

PRINCETON PRIMERS IN CLIMATE

PRINCETON PRIMERS IN CLIMATE is a new series of short, authoritative books that explain the state of the art in climate-science research. Written specifically for students, researchers, and scientifically minded general readers looking for succinct and readable books on this frequently misunderstood subject, these primers reveal the physical workings of the global climate system with unmatched accessibility and detail. Princeton Primers in Climate is the ideal first place to turn to get the essential facts, presented with uncompromising clarity, and to begin further investigation—whether in the classroom or in one's own reading chair.

Michael L. Bender is professor of geosciences and atmospheric/ocean sciences at Princeton University, a fellow of the American Geophysical Union, and a member of the National Academy of Sciences. He has taught paleoclimate at the graduate and undergraduate levels, and published widely on the topic in *Science*, *Nature*, and other journals.

"Michael Bender, a giant in the field, fits the excitement, rigor, and deep insights of paleoclimatology into a succinct text suitable for a semester-long course introducing this indispensable branch of environmental science."

—RICHARD B. ALLEY

PENNSYLVANIA STATE UNIVERSITY

Earth's climate has undergone dramatic changes over the geologic timescale. At one extreme, Earth has been glaciated from the poles to the equator for periods that may have lasted millions of years. At another, temperatures were once so warm that the Canadian Arctic was heavily forested and large dinosaurs lived on Antarctica. Paleoclimatology is the study of such changes and their causes. Studying Earth's long-term climate history gives scientists vital clues about anthropogenic global warming and how climate is affected by human endeavor.

In this book, Michael Bender, an internationally recognized authority on paleoclimate, provides a concise, comprehensive, and sophisticated introduction to the subject. After briefly describing the major periods in Earth history to provide geologic context, he discusses controls on climate and how the record of past climate is determined. The heart of the book then proceeds chronologically, introducing the history of climate changes over millions of years—its patterns and major transitions, and why average global temperature has varied so much. The book ends with a discussion of the Holocene (the past 10,000 years) and by putting manmade climate change in the context of paleoclimate.

The most up-to-date overview on the subject, *Paleoclimate* provides an ideal introduction to undergraduates, nonspecialist scientists, and general readers with a scientific background.

"Paleoclimatology has been missing a concise, modern, overview textbook, and I think this book will fill that niche. There is much ground to cover and the text does a good job of bringing the reader up to speed on most of the important patterns and processes in Earth's climatic history. The book combines excellent coverage of basic physical and chemical aspects of the climate system with a long-term historical overview of the climate system in action."

—MATTHEW HUBER

PURDUE UNIVERSITY



PRINCETON
press.princeton.edu

EARTH SCIENCE | CLIMATE SCIENCE

ISBN-13: 978-0-691-14555-6



9 780691 145556

<i>List of Boxes</i>	vi
<i>Preface</i>	vii
<i>Acknowledgments</i>	xiii

1	Earth's Climate System	1
2	The Faint Young Sun	24
3	Precambrian Glaciations	38
4	Regulation of the Earth System and Global Temperature	54
5	The Late Paleozoic Ice Ages	73
6	Equable Climates of the Mesozoic and Paleogene	97
7	The Paleocene-Eocene Thermal Maximum	125
8	The Long Cooling of the Cenozoic	144
9	The Origin of Northern Hemisphere Glaciation and the Pleistocene Ice Ages	172
10	Rapid Climate Change during the Last Glacial Period	235
11	The Holocene	264
12	Anthropogenic Global Warming in the Context of Paleoclimate	287
	<i>Glossary</i>	295
	<i>Index</i>	303