

Front cover photograph: Apollo 17 view of Earth courtesy of the National Aeronautics and Space Administration. The view extends from the Mediterranean Sea at the top to the Antarctic ice cap at the bottom. The coastline of Africa, the Arabian Peninsula, and the island of Madagascar are clearly visible, and the Asian mainland is on the horizon toward the northeast. Note the bright clouds over equatorial Africa, with a band of dark vegetated land just to the north of it in the Sahel region, and to the north of the dark band the much brighter surfaces of the Sahara Desert. Cover design assistance was provided by K. M. Dewar and G. C. Gudmundson, Department of Atmospheric Sciences, University of Washington.

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Preface

The science of climatology began to evolve rapidly in the last third of the twentieth century. This rapid development arose from several causes. During this period, the view of Earth from its moon made people more aware of the exceptional view of their planetary home at about the same time that it became widely understood that humans could alter our global environment. Scientific and technological advances gave us new and quantitative information on past climate variations through observations of climate parameters from space, and computer models with which we could simulate the global climate system. These new tools together with advances in our understanding of global environmental change and its consequences for humanity caused a great increase in the intensity of scientific research about climate.

Modern study of the Earth's climate system has become an interdisciplinary science incorporating the atmosphere, the ocean, and the land surface, which together through physical, chemical, and biological processes. A fully general treatment of this system is as yet impossible, because the understanding of it is just beginning to develop. This textbook provides an introduction to the physical interactions of the climate system, viewed from a global perspective. Even this endeavor is a great one, since many earth science subdisciplines must be incorporated, such as meteorology, physical oceanography, radiative transfer, glaciology, and boundary-layer meteorology, and paleoclimatology. To make a book of this size about such a complex topic requires many difficult choices. I have endeavored to provide a sense of the complexity and interconnectedness of the climate system without going into excessive detail in any one area. Although the modern treatment of climatology has arisen out of diverse disciplines, a coherent collection of chapters is emerging that defines a starting point for a distinct science. This textbook attempts to present the physical elements of that beginning, with occasional forays into where the chemical and biological elements are connected.

This book is intended as a text for upper-division undergraduate physics majors and, especially in the later chapters, graduate students. I have used seven chapters as the basis for a 10-week undergraduate course in atmospheric sciences majors. A graduate course can be fashioned by supplementing the text with readings from the current literature. Most climatology textbooks are descriptive and written from the perspective of geographers, but this one