

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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Contents

Preface

Chapter 1 Introduction to the Climate System

1.1 Atmosphere, Ocean, and Land Surface	
1.2 Atmospheric Temperature	
1.3 Atmospheric Composition	
1.4 Hydrostatic Balance	
1.5 Atmospheric Humidity	
1.6 The World Ocean	
1.7 The Cryosphere	
1.8 The Land Surface	
Exercises	

Chapter 2 The Global Energy Balance

2.1 Warmth and Energy	
2.2 The Solar System	
2.3 Energy Balance of Earth	
2.4 Emission Temperature of a Planet	
2.5 Greenhouse Effect	
2.6 Global Radiative Flux Energy Balance	
2.7 Distribution of Insolation	
2.8 The Energy Balance at the Top of the Atmosphere	
2.9 Poleward Energy Flux	
Exercises	

Chapter 3 Atmospheric Radiative Transfer and Climate

3.1 Photons and Minority Constituents	
3.2 The Nature of Electromagnetic Radiation	
3.3 Description of Radiative Energy	
3.4 Planck's Law of Blackbody Emission	
3.5 Selective Absorption and Emission by Atmospheric Gases	
3.6 The Lambert–Bouguer–Beer Law: Formulation of Flux Absorption	
3.7 Infrared Radiative Transfer Equation: Absorption and Emission	

3.8	Heuristic Model of Radiative Equilibrium	61
3.9	Clouds and Radiation	63
3.10	Radiative-Convective Equilibrium Temperature Profiles	66
3.11	A Simple Model for the Net Radiative Effect of Cloudiness	72
3.12	Observed Role of Clouds in the Energy Balance of Earth	75
	Exercises	79

Chapter 4 The Energy Balance of the Surface

4.1	Contact Point	81
4.2	The Surface Energy Budget	81
4.3	Storage of Heat in the Surface	83
4.4	Radiative Heating of the Surface	87
4.5	The Atmospheric Boundary Layer	92
4.6	Sensible and Latent Heat Fluxes in the Boundary Layer	99
4.7	Variation of Energy Balance Components with Latitude	103
4.8	Diurnal Variation of the Surface Energy Balance	106
4.9	Seasonal Variation of the Energy Balance of Land Areas	109
4.10	Surface Energy Flux Components over the Oceans	111
	Exercises	114

Chapter 5 The Hydrologic Cycle

5.1	Water, Essential to Climate and Life	115
5.2	The Water Balance	117
5.3	Surface Water Storage and Runoff	120
5.4	Precipitation and Dewfall	121
5.5	Evaporation and Transpiration	122
5.6	Modeling the Land Surface Water Balance	127
5.7	Annual Variation of the Terrestrial Water Balance	130
	Exercises	134

Chapter 6 Atmospheric General Circulation and Climate

6.1	The Great Communicator	136
6.2	Energy Balance of the Atmosphere	136
6.3	Atmospheric Motions and the Meridional Transport of Energy	138
6.4	The Angular-Momentum Balance	150
6.5	Large-Scale Circulation Patterns and Climate	155
	Exercises	169

Chapter 7 The Ocean General Circulation and Climate

7.1	Cauldron of Climate	171
7.2	Properties of Seawater	172
7.3	The Mixed Layer	176
7.4	The Wind-Driven Circulation	180

7.5	Theories for Wind-Driven Circulations	
7.6	The Deep Thermohaline Circulation	
7.7	Transport of Energy in the Ocean	
7.8	Mechanisms of Transport in the Ocean	
	Exercises	

Chapter 8 History and Evolution of Earth's Climate

8.1	Past Is Prologue	
8.2	The Instrumental Record	
8.3	The Historical Record	
8.4	Natural Recording Systems: The Paleoclimatic Record	
8.5	A Brief Survey of Earth's Climate History	
8.6	Uses of Paleoclimatic Data	
	Exercises	

Chapter 9 Climate Sensitivity and Feedback Mechanisms

9.1	Fools' Experiments	
9.2	Objective Measures of Climate Sensitivity and Feedback	
9.3	Basic Radiative Feedback Processes	
9.4	Ice Albedo Feedback	
9.5	Dynamical Feedbacks and Meridional Energy Transport	
9.6	Longwave and Evaporation Feedbacks in the Surface Energy Balance	
9.7	Cloud Feedback	
9.8	Biogeochemical Feedbacks	
	Exercises	

Chapter 10 Global Climate Models

10.1	Mathematical Modeling	
10.2	Historical Development of Climate Models	
10.3	The Atmospheric Component	
10.4	The Land Component	
10.5	The Ocean Component	
10.6	Validation of Climate Model Simulations	
10.7	Sensitivity Estimates from Climate Models with Mixed-Layer Oceans	
10.8	Coupled Atmosphere-Ocean Processes and the Thermohaline Circulation	
	Exercises	

Chapter 11 Natural Climate Change

11.1	Natural Forcing of Climate Change	
11.2	Solar Luminosity Variations	
11.3	Natural Aerosols and Climate	
11.4	Volcanic Eruptions and Stratospheric Aerosols	
11.5	The Orbital Parameter Theory of Ice Ages	

11.6 Modeling of Ice Age Climates	312
Exercises	317

Chapter 12 Anthropogenic Climate Change

12.1 The Wings of Daedalus	319
12.2 Humans and the Greenhouse Effect	319
12.3 Anthropogenic Aerosols and Atmospheric Sulfur	327
12.4 Changing Surface Conditions	330
12.5 Equilibrium Climate Changes	330
12.6 Time-Dependent Climate Changes	337
12.7 Comparison with Observed Temperature Trends	340
12.8 Sea Level Changes	342
12.9 Outlook for the Future	344
Exercises	344

Appendix A: Calculation of Insolation under Current Conditions	347
Appendix B: The Clausius–Clapeyron Relation	350
Appendix C: The First Law of Thermodynamics, Lapse Rate and Potential Temperature	352
Appendix D: Derivation of Simple Radiative Flux Equations	356
Appendix E: Symbol Definitions	360
Appendix F: Système Internationale (SI) Units	369
Appendix G: Useful Numerical Values	373
Appendix H: Answers to Selected Exercises	375
Glossary	377
References	387
Index	399
International Geophysics Series	409

Preface

The science of climatology began to evolve rapidly in the last third of the 20th 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