PREFACE

Welcome to *Weather Studies*! You are about to embark on an exciting study of the science of the atmosphere. The purpose of this book is to provide you with background information on the properties of the atmosphere, the scientific principles that govern weather and climate, interactions between the atmosphere and the other components of the Earth system, and the implications of those interactions for humankind. *Weather Studies* was developed by the Education Program of the American Meteorological Society (AMS) with support from the National Science Foundation (NSF) and the National Oceanic and Atmospheric Administration (NOAA).

Weather Studies may serve as a stand alone textbook in a traditional undergraduate college course on the atmosphere, meteorology, or weather and climate. *Weather Studies* also serves as the reference book for *AMS Weather Studies*, a turnkey course package developed, licensed, and nationally implemented by AMS. A companion Investigations Manual plus website provide students with twice-weekly investigations on weather partially delivered via the Internet. The course can be offered in face-to-face, blended, and totally online instructional environments.

Weather Studies introduces the reader to scientific inquiry and the scientific method. Atmospheric science is particularly suited to these aims because it is an applied science that readily lends itself to familiar everyday illustrations. The inquiry-based approach is designed to promote the development of critical thinking skills. The emphasis on scientific methodology provides a perspective on the accomplishments of atmospheric scientists and the challenges still facing them. Early on the reader realizes that weather is not an arbitrary act of nature, weather forecasting has its limits, and the climate future is uncertain. Integrated throughout the book are topics of contemporary interest including, for example, threats to the stratospheric ozone shield, global climate change, and severe weather.

This book consists of 15 chapters. Each of the first 12 chapters corresponds to one week of the *AMS Weather Studies* course. Chapters are organized so that concepts build logically one upon the other so that Earth's atmosphere emerges as an interactive system subject to physical laws. Investigations are tied directly to each chapter. Topics covered include sources of weather information (Chapter 1), composition and structure of the atmosphere (Chapter 2), the planet's radiation budget and controls of temperature (Chapters 3 and 4), air pressure (Chapter 5), humidity, clouds and precipitation (Chapter 6 and 7), forces governing atmospheric circulation (Chapter 8), planetary-scale circulation (Chapter 9), weather systems of middle latitudes (Chapter 10), thunderstorms and tornadoes (Chapter 11), and tropical storms and hurricanes (Chapter 12). The final three chapters cover weather analysis and forecasting (Chapter 13), atmospheric optics and acoustics (Chapter 14), and climate and climate change (Chapter 15). All chapters have accompanying investigations in the optional *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 covered in the chapter. In essence, the Case-in-Point previews the chapter and is intended to engage reader interest early on. Chapter 12 (Tropical Weather Systems), for example, opens with a discussion of Hurricanes Katrina (2005) and Gustav (2008) and their impact on the Gulf Coast. 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 week's study. 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*. One or more *Essays* at the end of each chapter address in some depth specific topics that complement or supplement a concept covered in the narrative. Examples include *The Atmosphere of Mars*, *The Global Positioning System*, *Wind Power*, and *Space Weather Prediction*. All terms bold-faced in the narrative are defined in the *Glossary* at the back of the book. Appendixes cover unit conversions, milestones in the history of atmospheric science, and climate classification.

In this fourth edition, we have updated the science and case studies, included more Essays, and added many new photographs and line drawings. New, expanded or significantly revised topics include Space Weather Prediction (Chapters 2 and 13), Global Climate Change (Chapters 3 and 15), Weather Radar (Chapter 7), Wind Power (Chapter 8), El Niño, La Niña, and the Southern Oscillation (Chapter 9), Ocean Surface Currents (Chapter

9), Local and Regional Circulation Systems (Chapter 10), Tornado Hazards and the EF-Scale (Chapter 11), Long Range Forecasting of Atlantic Hurricanes (Chapter 12), and Weather Prediction (Chapter 13).

The course package, *AMS Weather Studies*, is pedagogically guided by a teaching approach (project-based science) that seeks to engage learners in exploring their world by investigating meaningful questions. *Weather Studies* offers one driving question per chapter but each chapter plus investigations inspire and explore many other driving questions. Each investigation has printed and electronic components that make use of weather and climate data available via the course website. Investigations engage participants in observation, prediction, data analysis, inference, and critical thinking (processes of science). The course presents opportunities for collaboration among participants as together they negotiate understanding. Application of information-age technology helps participants to develop their ability to retrieve and analyze real-world data and share interpretations. Throughout the course, participants assemble learning materials (artifacts) for assessment purposes.

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Weather Studies is the product of collaboration among many individuals having considerable teaching experience in the atmospheric sciences. This book is primarily the work of 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. Elizabeth W. Mills of the AMS Education Program served as technical editor throughout this revision.

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A special note concerns the use of units in *Weather Studies*. Generally the International System of Units (abbreviated SI, for Systéme Internationale d'Unitès) is employed with equivalent English or other units following in parentheses. Exceptions are units used by convention or convenience in meteorology 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.

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