

PREFACE

Welcome to *Climate Studies*! You are about to embark on an exciting study of climate science. The purpose of this book is to provide you with background information on Earth's climate system, the scientific principles that govern climate, climate variability and climate change with the implications for society. Also covered are risk management strategies aimed at countering negative impacts of global climate change. *Climate Studies* was developed by the Education Program of the American Meteorological Society (AMS) with support and assistance provided by the National Aeronautics and Space Administration (NASA).

Climate Studies is closely aligned with the essential principles of climate science identified in a recent climate literacy initiative by the National Oceanic and Atmospheric Administration (NOAA) and the American Association for the Advancement of Science (AAAS). The ultimate goal is to promote climate science literacy at all levels of formal and informal education where climate science literacy is defined as “an understanding of the climate’s influence on you and society and your influence on climate.” The NOAA/AAAS initiative emphasizes that climate science literacy is part of science literacy. That is, “each essential principle is supported by fundamental concepts comparable to those underlying the National Science Education Standards and the AAAS Benchmarks for Science Literacy.”

Climate Studies is guided by new findings of learning science that redefine what it means to be proficient in science. According to the National Research Council of the National Academies, Board on Science Education (2007), students who are proficient in science “(1) know, use, and interpret scientific explanations of the natural world, (2) generate and evaluate scientific evidence and explanations, (3) understand the nature and development of scientific knowledge, and (4) participate productively in scientific practices and discourse.” These strands of proficiency are learning goals in *Climate Studies* that address the knowledge and reasoning skills essential for students to be proficient in climate science and participate as climate science literate citizens.

Climate Studies may serve as a stand-alone textbook in an undergraduate college course on climatology, climate change, weather and climate, or

atmospheric science. No prior course work in meteorology or atmospheric science is assumed. *Climate Studies* also serves as the reference book for *AMS Climate Studies*, a turnkey course package developed, licensed, and nationally implemented by AMS. Each of the first 12 chapters corresponds to one week of the *AMS Climate Studies* course. A companion *Investigations Manual* plus course website provide students with twice-weekly investigations on climate science partially delivered via the Internet. The course can be offered in face-to-face, blended, and totally online instructional environments.

The course package, *AMS Climate Studies*, follows learning science in providing strategically designed “student encounters with science that take place in real time and over a period of months and years (e.g., *learning progressions*).” *AMS Climate Studies* seeks to engage learners in exploring their world by investigating meaningful questions. Investigations have printed and electronic components that make use of climate information/data available via the course website. Investigations engage participants in observation, prediction, data analysis, inference, and critical thinking. Application of information-age technology enables participants to develop their ability to retrieve and analyze real-world data and share interpretations. Throughout the course, participants assemble learning materials for assessment purposes.

This book consists of 15 chapters. Chapters are organized so that concepts build logically one upon the other so that the components of Earth's climate system emerge as highly interactive and subject to fundamental laws. Topics covered include the components of Earth's climate system (Chapter 1), observing and modeling Earth's climate system (Chapter 2), Earth's radiation budget and the greenhouse effect (Chapter 3), heat transfer mechanisms and controls of temperature (Chapter 4), humidity, clouds, and precipitation (Chapter 5), how the planetary-scale circulation influences climate (Chapter 6), synoptic and regional climatology (Chapter 7), atmosphere-ocean interactions and climate (Chapter 8), reconstructing the climate past (Chapter 9), trends in the instrument-based climate record and the climatology of severe weather systems (Chapter 10), natural agents and mechanisms responsible for climate change (Chapter 11),

and the influence of human activity on climate change (Chapter 12). The final three chapters cover climate classification systems (Chapter 13), climate change mitigation, adaptation, and geoengineering (Chapter 14), and international and national aspects of public policy directed at reducing anthropogenic emissions of heat-trapping gases (Chapter 15). Accompanying all chapters are investigations in the separate *Investigations Manual*.

Each chapter opens with a *Case-in-Point*, an authentic, relevant, and real-life event or issue that highlights or applies one or more of the main concepts or principles covered in the chapter. In essence, the Case-in-Point previews the chapter and is intended to engage reader interest early on. For example, Chapter 4 opens with a summary of the reasons why Death Valley, CA, has the hottest and driest climate of any place in North America. The Case-in-Point is followed by a sample *Driving Question*, a broad-based query that links chapter concepts and provides a central focus for that chapter's topics. Chapter content is science-rich and informs additional driving questions. Each chapter closes with a list of *Basic Understandings* and *Enduring Ideas*, as well as questions for *Review* and *Critical Thinking*. Two *Essays* at the end of each chapter address in some depth specific topics that complement or supplement a concept covered in the chapter narrative. Examples include *Asteroids, Climate Change, and Mass Extinctions*, *Contrails and Climate Change*, *Cloud Forests and Climate Change*, *Permafrost and Climate Change*, and *The Extreme Climate of Mount Washington, NH*. All terms bold-faced in the narrative are defined in the *Glossary* at the back of the book. Appendixes cover unit conversions and milestones in the history of climate science.

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Climate Studies was a team effort involving atmospheric scientists, climate specialists, and educators at all levels from K-12 through college. The principal author of the textbook is Joseph M. Moran, Associate Director

of the American Meteorological Society's Education Program and Professor Emeritus of Earth Science at the University of Wisconsin-Green Bay. Much of the initial design of the course scope and sequence was inspired by the insightful comments and suggestions of Kathleen V. Schreiber, Millersville University, and Samantha W. Kaplan, the University of Wisconsin-Stevens Point. We also acknowledge with much thanks the active encouragement and interest of Frank Niepold of NOAA's Climate Program Office.

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A special note concerns the use of units in *Climate Studies*. Generally, the International System of Units (abbreviated SI, for *Système International d'Unités*) is employed with equivalent English or other units following in parentheses. Exceptions are units used by convention or convenience in the atmospheric sciences or the user community (e.g., knots, calories, millibars). Also, the equivalence between units is given in context; that is, where general estimates are used, approximate values are shown in all units. Conversion factors are given in Appendix I. Note also that dates adhere to the system whereby BCE is Before the Common Era and CE is the Common Era.

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