesystem:

- Web links to data and other key resources.
- Solutions and hints to answers to the student questions (password-protected for access by course instructors).
- PowerPoint slides and JPEGs of all the figures in the book for the use of course instructors.

Roger G. Barry

Distinguished Professor of Geography Emeritus
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